LOOKING AFTER THE SOIL

DEPARTMENT OF PRIMARY INDUSTRY
PORT MORESBY
Revised 1983

To obtain copies of these booklets, ask your agricultural officer or write to -

The Secretary (Attn: Publications Section)
Department of Primary Industry
P.O. Box 417
KONEDOBU
Papua New Guinea

LOOKING AFTER THE SOIL

INTRODUCTION

Soil gives plants three things they need for growing, food, water and air.

Soil with enough plant food is a fertile soil. The soil must also have enough water for the plant to grow. There must be spaces in the soil for air, otherwise plant roots will die.

When the soil is not able to give enough food we say that it has lost it's fertility, and it is no longer able to grow strong healthy plants, even if the soil can supply enough water.

It is most important for every gardener and farmer to understand how a soil loses its fertility, and what methods can be used to stop this from happening.

Traditional farming

When land is cleared and planted for traditional gardens, harvests are good immediately after clearing the land.

But little by little the harvests become less good. The soil loses its fertility.

When this happens, the people allow the old garden to go back to bush, and make a new garden by clearing new land.

Many years later, the land can be used again. The soil has become fertile again while the bush was growing on it.

This method of looking after the soil is the traditional method in Papua New Guinea.

What is wrong with the traditional way?

The trouble with the traditional method is that,

1. a great deal of land is needed,
2. much time is spent clearing new land,
3. often people have to walk long distances to their gardens.

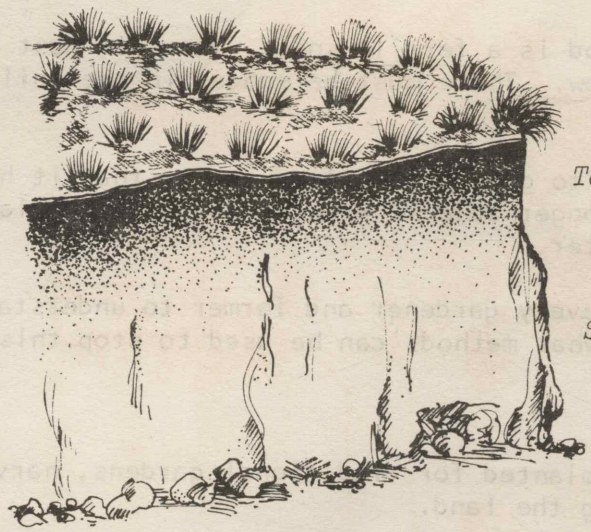
The new methods that are going to be talked about in this book will allow the same piece of land to be used over and over again, for longer periods, without the land losing its fertility.

HOW THE SOIL IS MADE UP

In order to understand how to look after the soil, it is necessary to know how the soil is made up.

The soil is made up of layers.

If possible, look at a place where a deep hole has been dug, or at a road cutting where the soil has been cut away.



This picture shows the layers of the soil

Layers of the soil

The topsoil

You will see that the soil colour changes as it gets deeper. There is a top layer which is darker. Most of the plant roots grow in this layer. It is also full of small pieces of rotting leaves and stems.

This top layer is called the topsoil.

The rotting leaves and stems in the topsoil are called humus. They are important for many reasons.

1. Humus gives plant food to the soil.
2. Humus makes the soil easier to dig.
3. Humus helps water to stay in the soil.

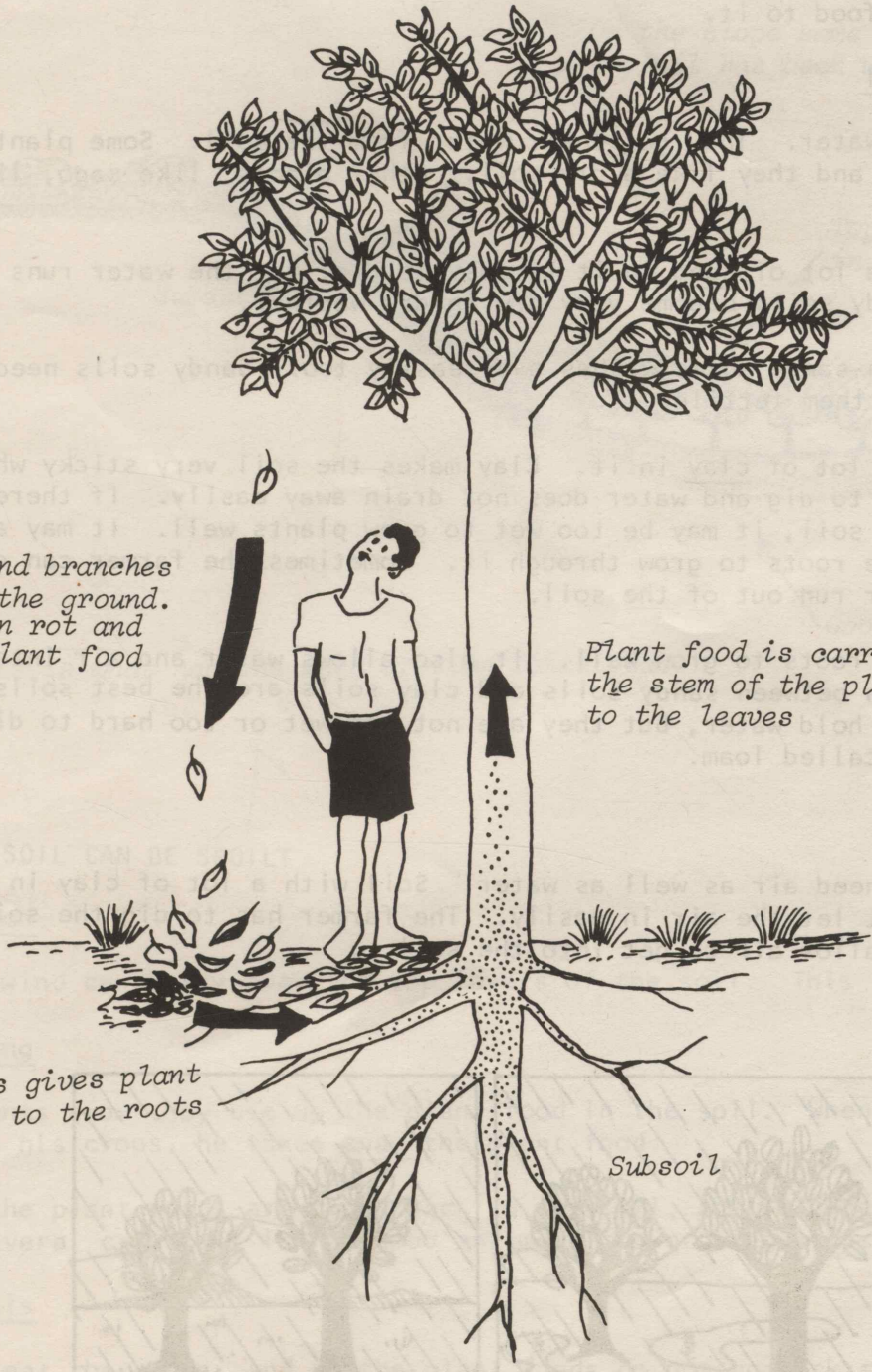
This is why the soil becomes fertile again when bush is growing on it. The leaves and stems from the trees fall to the ground, and mix with the soil making it fertile.

As they decay they become humus and release plant food to the soil.

The subsoil

The second layer of the soil is called the subsoil. It is usually a lighter colour than the topsoil. Only a few large roots go down into this soil. Roots of trees go down into the subsoil, but small plants like cabbage, peanuts and so on, only send their roots into the topsoil.

The subsoil is important if you want to grow tree crops like cocoa, coffee, tea, rubber and coconuts because the roots which grow into the subsoil help the trees stand up in windy weather and bring up water from deep in the ground during dry spells.



This is how the plants take food from the soil

WHY SOME SOILS ARE BETTER THAN OTHERS

Plant food in the soil

Some soils have more plant food in them than other soils. A soil with plenty of plant food is a fertile soil.

A good soil also has plenty of humus. The humus adds plant food which makes the soil dark-coloured. Dark soils are usually fertile soils.

If there is not enough plant food in the soil, the farmer can improve the soil by adding plant food to it.

Water in the soil

All plants need water. They get their water from the soil. Some plants do not need much water, and they like a dry soil. Other plants, like sago, like a very wet soil.

A soil that has a lot of sand in it is easy to dig, but the water runs through it quickly. Sandy soils become very dry in dry weather.

The plant food in sandy soils washes away easily too. Sandy soils need a lot of humus to make them fertile.

Other soil has a lot of clay in it. Clay makes the soil very sticky when it is wet. It is hard to dig and water does not drain away easily. If there is too much clay in the soil, it may be too wet to grow plants well. It may also be too hard for tree roots to grow through it. Sometimes the farmer can dig drains to help the water run out of the soil.

The humus allows roots to grow well. It also allows water and air into the soil. Soils that are in between sandy soils and clay soils are the best soils. They are fertile, and hold water, but they are not too wet or too hard to dig. This kind of soil is called loam.

Air in the soil

The plant roots need air as well as water. Soil with a lot of clay in it is hard and does not let the air in easily. The farmer has to dig the soil to break it up and allow air to get into the soil.

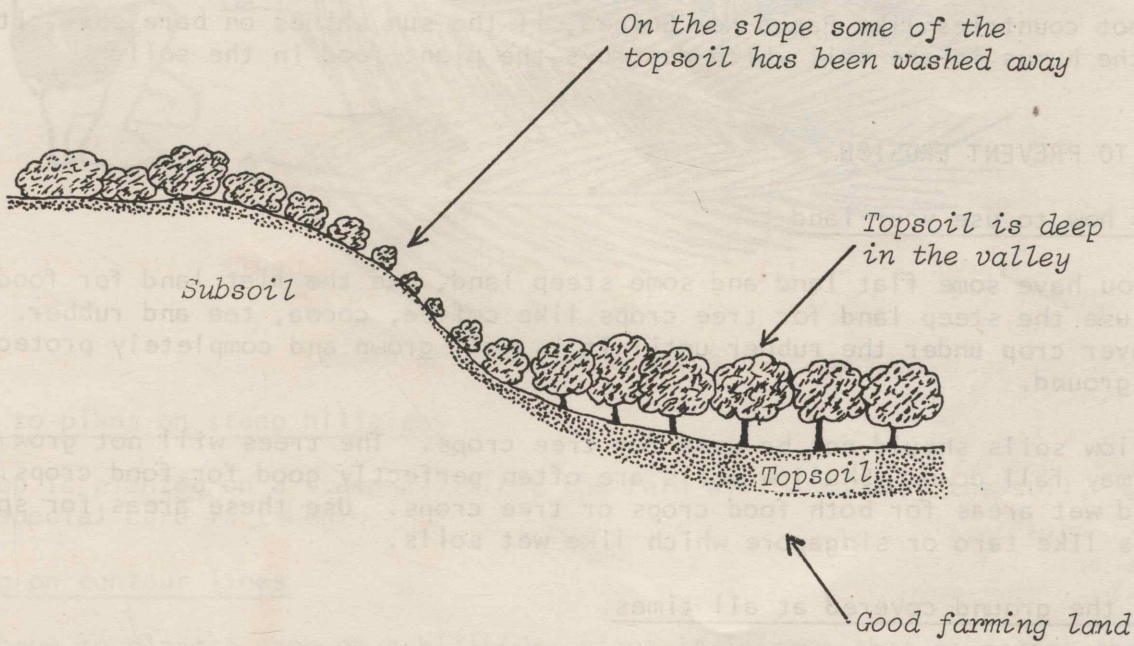
Water sinks slowly in clay soil

Water sinks quickly in sandy soil

Thickness of the topsoil

The topsoil is the part of the soil that holds the plant foods. Good soils have a thick layer of topsoil.

In the valleys, the topsoil is thick. On the sides of the hill, the topsoil is thinner. Some of the topsoil has been washed away by the rain, and the subsoil is nearer to the surface. This washing away of the soil is called erosion.



This is what happens when erosion takes place

HOW THE SOIL CAN BE SPOILT

By erosion

Rain or wind can carry away the top layers of the soil. This is erosion.

By farming

When plants grow they use up the plant food in the soil. When the farmer harvests his crops, he takes away the plant food.

Unless the plant foods are given back to the soil, the soil becomes less fertile. After several crops, it is not good any more for growing crops.

By animals

Animals eat the grass, and so the plant foods do not go back to the soil.

If animals are left too long on the same piece of land, the grass does not grow and the soil is left uncovered. In wet weather it may be washed away, in dry weather it may be blown away by wind.

By burning

If burning is used to clear the land, then some of the plant foods are lost.

Burning helps to cause erosion, because it removes the plants which protect the soil from the rain.

By the sun

In hot countries like Papua New Guinea, if the sun shines on bare soil, it burns up the humus in the soil which destroys the plant food in the soil.

HOW TO PREVENT EROSION

Plan how to use your land

If you have some flat land and some steep land, use the flat land for food crops and use the steep land for tree crops like coffee, cocoa, tea and rubber. Plant a cover crop under the rubber until it is well grown and completely protects the ground.

Shallow soils should not be used for tree crops. The trees will not grow well and may fall down. Shallow soils are often perfectly good for food crops. Avoid wet areas for both food crops or tree crops. Use these areas for special crops like taro or singapore which like wet soils.

Keep the ground covered at all times.

After clearing the land, try to burn as little as possible. Let the leaves and small twigs stay on the ground to protect the soil from the sun, and to stop the rain from washing the soil away.

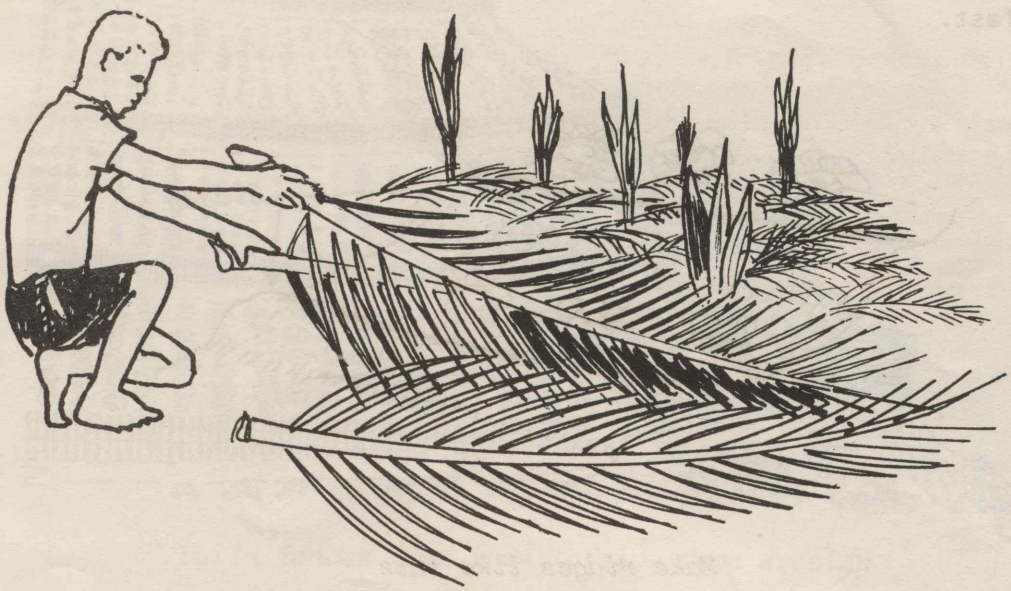
Carry big branches and logs away to a heap and burn them or keep them for fire-wood.

Often it is a good idea to leave some trees or bushes on the land to shade the soil while the crops are growing.

Shade trees are often planted to protect the soil and the young plants from the sun.

When the soil is not being used to grow crops, plant a cover-crop to protect the soil. There are a number of kinds of plants which are good to use as a cover-crop. The cover-crop must grow quickly and cover the soil well to protect it from the sun and rain.

When the seeds or the small plants are put into the ground, cover the soil again with leaves or cut grass. This covering of leaves or cut grass is called mulch.



Leaves are used as a mulch

Try not to plant on steep hillsides

If a crop is planted on a steep hillside, the rain will wash away the soil, unless special care is taken.

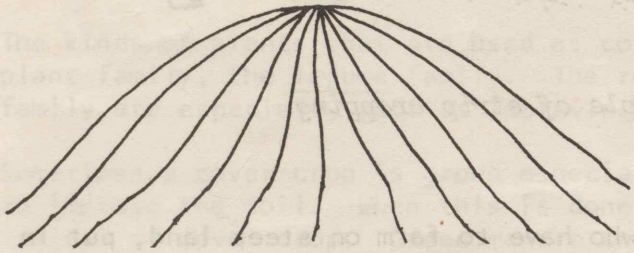
Planting on contour lines

If you have to plant a crop on a hillside, plant it in rows that go across the hillside, not up and down.

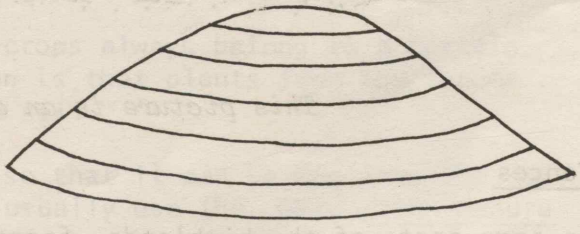
This is called planting on the contour of the hill.

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

Special note. Planting on the contour line is the general rule, but in some parts of Papua New Guinea the soils need more drainage than usual, and the people plant sweet potato in lines up and down the slope, instead of in contours. This is to help the water get away as quickly as possible, because sweet potato does not grow well in very wet soils.



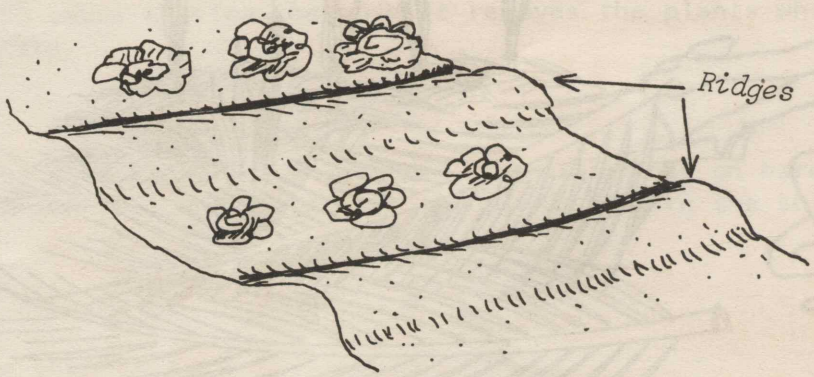
Lines up and down the slope



Lines across the slope

Ridges

Make ridges between the rows of plants to stop the water from running down the hill too fast.

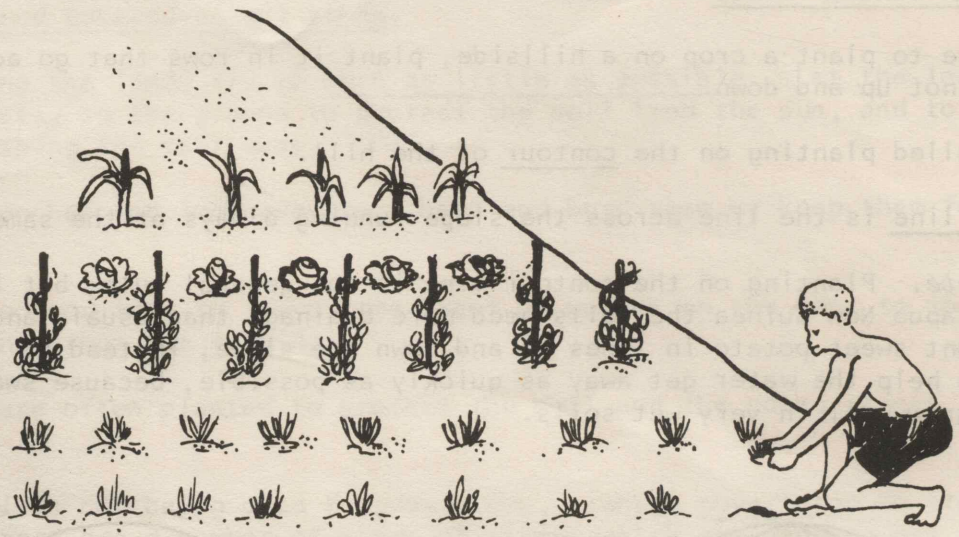


Make ridges like this

Strip cropping

Plant different crops in strips so that when one crop is harvested the ground is still protected by other crops which are still growing.

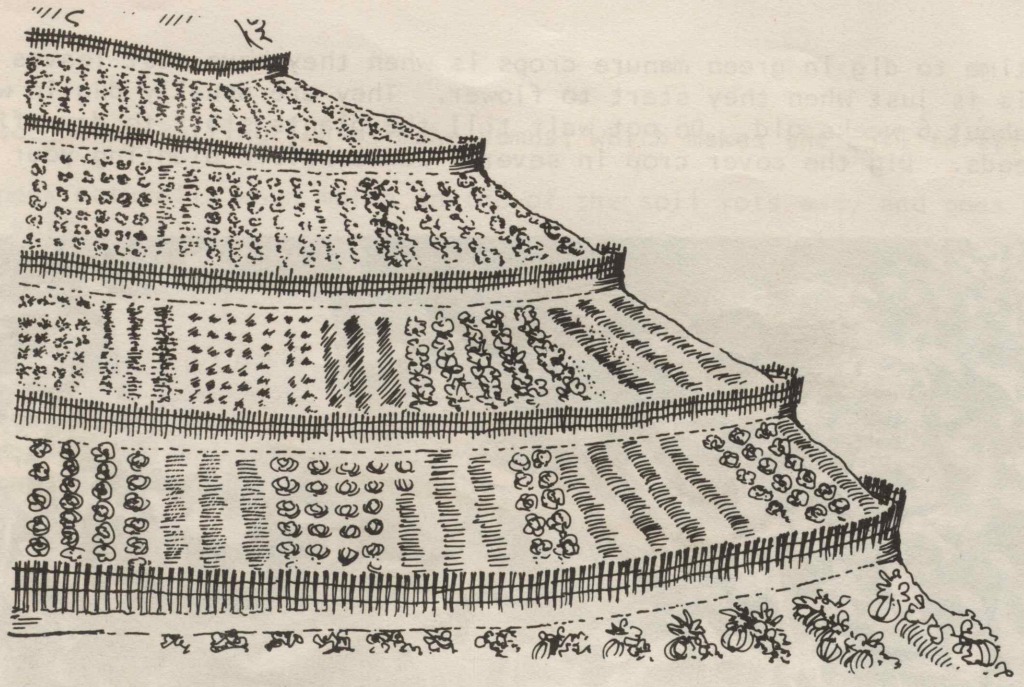
This is a good idea even on flat ground.



This picture is an example of strip cropping

Fences

In some parts of the highlands, farmers who have to farm on steep land, put in fences across the slope. These fences are close together (2 to 3 metres apart). They catch soil that is eroding (moving) down the slope. This prevents the soil leaving the garden completely and helps it to recover more quickly for the next growing season.



Build fences like this to slow down erosion

HOW TO IMPROVE THE SOIL

Mulch

Mulch has more than one use. Mulch is leaves, cut grass, dead plants and so on that are put on top of the soil to protect the soil from erosion.

Mulch also gives back plant foods to the soil, because when the leaves rot they go back to the soil.

A third use for mulch is to stop weeds from growing.

A fourth important use for mulch is to stop the soil from drying out.

Cover-crops

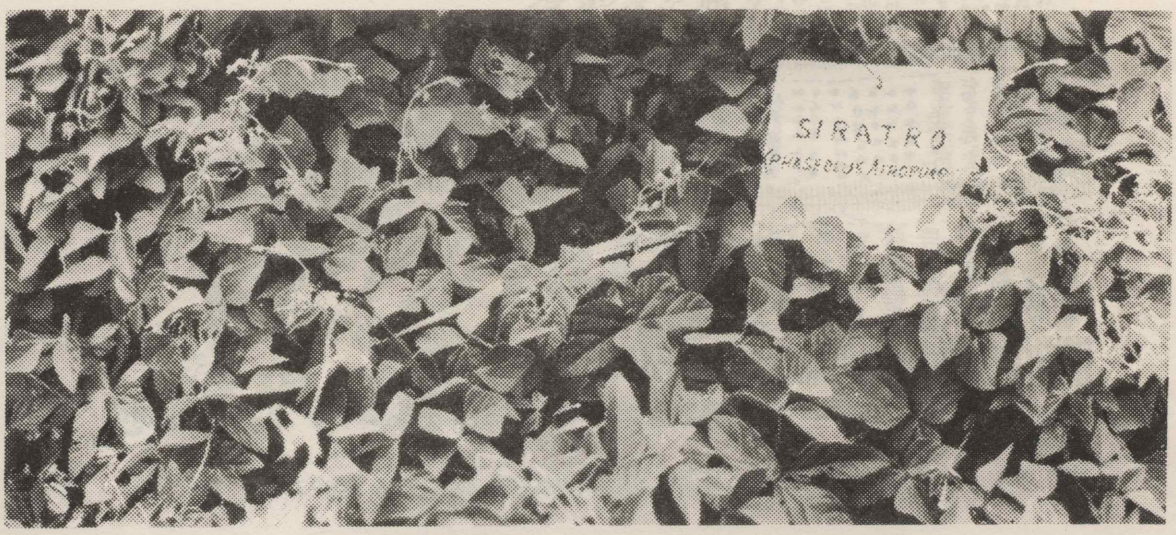
Cover-crops have two uses. They protect the soil from erosion. They also give back plant foods to the soil.

The cover-crop is not harvested by the farmer. Therefore the plant foods are not taken away from the soil. When the farmer wants to get rid of the cover-crop, he does not take it away. He digs the plants into the soil, so that they can rot in the soil and give back their plant foods.

The kinds of plants that are used as cover-crops always belong to a certain plant family, the legume family. The reason is that plants from the legume family are especially good at improving the soil.

Sometimes a cover-crop is grown especially so that it can be dug into the soil to improve the soil. When this is done we usually use the word green manure instead of cover-crop. Green manure and cover crop are actually the same thing, but we use "green manure" when the plants are going to be dug back into the soil while they are still young and green, and "cover-crop" when they are going to be left growing for a long time to protect the soil.

The best time to dig in green manure crops is when they have most leaves on them. This is just when they start to flower. They are usually dug in when they are about 6 weeks old. Do not wait till the plants start to dry off and produce seeds. Dig the cover crop in several weeks before planting your food crop.



Plant a cover-crop on a land that is not going to be used for a long time

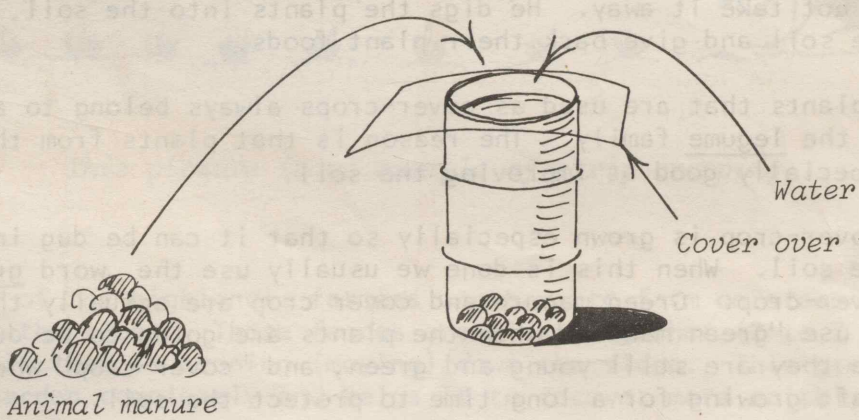
Manure

Manure also contains a lot of plant foods. It is made from animal droppings.

If you have poultry, pigs or cattle, collect the droppings and use them to make the soil more fertile.

Animal manure is never put straight onto the garden. It should be mixed with soil, and dug over every 2 weeks, until it is well rotted. When it is well rotted it can be used safely on the garden. It can burn the plants if it is put on fresh.

Liquid manure is also very useful. This is made by mixing manure with water. Some fresh animal manure is put into the bottom of an old 200 litre drum, to a depth of about 30 centimetres. The drum is then filled with water. The mixture is stirred, and then the top of the drum is covered, and it is left for a week. It is then ready for use on the garden. When using liquid manure be careful to pour it around the plant. If you put it on the leaves of the plant, it may burn them.



Animal manure can be mixed with water in a drum before using it in the garden

Compost

We have seen that rotting leaves make humus, which makes the soil fertile.

This happens naturally when mulch on top of the soil rots away and goes back into the soil.

The farmer can make this happen more quickly by making compost.

How to make compost

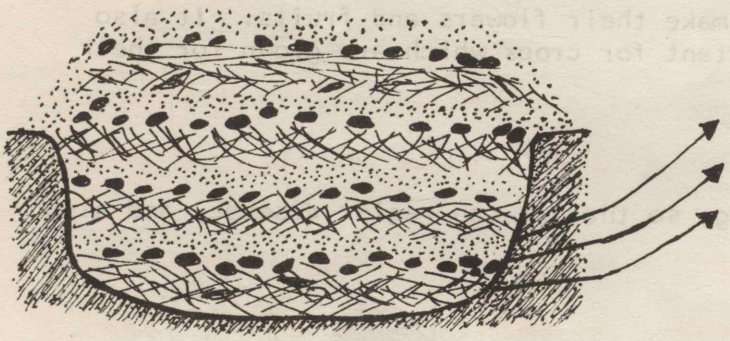
Dig a large hole. Throw in the rubbish from the crops, leaves, grass, weeds, vegetable peelings and leftover food from the kitchen. Anything that will rot quickly can be put on the compost heap. They contain plant foods.

Do not put sticks or weeds with seeds onto the compost heap.

To help the rubbish rot properly, animal manure should be added.

Cover 15 centimetres (cm) of rubbish with 5 cm of soil, and pour on water to help it rot if there is no rain.

Keep on adding more rubbish, and covering it with soil in layers until you have a big heap.



Compost made in a hole

If the climate is hot, have your compost heap in a shady place, or make a shade cover, so that it will not get too dry. Add more water if the heap gets dry.

If the climate is wet, do not make the compost heap in a hole. Put it on top of the ground in a fairly dry place. Make a cover over the compost heap to stop it from getting too wet.

Important. If any of your plants get a disease, or have insects on them, burn these plants. Do not put them on the compost heap, or the germs from the diseased plants and the insects will mix with the compost.

Every 3 or 4 weeks, dig up the heap to mix the rubbish and the soil.

When the whole mixture is well rotted, you can use the compost in the garden. The compost is very rich in humus and plant food.

If the climate is wet, make your compost heap on dry ground

Fertilizers

Manure and compost are the best things to use to make your garden more fertile, but if you do not have enough of these, then you can buy fertilizers.

Fertilizers are plant foods in a very strong form. Only a small amount of fertilizer is needed for each plant.

Ask the didiman for advice if you want to use fertilizers. He will tell you how much to use for each crop.

The names of the three most important plant foods are nitrogen, phosphorus, and potassium.

You can buy fertilizers with just one of these plant foods, or a mixture.

The most common fertilizer contains a mixture of all three of these plant foods. It is known as NPK fertilizer.

Nitrogen (N)

Nitrogen makes plants grow, especially the leaves.

Phosphorus (P)

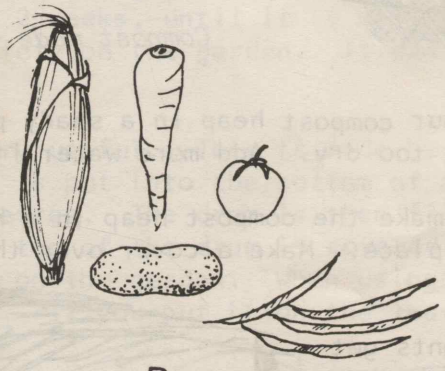
Plants need phosphorus to help them make their flowers and fruits. It also helps the roots grow, so it is important for crops which are grown for their roots.

Potassium (K)

Potassium helps make the plant strong, so that it can resist disease, and also helps it to stand up to dry weather.

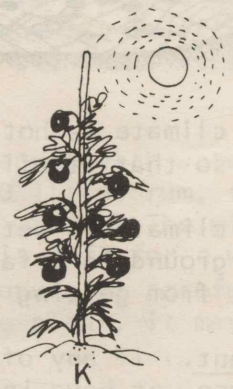
N

Leafy vegetables use a lot of nitrogen



P

These kinds of vegetables use a lot of phosphorus



K

This kind of plant uses a lot of potassium

There are also other foods which the plant needs, but there is usually enough of these foods in the soil, so you do not need to add them as fertilizer. Here is a list of other plant foods: calcium, magnesium, zinc, sulphur, copper, iron, boron, chlorine, manganese and molybdenum.

Crop rotation

If the same crop is grown on the same land every year, the harvests get much smaller, as the soil loses its fertility.

If the crop on the land is changed every time, the harvest can stay good, and the soil stays fertile.

This is called crop rotation.

Why crop rotation is useful

1. *Using different plant foods.*

Different plants use different kinds of plant foods. For example, yams use a lot of potassium, corn uses a lot of nitrogen and peanuts use a lot of phosphorus.

If different kinds of plants are planted one after the other, then all the different plant foods will be used evenly.

2. *Using all parts of the soil.*

Some plants take their food from the top layer of the soil, while other plants send their roots deeper to find plant foods deep down in the soil.

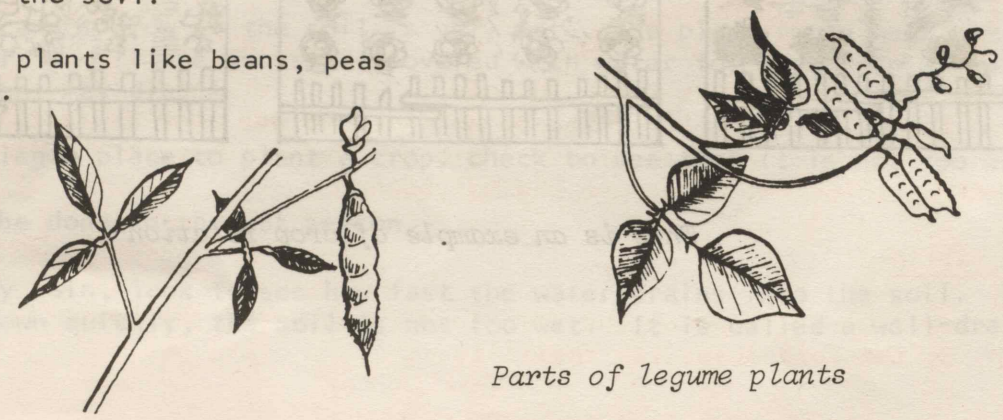
It is a good idea to plant shallow-rooted plants first, and deep-rooted plants afterwards.

Use all parts of the soil by planting a shallow rooted crop and a deep rooted crop

3. *The plants belonging to the legume family are always used in a rotation.*

This is because these kinds of plants give the important plant food called nitrogen to the soil.

Legumes are plants like beans, peas and peanuts.



Parts of legume plants

4. Controlling insects and disease

Rotation also helps to stop diseases and insects from spoiling the crop.

The first year that a crop is planted on new land, the insects and diseases are not too bad. But if the same crop is planted again, the insects and diseases become much worse, and sometimes they completely spoil the crop.

Most diseases and insects only attack one particular type of plant. If the crops are changed, then these diseases and insects do not have a chance of building up to dangerous levels.

How to choose a rotation

Rotation is used for crops that grow quickly and are finished within a short time, for example, vegetables, peanuts, corn, sorghum, banana and other crops.

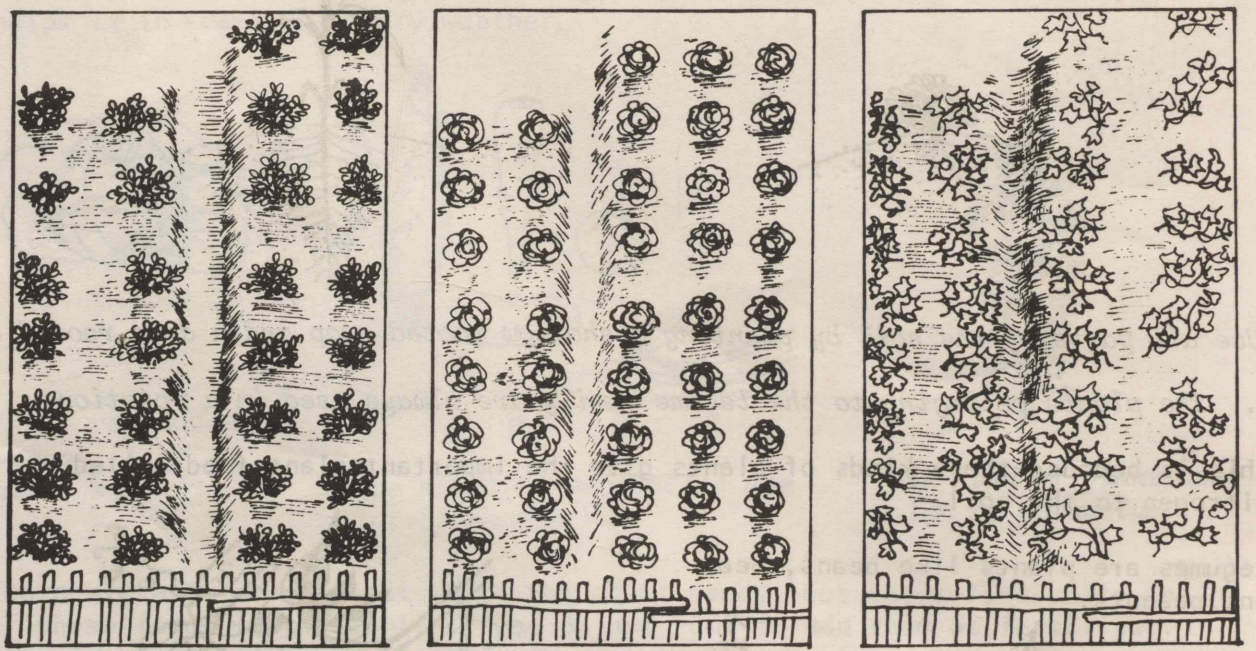
First of all you have to decide what crops can be sold in your area.

In Port Moresby, for example, peanuts, cabbage and sweet potato can be sold.

Peanuts, cabbage and sweet potato are good for rotation, because they use different plant foods. Peanuts and cabbage are shallow-rooted, and sweet potato is deep-rooted. Peanuts are a legume, they give nitrogen to the soil, try to leave the peanut roots in the soil. Cabbage uses a lot of nitrogen.

Peanuts can be grown first on the land, then followed by cabbage. After this plant sweet potato. Then plant peanuts and repeat the rotation again. All these crops can be grown at one time in different parts of the garden.

Peanuts *Cabbage* *Sweet potato*



This is an example of crop rotation

Rotation is always used in a vegetable business. Working out the rotation programme is a difficult problem. You should ask the agricultural officer to get the advice of an agronomist to help you work out your programme.

Intercropping

The custom of growing many kinds of crops all mixed up in one garden is similar to rotation. The different plants take different plant foods from the soil, but this time they are all growing together, instead of one after the other.

This method is useful for the small home garden.

This picture is an example of intercropping

Drainage

Most plants cannot grow if the soil is very wet. The plant roots need air as well as water, and if the roots are covered with water for more than a few days, the plant may die.

Before choosing a place to plant a crop, check to see that it is not too wet.

This should be done in the wet season.

After a heavy rain, look to see how fast the water drains into the soil. If the water goes down quickly, the soil is not too wet. It is called a well-drained soil.

If the water lies on the surface for several days, the soil is not well-drained. This would not be a good soil for planting tree crops in and you may have to dig drains to grow food crops.

It is best not to use land that is very wet. However, if there is not much land available, the wet land can be improved by digging drains to help the water run away.

MORE INFORMATION

A film called "Living off the land" can be borrowed from the United Nations Information Office, Port Moresby.

Acknowledgements

Technical information: L. Sewell, G. Tyrie and P.B. Bull. *Editors:* Maureen A. Wright and A. Kikala. *Illustrations:* Christina Croft and B. Siwaka. *Photographs:* Office of Information.

METRIC INFORMATION

1 centimetre	= 0.39 inches	1 kilogram	= 2.2 pounds
2.54 centimetres	= 1 inch	0.45 kilograms	= 1 pound
30 centimetres	= 1 foot	1 tonne	= 1,000 kilograms
1 metre	= 3 feet 3 inches		= 2,200 pounds
0.91 metres	= 1 yard	1 litre	= 1.76 pints
1 hectare	= 10,000 square metres	0.57 litres	= 1 pint
	= 2.47 acres	4.55 litres	= 1 gallon
0.4 hectares	= 1 acre		

FARMING NOTES SERIES

1 Looking After the Soil
2 Sorghum
3 Corn (Maize) (Kon)*
4 Goats
5 Passionfruit
6 Rice
7 Peanuts (Ol Pinat)*
8 Pineapples
9 Sweet Potato (Kaukau)*
10 Vegetables
11 Rubber
12 Bananas
13 Coconuts
14 Pyrethrum
15 Wildlife
16 Pepper
17 Chillies
18 Cardamom
19 Winged Bean (As Bin)*
20 Soya Bean
21 Arabica Coffee
22 Robusta Coffee
23 Cocoa
24 Fattening Pigs (Mekim ol Pik i Kamap Fatpela)*
25 Moscovy Ducks (Ol Pato)*
26 Fruit and Nut Trees
27 Potatoes
28 Beekeeping (Lukautim Binen)*
29 Poultry - Australorp Chickens (Ol Kain Kakaruk - Ol Ostrelop Kakaruk)*

* Pidgin versions

PRINTED BY dpi Department of Primary Industry
Printing Section, Hohola.