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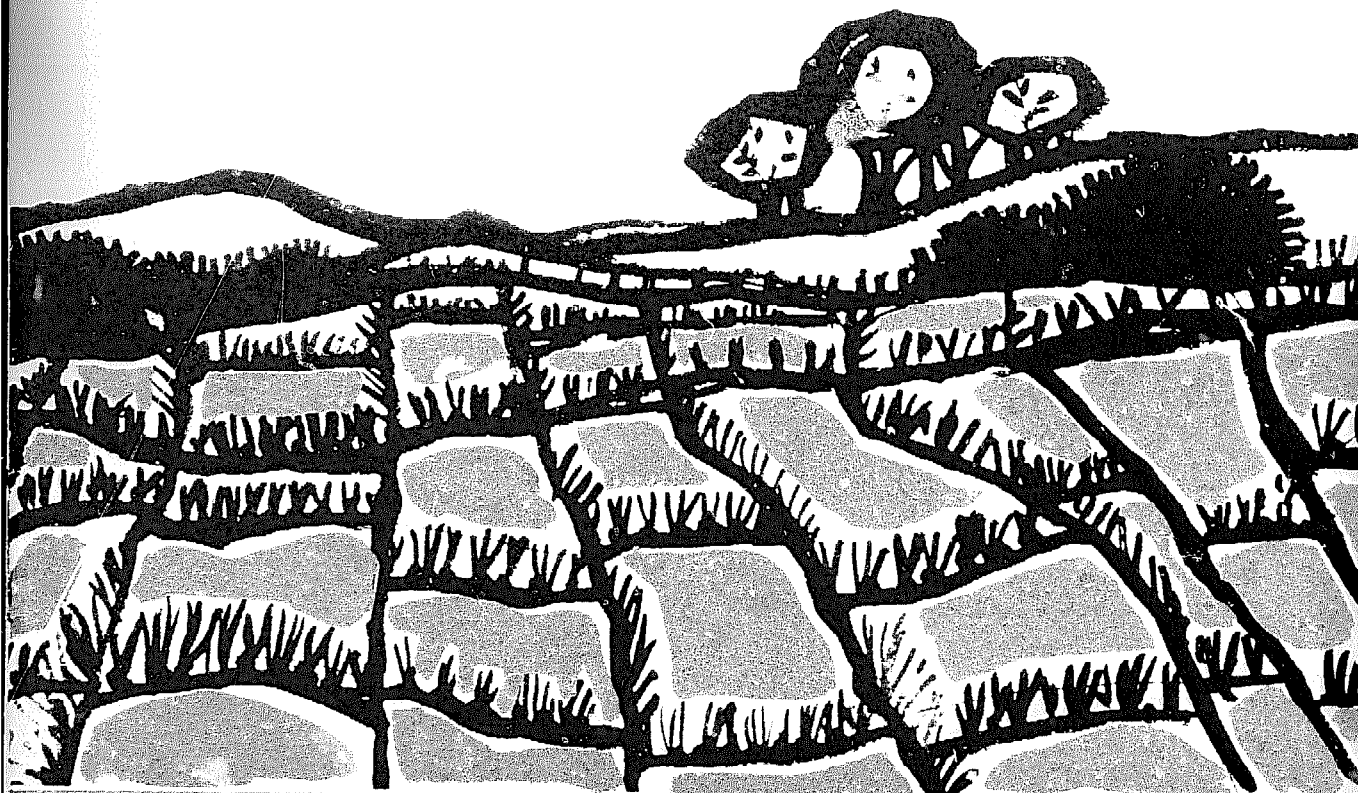
**better farming series**

**5**

1978 edition

# **the soil**

**how to conserve the soil**



**FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS**

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21. Wet paddy or swamp rice
22. Cocoa
23. Coffee
24. The oil palm
25. The rubber tree
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# **The soil**

## **How to conserve the soil**

**Published by arrangement with the  
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## **PREFACE**

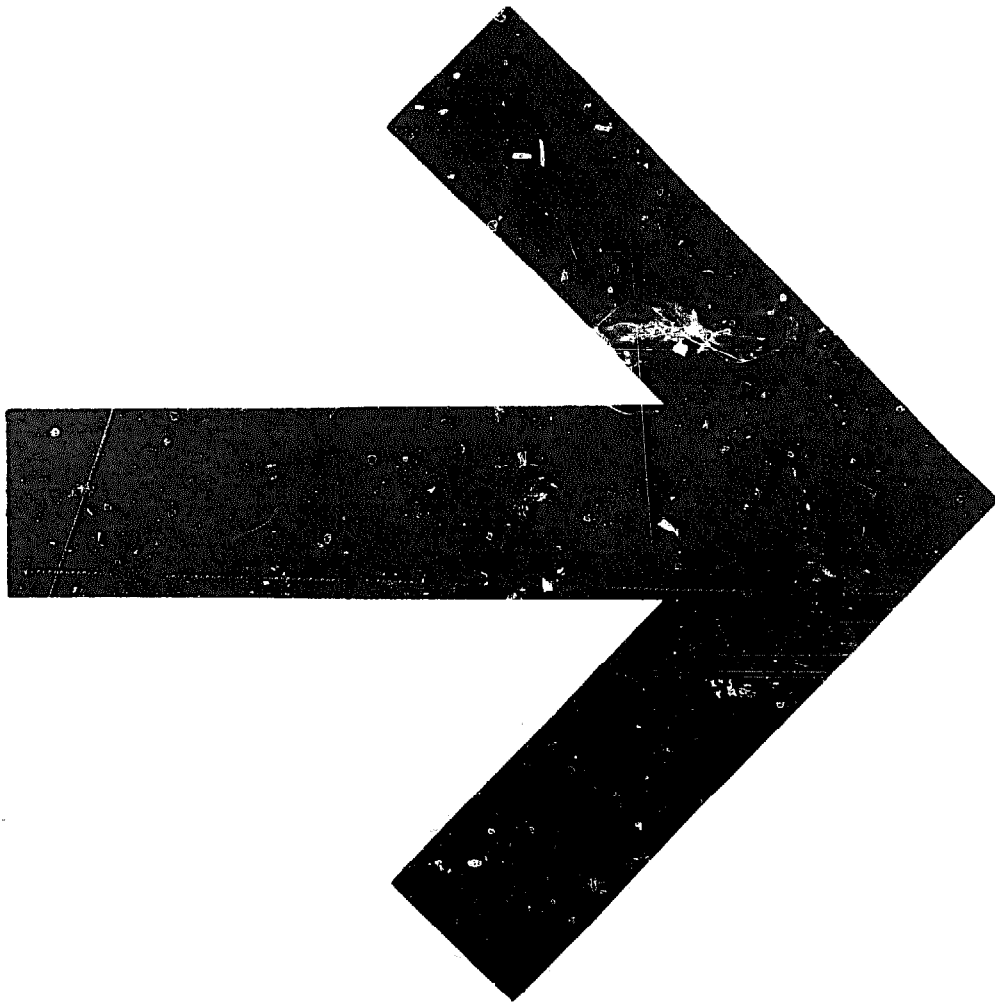
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This manual is a translation and adaptation of "Le sol — comment conserver le sol?", published by the Agri-Service-Afrique of the Institut africain pour le développement économique et social (INADES), and forms part of a series of 26 booklets. Grateful acknowledgement is made to the publishers for making available this text, which it is hoped will find widespread use at the intermediate level of agricultural education and training in English-speaking countries.

The original texts were prepared for an African environment and this is naturally reflected in the English version. However, it is expected that many of the manuals of the series — a list of which will be found on the inside front cover — will also be of value for training in many other parts of the world. Adaptations can be made to the text where necessary owing to different climatic and ecological conditions.

Applications for permission to issue this manual in other languages are welcomed. Such applications should be addressed to: Director, Publications Division, Food and Agriculture Organization of the United Nations, Via delle Terme di Caracalla, 00100 Rome, Italy.

The author of this English version is Mr. A.J. Henderson, former Chief of the FAO Editorial Branch.



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# PLAN OF WORK

---

## FIRST WEEK

### Erosion.

- Read pages 4 to 7.

This lesson for the first week  
is not very long

But you have to understand  
that erosion is very bad,  
and how and why  
soils are carried away  
by rain and wind.

## SECOND WEEK

### How to stop the flow of water.

- Reread pages 4 to 7.
- Read pages 8 to 16.

We see that  
there are several ways of controlling erosion.

- Where you live, do they make  
**contour line ridges or ditches?**  
**Or barrier strips?**  
**Do they go in for terrace farming?**
- You must understand  
why keeping to the **contour lines**  
prevents erosion.

## THIRD WEEK

### How to cover the soil.

- Reread pages 7 to 9.
- Read pages 17 to 22.
  - Why is mulching used?
  - Why sow cover crops?
- Where you live, do they make brush fires?
  - Try to find out why.
  - In what season do they make brush fires?
  - Why?

## FOURTH WEEK

### Fallow, crop rotation, land-use allocation.

- Read pages 23 to 28.
  - Fallow and green manuring**  
improve the soil.
  - It is best to grow crops  
and raise animals as well. Why?
  - Were **crop rotations**  
and **land-use allocation** used in the past?
  - How long did the fallow last?
  - Why must a change be made?
- Reread the whole booklet.
- Answer the question paper.

## **THE SOIL CAN CHANGE**

**In Africa many soils can become bad.**

**Why?**

- **The sun, the rain and the wind change the soil a great deal.**

**In Africa the rains are often very heavy.**

**After the rains the heat is very great.**

**Great heat after heavy rains ruins the soil:  
the humus is quickly destroyed.**

**The wind too ruins the soil.**

**So we have to protect the soil from sun, rain and wind  
by stopping the water from flowing away;  
by covering the soil.**

- **If you always farm the same field, the plants will take all the mineral salts out of the soil.**

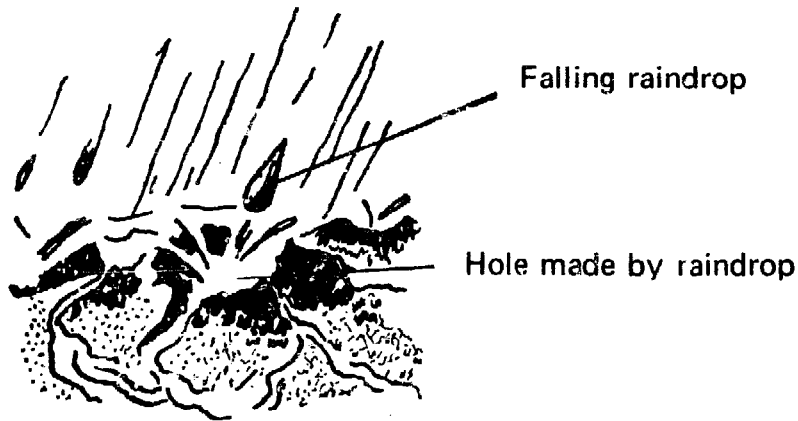
**You must let the earth rest  
by fallows;  
by crop rotation;  
by land-use allocation.**

# EROSION

- **Rainwater may carry away cultivable land.**  
This is **water erosion**.

Let us see what happens  
when it rains heavily.

Every drop of heavy rain  
that falls on the soil  
takes away a little earth.



Around the house,  
the water that falls from the roof  
makes holes and takes away earth.

**When the rain falls gently,**  
it does not flow off,  
it goes into the soil.  
All the earth becomes wet.  
Gentle rain does not carry away earth.

**When the rain is very heavy,**  
it does not all go into the soil.  
It flows and makes ditches.  
If the soil is on a slope,  
the water flows more quickly,  
and makes deeper ditches.  
A lot of earth is carried away.  
Along the sides of the road,  
the water runs very fast,  
it carries away the earth,  
and makes deep ditches.

## Water erosion is worse

- **when the soil slopes:**  
the water flows quickly  
and carries away a lot of earth;
- **when there are no plants growing on the soil:**  
plant roots hold the earth  
and the leaves shelter it from the rain.

*For instance, at Adiopodoumé, Ivory Coast,  
the weight of earth in kilogrammes (kg)  
carried away by the rain in one year  
has been calculated as follows:*

<i>From 1 hectare of</i>	<i>kg carried away</i>
<i>bare land . . . . .</i>	<i>117 000</i>
<i>land under crops . . . . .</i>	<i>52 500</i>
<i>forest land . . . . .</i>	<i>2 400</i>

- **The wind can also carry away earth.**

This is erosion by wind.

In some very dry regions  
where the wind is very strong,  
it carries away earth.

Bare soils, without plants,  
and soils with a bad structure  
(see Booklet No. 4, page 24)  
are most easily carried away by the wind.

What remains in the field is poor soil.

- **Strong sun spoils the soil.**

When there are no plants on the soil,  
the soil is bare,  
the earth is not protected.  
The earth becomes dry.  
The humus is quickly destroyed.  
The soil structure becomes bad.  
Good earth is easily carried away.  
The soil becomes poor.

# HOW TO CONSERVE THE SOIL

Erosion can be prevented:

- **by stopping the water from flowing away.**

Quickly running water carries earth away.  
It is dirty water, mixed with earth.

If the flow of water is stopped,  
the earth mixed with the water settles on the ground.

The water becomes cleaner.  
The earth is not lost.

In order to stop the flow of water and keep the earth,  
we use:

- **contour line ridges,**
- **ditches,**
- **barrier strips,**
- **strip cropping.**

- **by covering the soil.**

Water that falls on bare soil  
carries away the soil.

Water that falls on soil covered by plants  
damages the soil less.

The plants that cover the soil reduce erosion.

To cover the soil, use **mulches** and sow **cover crops**.

Brush fires

leave the soil bare and without plants.

They destroy organic matter.

The soil structure becomes bad.

Brush fires are bad for the soil.

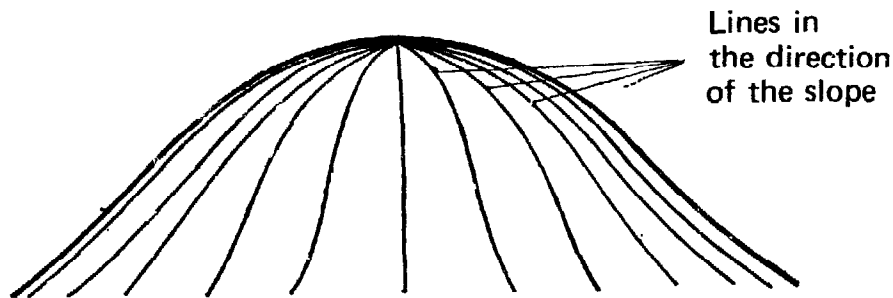
# **Prevent erosion by stopping the flow of water**

## **CONTOUR LINE RIDGES**

Water flows very fast on sloping land.  
It flows strongly and carries away earth.

When ridges are made **in the direction of the slope**,  
or if you plough in the direction of the slope,  
the water flows faster and faster between the ridges.  
It carries away a lot of earth.

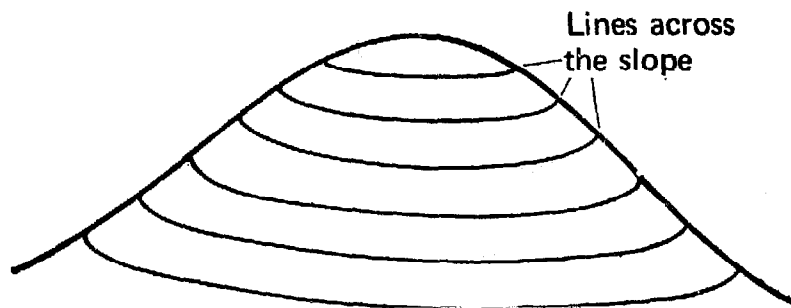
Look at this drawing:



The lines are in the direction of the slope.  
The water flows very fast. Earth is carried away.

When ridges are made **across the slope**,  
water cannot go fast.  
It is stopped by the ridges.  
Earth is not carried away.

Look at this drawing:



These lines are across the slope.  
Water and earth are held up.

When you make ridges  
across the slope,

When you plough  
across the slope,

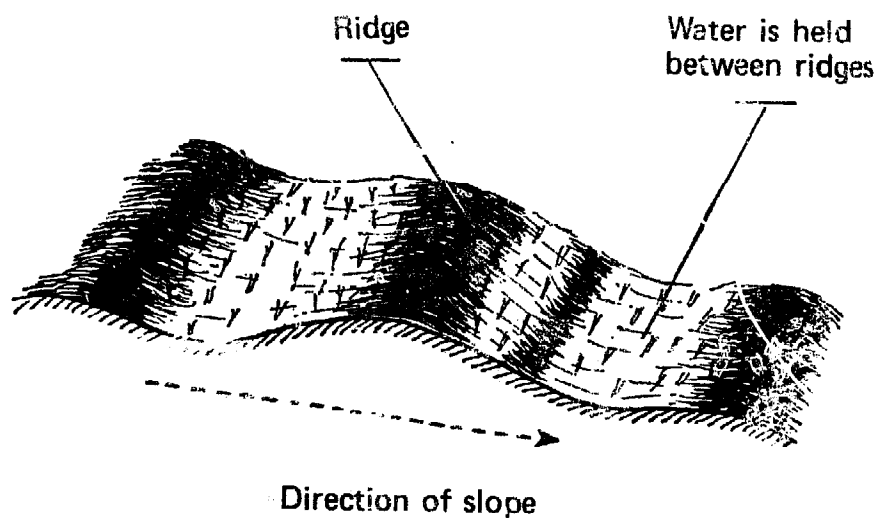
**You are working on the contour line.**

**A contour line  
is a line across the slope  
running always at the same height.**

Making ridges  
along the contour lines  
helps to control erosion.

**The water cannot flow fast.**

The water is held by the ridges.



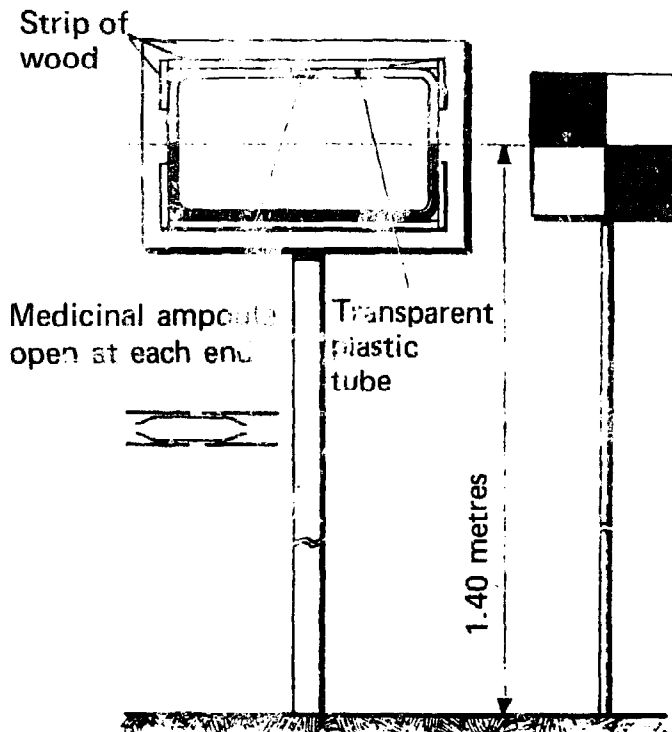


## HOW TO MAKE CONTOUR LINES

### THE TOOLS:

Water level

Sighting mark



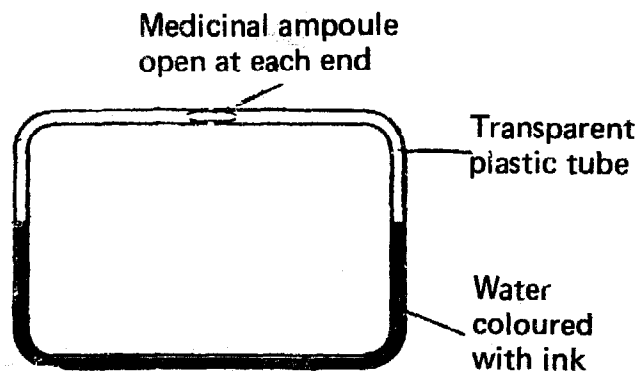
### • The water level

We need:

- a board 80 centimetres by 50 centimetres;
- an empty medicinal ampoule;
- 1.80 metres of plastic tube of the same size as the ampoule (the dispensary may have it).

Half fill the tubing with water mixed with a little ink.

Join the two ends of the tube with the ampoule, which should be open at each end.



Fix the tube on the board  
as shown in the drawing,  
putting the ampoule at the bottom.

Protect the tube  
by strips of wood,  
except in the places  
shown in the drawing.

Nail the board to a stake 1.40 metres high

● **The sighting mark**

Get a board 30 centimetres by 30 centimetres.  
Nail the board  
to a stake 1.40 metres high.  
Paint two squares on the board  
as shown in the drawing.  
This is our sighting mark.

● **Stakes**

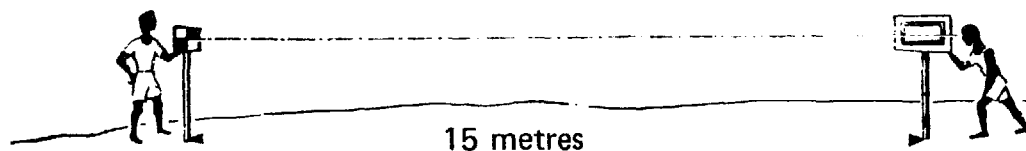
Get ten stakes 1 metre high.

**MARKING THE LINES**

Two people are needed,  
the man in charge and his helper.

The man in charge  
takes the water level.

His helper  
takes the sighting board and the stakes.

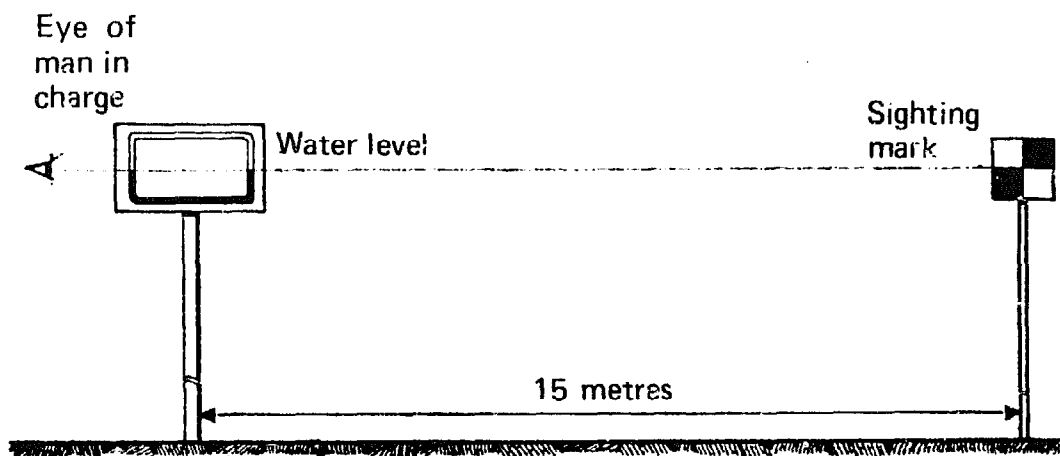


The man in charge goes to the top of the field.  
His helper goes to the same height at a distance  
of 15 metres or paces.  
The sighting mark and the level are held quite straight.

As shown in the drawing,  
the man in charge  
tries to get in the same line of sight  
the levels of the water in the tube  
and the centre of the sighting mark.

**He takes a sight.**

The man in charge does not move from his place.  
He signs to his helper  
to go up or down the slope.  
When he has got a good sight,  
the helper fixes a stake  
in place of the sighting mark.



The helper goes 15 metres or 15 paces away  
from the stake he has just fixed in the ground.  
He is now 30 metres from the man in charge.

The man in charge takes a new sight.  
His helper marks the spot  
with another stake.

The helper again goes 15 metres away.  
The man in charge takes another sight.

The helper gets to the end of the field.  
**All the stakes are at the same level.**

The man in charge marks a ridge joining all the stakes.

**This ridge marks the contour line.**

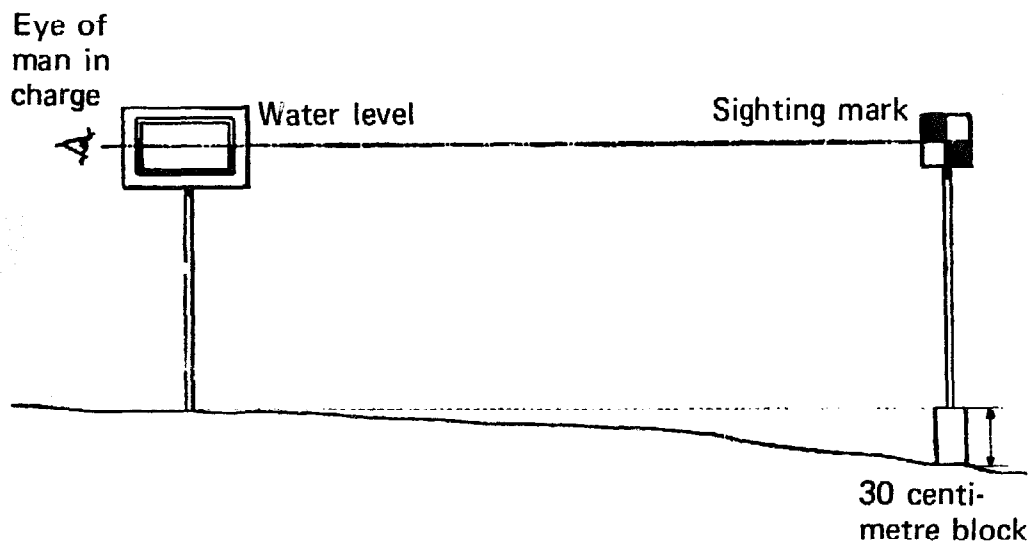
**To make a line 30 centimetres lower,**  
the man in charge puts his level  
on the line he has just marked.

His helper puts a block 30 centimetres high  
under the sighting mark.

The man in charge takes a sight.

He finds the beginning of a contour line  
that is 30 centimetres lower.

He looks for points on the new line.



Then he marks a third line,  
and a fourth line.

## CONTOUR LINE BARRIER STRIPS

- On a slope  
the soil can be even better protected  
by making **barrier strips**.

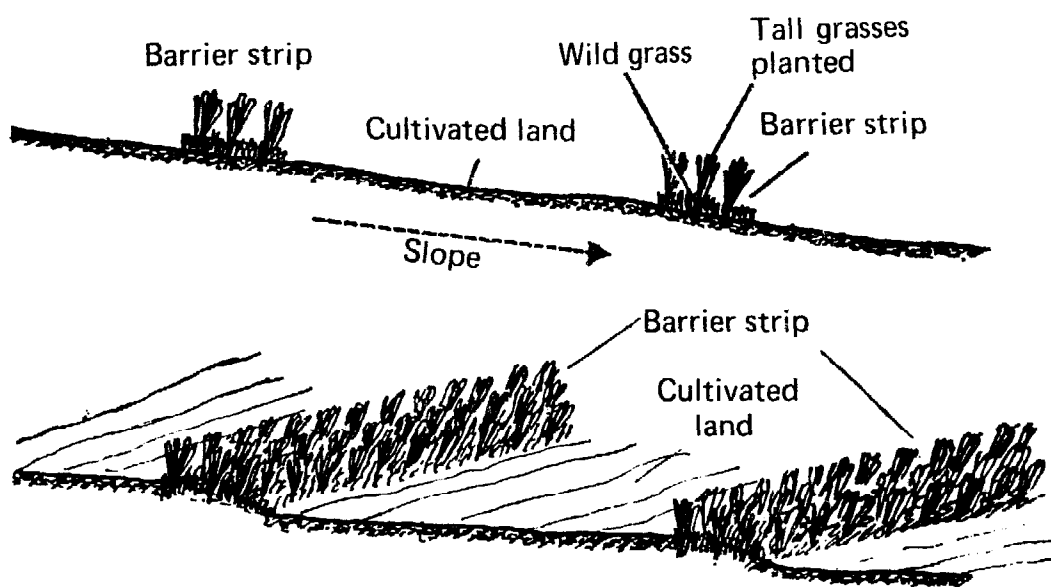
**A strip of uncultivated land is left.**  
Grass grows on this strip;  
it stops the flow of water  
and the earth is not carried away.

**Barrier strips must also be made  
on the contour lines, across the slope.**

A barrier strip should be at least 2 metres wide.

**To better stop the flow of water  
tall grasses can be planted.**  
Even trees can be planted.

- If the slope is slight,  
barrier strips are made 30 to 40 metres apart.  
If the slope is a little steeper,  
barrier strips are made 10 to 20 metres apart.



## CONTOUR LINE DITCHES

- If the slope is very steep,  
and if the water flows very fast,  
it is difficult to stop the water  
with ridges or barrier strips.

- Ditches 30 centimetres deep  
are dug along the contour lines.

The earth from the ditch  
is piled up along the lower edge of the ditch  
and forms a big ridge.

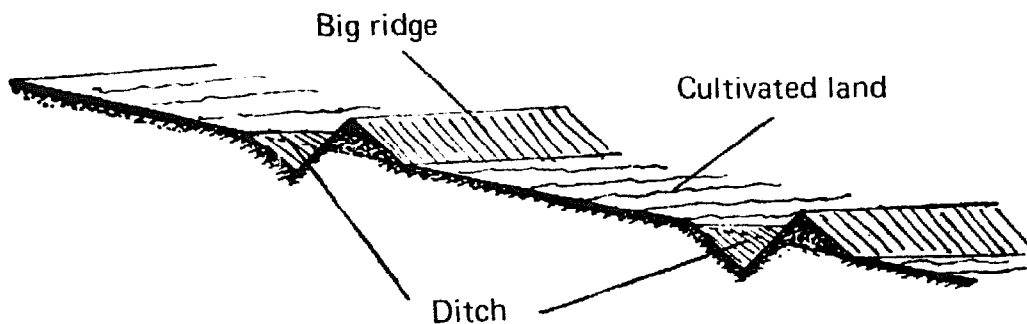
The water is stopped  
by the ditch and the ridge.

- No crops are grown on this big ridge.

Grass is allowed to grow on it;  
the roots prevent water from carrying away  
the ridge.

The ditches are made 20 to 30 metres apart.

Crops are grown on the strips of land between the ditches.

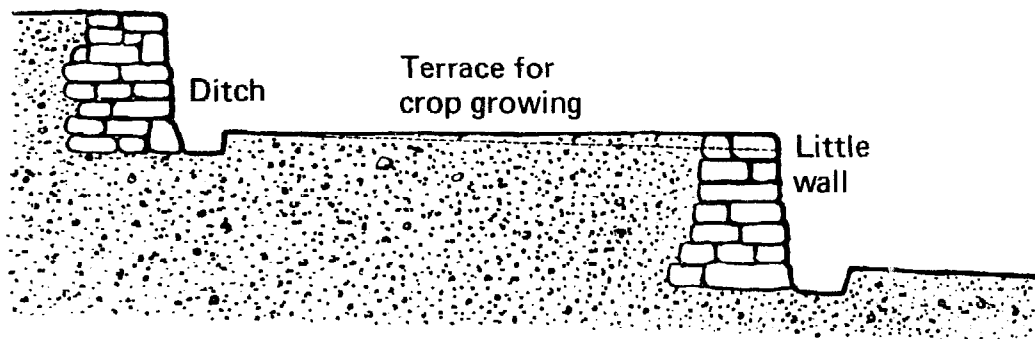


Ditches control erosion very well,  
but they must be cleaned out  
from time to time.

## TERRACE FARMING

- If the slope is even steeper,  
it is impossible to grow crops on the slope.
- But little walls of earth or stone can be built.  
These walls are built across the slope.  
Earth is put behind the little walls.

In this way terraces are made.  
Crops are grown on the terraces.



A ditch is made at the foot of the wall.

The ditch takes the water  
that runs down from the terrace.

In some African countries  
there is a lot of terrace farming,  
for example:

- among the Dogons in Mali;
- among the people of the highlands of northern Cameroon;
- among the hill people of Rwanda and Burundi.

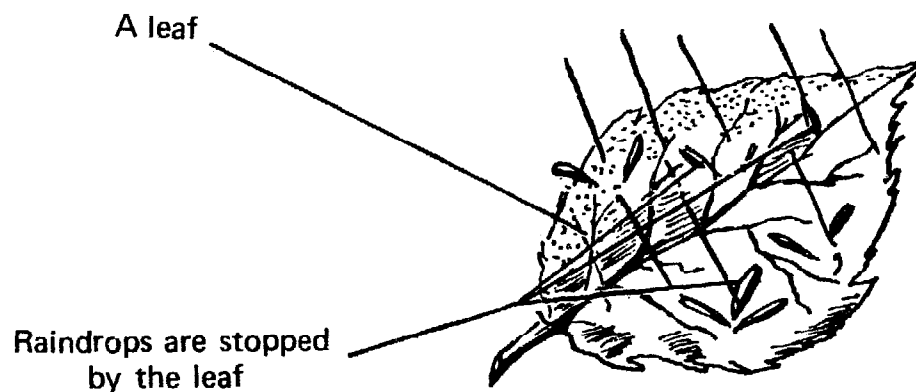
## Prevent erosion by covering the soil

Heavy rains, dry wind and sun  
all ruin the soil (see pages 5 to 6).

Plants protect the soil  
against rain, wind and sun.

- **Plants that cover the soil prevent erosion.**

The rain drops do not fall on the soil.  
They fall on the leaves.  
Then they run gently on to the soil  
and do not carry away earth.



Plants break the force of the **wind**,  
and make it less strong.  
Herbage protects the soil.  
The wind does not blow away the soil in dust.

The **sun** does not shine straight on to the soil.  
Plants with their leaves cast shade.  
The earth remains damp.  
Humus is not destroyed.



## MULCHING

- You can cover the soil with:

straw  
cut herbage;  
leaves,  
stems of millet, maize, etc.

**This cover of dead plants is called a mulch.**

- **A mulch is useful because:**

It protects the soil against water and wind  
that carry away earth.

It protects the soil against the sun  
which dries the earth.

The soil stays damp.

It prevents weeds from growing.

- **After mulching**

the straw etc. rots and makes humus.

The soil is made richer.

- **Mulching is used**

to protect the soil of gardens,  
and in growing bananas.

Mulches are also spread  
round certain **fruit trees**,  
such as mango, papaw and orange.

**For palms and coconuts**

the residues of fruit clusters and coconut fibre  
are used for mulching.

- **When you clear a field,**  
do not burn the herbage and the small trees.  
Leave them on the soil  
so that the leaves and cut trees  
cover the soil.

## COVER CROPS

- **Cover crops**

are the plants which are sown or planted to cover the soil in certain plantations.

When you let soil rest by leaving it fallow after three or four years of crop production, you can sow cover crops which protect the soil from erosion.

In tree plantations, such as palms, coffee, cocoa, rubber, you must sow a cover crop between the lines of trees, for example, Pueraria.

When the cover crops grow too big, cut them down. Prevent them from climbing up the trees.

- **Choose the right cover crops.**

A good cover crop must **grow quickly and last a long time.**

Some cover crops can be used for **feeding animals**, for example, Stylosanthes and Pueraria.

The agricultural extension service will tell you which is the best cover crop for your plantation.

- The cover crop also improves the soil by giving it **organic matter** (see Booklet No. 2, page 23).

## BRUSH FIRES

During the dry season,  
many plants die and lie on the soil.  
They are burned in a brush fire.

### Why are brush fires made?

- **To clear the land.**  
Fire cleans the field and makes work easier.
- **For hunting.**  
Animals are afraid of the fire  
and take flight.  
They are caught and eaten.
- **To make the grass grow again.**  
Cattle do not want to eat dry grass.  
After the fire, green grass grows,  
and cattle eat it.
- **To protect the following crop**  
(see Booklet No. 2, page 28).  
Many little animals,  
such as agoutis, rats and insects  
spoil crops.  
The fire kills them.  
They won't attack the following crop.  
The fire also burns up diseased plants.  
They won't pass the disease  
to the following crop.
- **To walk more easily in the bush.**  
The fire burns tall grasses.  
It is easier to get about.

## WHY WE MUST NOT MAKE BRUSH FIRES

### **Fire destroys organic matter.**

Plants burned by the fire  
do not yield any humus.  
After the fire  
there is nothing left but ashes.  
Wind and rain can carry them away.  
Humus enriches the soil  
and improves its structure.  
Ashes enrich the soil  
but do not improve its structure.

### **Fire leaves the soil bare.**

Grass cannot grow again  
on soil burned at the end of the dry season;  
the soil is too dry.  
The first rains are often very heavy.  
They fall on bare soil.  
They easily carry it away  
after a brush fire.

### **Fire destroys good plants.**

After the fire a lot of plants die.  
Often the good plants die  
more easily than the bad ones.  
Each year bad plants  
take the place of good plants.  
In this way savanna takes the place of forest.

### **Fire is dangerous.**

Often whole plantations are destroyed,  
for instance,  
coffee trees, or oil palms.  
Often houses and barns are burned,  
sometimes the whole village.  
In Africa many soils have often become poor  
because of fire.

**The brush fire is bad.**

If we want to stop making it,  
we must:

- **destroy insects**, small animals and diseases  
by using chemical products.
- **bury weeds** by ploughing.
- **feed animals** during the dry season with hay.

But farmers do not always have  
the machines and the chemical products.  
Many of them must still make fires.  
**However, they can prevent the fire being too bad.**

If the fire is lit at the beginning of the dry season,  
the fire is not so fierce and not everything is burned.  
The grass has time to grow again.

Then the soil will not be bare  
at the beginning of the rainy season.

**When a farmer  
cannot get the good results of fire by other means,  
he should make brush fires  
at the beginning of the dry season.**

## **FALLOW**

When you clear a field,  
the first harvests are good.  
But after four or five years  
the harvest is less good;  
the plants have taken the mineral salts from the soil  
and **the soil becomes poor.**  
The soil must not be used again.  
The soil must be allowed to rest.  
This rest for the soil is called a **fallow.**

On soil that is left fallow,  
grass and other herbage grows.  
The plants protect the soil against erosion.  
The plants die.  
The organic matter from the plants  
(see Booklet No. 2, page 23)  
enriches the soil with humus.  
The soil becomes rich again.

**To get a better fallow:**

- **Sow plants.**  
These plants grow more quickly than grasses,  
and cover the soil better.  
They make more organic matter.  
For example, *Stylosanthes* and *Crotalaria*  
are **good fallow plants.**
  
- **Do not burn plants growing on the fallow.**
  
- **The fallow can be used for feeding animals.**  
But the animals must not eat all the plants.  
Because then the soil will no longer be protected.

# CROP ROTATION

- If the same crop is grown on the same field every year the harvests get much smaller, and the soil becomes poor.
- If the crop is changed on the same field every year, the harvest can stay good, and the soil does not become poor. This is called crop rotation.

An example of crop rotation from the Baoulé country, Ivory Coast:

*First year: yams*  
*Second year: maize or rice*  
*Third year: cotton*  
*Fourth year: fallow*

- In traditional farming, the same crop is grown on the same field for several years.

The crop takes all the mineral salts.  
The soil becomes very poor.  
The soil structure (see Booklet No. 4, page 24) becomes bad.  
Erosion carries away soil.  
Sometimes even the village has to be moved.

**Crop rotation  
means growing a different crop  
each year  
on the same field.**

## REASONS FOR CROP ROTATION

- To make better use of all parts of the soil.

For example:

*The first year I grow cotton.*

*Cotton has a tap-root (see Booklet No. 1, page 23).*

*Cotton gets its food deep down.*

*The second year I grow rice.*

*Rice has fibrous roots (see Booklet No. 1, page 21).*

*Rice gets its food on the surface.*

*Thus all parts of the soil are used.*

- To make better use of all the mineral salts in the soil.

For example:

*The first year I grow cotton.*

*Cotton uses chiefly one mineral salt –  
phosphoric acid.*

*If I grow cotton*

*for two years running on the same field,  
the cotton will lack phosphoric acid.*

*The second year I grow rice.*

*Rice uses chiefly another mineral salt,  
one containing nitrogen.*

A farmer who grows cotton and then rice makes better use of all the mineral salts in the soil.

- To control insects and diseases.

For example:

*When you grow cotton,*

*the insect pests and diseases of cotton increase.*

*If you grow cotton again the next year,*

*the pests and diseases which have remained  
in the field do a lot of harm to the cotton.*

*If you grow rice after cotton,*

*the pests and diseases of cotton*

*do no harm to the rice, and disappear.*



- An example of crop rotation in the Central African Republic:

*First year: groundnuts*

*Second year: cotton*

*Third year: rice*

*Fourth year: cassava*

*Fifth year: fallow*

*Sixth year: fallow*

*Seventh year: fallow*

Thus four years of crops  
are followed by three years of fallow.  
Fodder crops can be sown on the fallow,  
and so the animals can be fed.

This is a seven-year rotation;  
every seven years  
the same crops are grown.

## HOW TO CHOOSE A CROP ROTATION

Before choosing a rotation  
you must think carefully.

- You must choose crops  
that will feed the family  
all the year.
- You must choose crops  
that will bring in money  
(industrial or cash crops).
- You must choose crops  
that can be grown one after the other  
without making the soil poor.  
They must be plants that have different roots,  
plants that do not use the same mineral salts.
- A crop rotation enables you to  
keep the soil rich,  
cut down the length of fallow,  
farm the same fields.

## LAND-USE ALLOCATION

- Every year the farmer needs several different crops.

For example:

millet or cassava to eat,  
cotton or maize to sell,  
grass for his animals.

- So every year he must grow different crops on different fields.  
He must allocate his land according to crop use.

Examples of land-use allocation:

*Mamadou has six fields.*

*He does not grow millet on all his fields.*

*On field 1, he plants cotton.*

*On field 2 he sows rice.*

*On field 3 he sows groundnuts.*

*On field 4 he sows millet.*

*Fields 5 and 6 he leaves fallow.*

1 Cotton
3 Groundnuts
5 Fallow

2 Rice
4 Millet
6 Fallow

*Mamadou has made a good land-use allocation.*

*He has crops to eat (millet and rice).*

*He has crops to sell (cotton, groundnuts, rice).*

*He has two fields of fallow to feed his animals  
and to let the soil rest.*

## REASONS FOR LAND-USE ALLOCATION

- **To organize your work better.**

Sowing, hoeing, cultivating, applying pesticides and harvesting of different crops do not always have to be done at the same time.

For instance,  
it is easier to grow during the same season one hectare of millet and one hectare of groundnuts, than to grow two hectares of millet.

If you grow only one crop, you have to do all the work at the same time.

With a good land-use allocation you always have enough time to do all your jobs well: ploughing, sowing, cultivating and harvesting.

- **To provide a safeguard.**

If you grow only one crop, and if a tornado, drought or animals destroy this crop, you have nothing left.

If you grow only one crop and this crop fetches a poor price, you earn no money.

**By growing several crops you can always have both food and money.**

# **SUGGESTED QUESTION PAPER**

## **FILL IN THE MISSING WORDS**

Many soils can become .....

Wind, sun and rain destroy soil; this is called .....

Erosion must be controlled by .....,  
or by covering the soil with .....  
and with ..... crops.

A good farmer ..... brush fires.

He knows that fire is ..... for the soil.

Fire destroys ..... and .....  
and it also leaves the soil .....

To conserve the soil, a good farmer lets his soil rest; this is called a .....

He grows a different crop each year on the same field; this is called .....

Each year he grows different crops on different fields; this is called .....

## **ANSWER THE FOLLOWING QUESTIONS**

What is erosion?

Why do we let soil lie fallow?

What is a cover crop?

Your field is on a steep slope. What do you do in order to grow a crop and conserve the soil?

What are the advantages of a good crop rotation?

Tell a friend why you do not make brush fires.

After having studied this course, what are you going to do to improve your farming?

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