



Food and Agriculture
Organization of the
United Nations

Woakem land kam up gud fala



Sustainable land management for
small-holder farmers in Solomon Islands

Woakem land kam up gud fala: Sustainable land management for small-holder farmers in Solomon Islands

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The Food and Agriculture Organization of the United Nations (FAO), supported by the Global Environment Facility, embarked on a project to improve sustainable forest management in the Solomon Islands. The project components included (i) development of the terrestrial protected area network, (ii) integrated land management, and (iii) capacity building for the management of forest carbon. FAO engaged Live & Learn to address part the second component, focussed on the outcome 'poor land-use practices reduced or reversed in and around protected areas.' This technical manual is one of the outputs of that work.

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Disclaimer: This edition is a pilot edition for field testing with 200 farmers involved in the project. The contents of this publication are the sole responsibility of Live & Learn and do not reflect the views of FAO or the Government of Solomon Islands.



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Introduction

Growing crops well and looking after our forests is important for the health of people, animals and our landscape in the Solomon Islands.

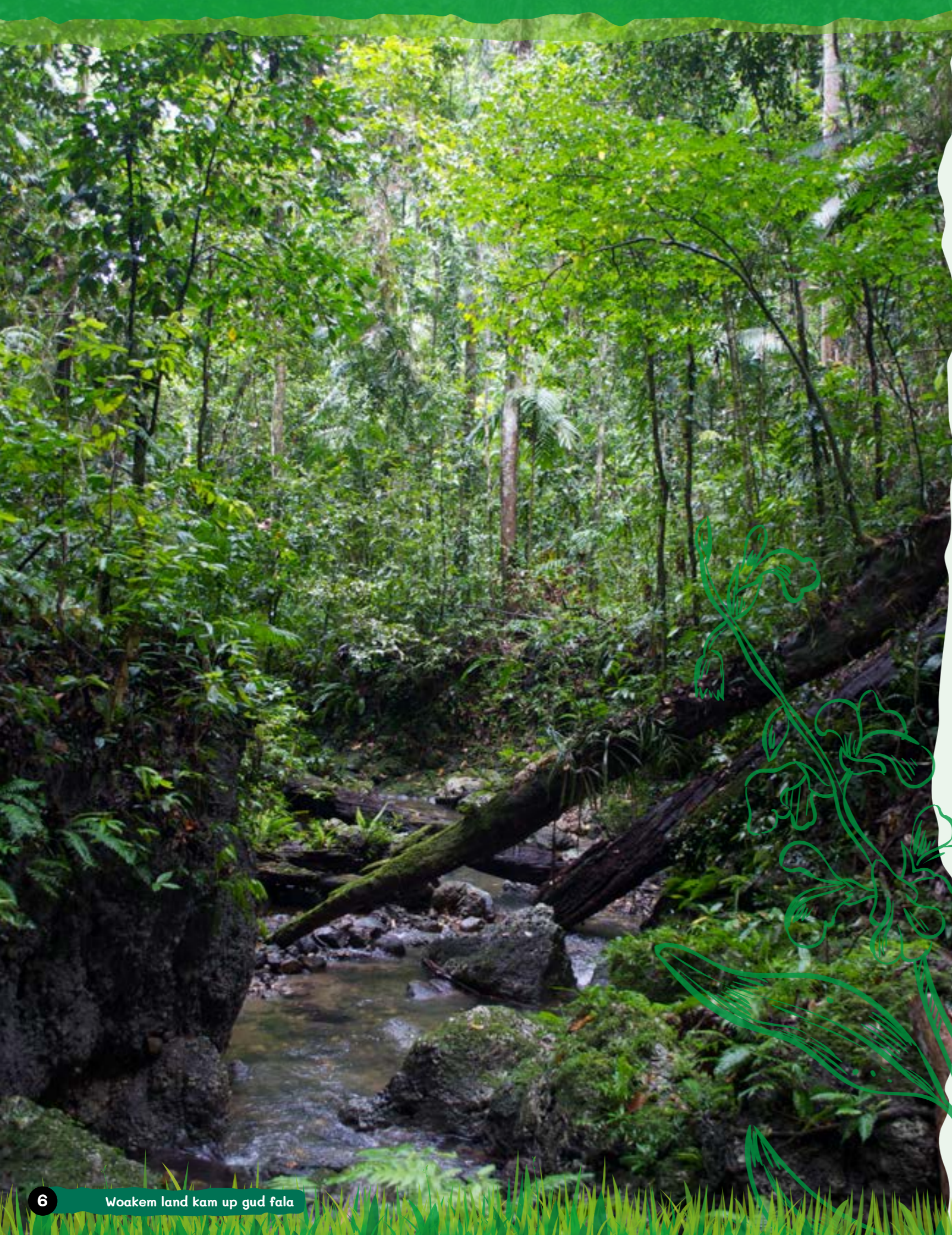
But the Solomon Islands faces problems from forest clearing due to growing population, and drought and flood. These problems are being made worse by climate change.

In the Solomon Islands, soil fertility, or the ability of the soil to produce good crops, is declining. Valuable topsoil is also being eroded by wind and rain. Floods and drought and not looking after the soil make this worse.

Farmland with a mix of crops and good soil helps to deal with these changes. Stronger plants and different types of crops are better able to deal with unusually dry or wet periods.

Healthy farmland and healthy forests are linked. Forests are valuable for biodiversity – having a mix of plants and animals – and for providing food, wood and income. Forests also keep our farmland healthy by storing water and keeping rivers clean, by providing shade and nutrients for soil and preventing landslips. Without forests, resources are lost, soil and water are poorer, and the weather is warmer and drier.





Why was this guide written?

During 2020 Live & Learn Solomon Islands surveyed 180 village farmers from Choiseul, Guadalcanal, Malaita, Makira, and Western provinces in the Solomon Islands about their challenges and successes in farming. Many of them are already using good farming practices, but there was high interest in improving their knowledge and skills in the following areas:

- soil fertility and preventing erosion/loss of topsoil
- reducing the impacts of flood and drought on land and crops
- increasing crop mixes and yields in existing land
- agroforestry

The survey report recommended that practical technical advice be provided for farmers and agriculture extension workers that address the above concerns. This *Woakem land kam up gud fala* guide is the result of talking with the village farmers and Ministry of Agriculture and Livestock staff.

This guide gives practical advice on methods such as cover cropping, mulching, composting and contour farming, which can be added to traditional methods.

Working with other farmers and with extension officers is also helpful for finding out the best ways to farm. While this manual gives you valuable information, you can get further information or more specialised information (e.g. atol farming, commercial crops and plantations and livestock management) from extension officers and the Ministry of Agriculture and Livestock. Crop fact sheets are also available from Live & Learn Solomon Islands.

This guide contains helpful information about sustainable land management, which the Food and Agriculture Organization of the United Nations (FAO) recommends.



Who this manual is for and how to use it

This manual is designed for farmers and community members working in plantations and gardens in the Solomon Islands.

The first chapters help you think about how plantations and gardens are connected to other parts of the landscape and the importance of healthy soil.

In the second part of the guide, further chapters are about ways of making the land more productive, so that we can continue farming while also protecting our valuable forests.

These chapters look at the following topics:

- reducing digging
- crop rotations
- alley cropping and intercropping
- composting and mulching instead of burning
- farming on hillsides
- using trees in plantations and conserving forests
- controlling pests.





What is Sustainable Land Management?

Healthy Land – Healthy People

What is sustainable land management?

Sustainable land management, or 'woakem land kam up gud fala', means using the land we have in healthy ways so that we can keep using it in the future. It means farmers and everyone in the village working together to protect gardens and surrounding forests and waterways. The health of a garden depends on what we do in the garden, and also what happens on areas around the garden or village.

The health of our land depends on what farmers do on the land. It also depends on the climate, and what other agricultural workers, such as foresters, can do on the land. Farmers can't control some of these things, but farmers can control the health of the land by using good farming practices on their gardens and plantations. Good yield will only come if good practices are carried out.

The first, key part of working the land for the future is looking after the soil. This involves using the three principles of conservation agriculture:

- covering the soil with mulch and cover crops, to improve soil fertility and reduce water loss
- less tilling or digging, to reduce water loss and opportunity for pest invasion
- intercropping and crop rotation, to improve soil fertility.

Other practices include:

- re-using left-over green material from pruning and crops
- water management
- looking after land around the farm
- using less agrochemicals
- less burning.

In the Solomon Islands, some sustainable land management practices are already used. Worn-out soil is rested by fallowing. Crop rotations and intercropping, where a variety of crops are used, stop soil becoming poor.



Why is sustainable land management important?

With a growing population around the world, it is important that we use the land we have in the best possible ways and protect our forests.

This has many benefits, including:

- saving money by re-using materials
- keeping soil fertile
- controlling erosion
- saving money by using less agrochemicals
- using water wisely
- improved income and better diet
- reducing risk of failed crops
- improving yield of crops
- reduced labour
- cleaner air through less burning
- creating microclimates that shelter farms
- keeping forests for their use in future.



We can talk to Ministry of Agriculture workers about policies that keep the land healthy and productive, and we can communicate with other farmers about good policy for the health of the land.

Climate and Climate Change

Climate change refers to a change in average conditions (like temperature and rainfall) in an area over a long period of time. While climate change will affect most of the world, impacts on small islands are likely to be particularly harsh. People living in the Pacific are already experiencing changes in rainfall patterns, more extreme weather events (such as storms or cyclones), longer dry seasons and rising sea levels.

Climate change can have natural causes, but currently climate change is being speeded by human activities that are releasing carbon dioxide into the atmosphere. Carbon dioxide is what we call a greenhouse gas, trapping warmth in the atmosphere and heating up the planet as a result. Plants contain carbon, and burning plants, coal and oil releases carbon into the air.

Climate change can have large effects on agriculture. Severe weather and flooding can damage crops, while drought and higher temperatures can make it harder to produce certain crops. Rising sea levels could flood land and make it unavailable for growing food. Severe weather may damage buildings, docks and roads and make it harder to access markets. It can also increase the number of pests and diseases.

Food crops depend on the climate (temperature, rainfall, humidity) and environment (landscape, soil and water availability) working together in harmony. Any change or shift in the climate will affect the growth of food crops. Some of the features of climate change exist throughout the year, while others have strong and regular seasonal cycles.



Effects of flooding

Coping with climate change

There are a number of ways to adapt to the challenges brought on by climate change.

How well farmland recovers after a disaster like a cyclone or strong storm can depend on how healthy land is before a disaster. The number and varieties of crops planted and the type of cropping system used all help the land and people cope with disasters.

These ways of adapting have been outlined in this guide and include the following:

● Improved varieties

Some new varieties and cultivars of crops and plantation species are being bred that cope better with wetter or drier soils, and with pests and disease. Farmers can also collect seed and planting materials from better performing plants in their own garden.

● Crop rotation and cover crops

Growing different crops on the same plot of land is a good way to improve soil health and naturally control pests, weeds and diseases. This will make your crops more resilient to the impacts of climate change. Cover crops also give the soil protection from bad weather, either dry or stormy.

● Alley and intercropping

When more than one crop is planted on the same land this makes more use of the land but also reduces the risk of total crop failure.

● Diversification of crops

Planting multiple crops also protects incomes. If one crop fails during bad weather, another may be more resilient.

● Changing planting times

Carefully note any seasonal changes brought on by climate change and change planting times for various crops. For example, climate change may make rains later or earlier, and you can adjust planting times to suit.

● Heavy mulch

Leaving plant materials on the ground (e.g. planting into an area that has been slashed, or with mulch) prevents the soil from drying out.

● Reducing carbon in the atmosphere

When soil is tilled or dug, or when plants are burned to clear land, carbon is released back into the atmosphere. Bare soil with no cover means no plants are growing there storing carbon.



But carbon can be naturally captured from the atmosphere by grasslands, soil and forests. Sustainable land management practices, as discussed in this guide, are a way to keep carbon in the soil and plants, rather than releasing it into the air. The practices you use to adapt for climate change are also the same ones that will slow down climate change.

Making the change to sustainable farming practices has many benefits, including increasing production while you save money. But most of all, they will help you create gardens and plantations that can prevent and deal with problems brought on by climate change.

ACTIVITY

Draw or make a map of the land where your crops are. Circle the areas that might be most affected by climate change. Note what problems might occur and how you can prevent them.



Soil Health

Why is it important?

Healthy soil is the basis for good farming. Good soil provides all the nutrients crops need.

The soil provides habitat for microorganisms that make good soil structure, recycle nutrients and feed plant roots, and help keep water in the soil.

Good soil acts like a sponge, holding water and slowing water flow, which then stops erosion and the loss of valuable topsoil.



HABITAT

Soil is like a miniature forest, full of bacteria, fungi and tiny animals such as earthworms. These tiny organisms break down waste, recycle nutrients, create food for plant roots and make tunnels that allow water and air to get to plant roots. Beetles and other insects eat slugs and other pests.

NUTRIENTS

The soil contains minerals that plants need to build healthy stems and leaves and fight off pests and diseases. When the soil is healthy and plants take up these good minerals, they are passed on to the humans and animals that eat the plants, giving them better diet and better health.

WATER AND AIR

The right soils have a good mix between letting water flow inside them and holding water so that the plants can use it over a long period. Good soil, with a cover of mulch, lets heavy rain soak in, rather than run off, which prevents erosion and washing valuable nutrients into streams and the ocean. Pockets within the soil that help hold water can also provide better air flow in the soil.

CAPTURING POLLUTANTS

Healthy soil can stop pollutants and heavy metals (bad minerals) getting into the water supply or food chain. Good soil with microorganisms and good water capacity can safely contain heavy metals. Microorganisms can break down many substances that can harm crops, humans and livestock.

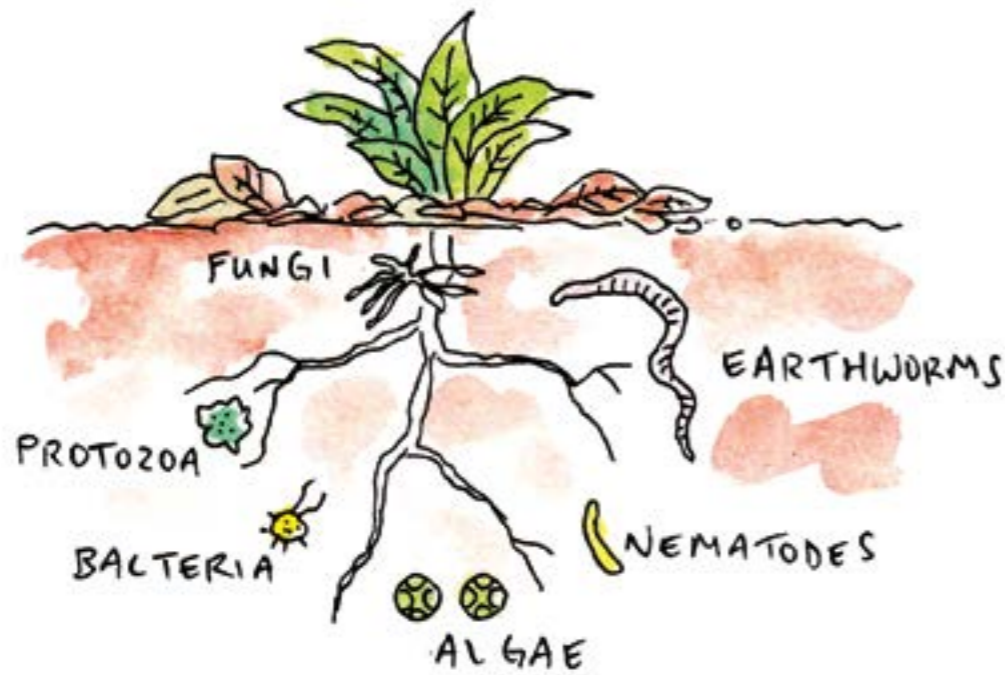


Structure of the soil

Soil is made of crushed rock and organic matter - the remains of plants and animals. It also contains millions of microorganisms, including protozoa, nematodes, mycorrhiza fungi, algae, earthworms and beetles. These all have a part to play in recycling nutrients and making the soil healthy. Beetles control insect pests, worms create holes for the soil to hold air and water, and their waste fertilizes the soil. Microorganisms feed on decomposing plant and animal matter and turn it into nutrients for plant roots to feed on.

Some microorganisms have relationships with plants whereby they feed on sugars produced from plant roots while making natural pesticides which the plants take up and use to keep away pests. They also break down minerals that plants need from the rocks in the soil. The soil is like an underground forest, with tiny plants and animals feeding each other.

It is important to keep these microorganisms healthy, because of their job of distributing nutrients to plant roots and making natural pesticides; human-made fertilizers can't do the same job.



Organisms in the soil

How soil can be degraded

When these organisms are reduced, soil is less healthy and productive. They can be reduced by:

- continuous gardening on the same piece of land
- using too many chemicals and fertilizers
- dry soil from not covering or mulching
- too much digging
- a lack of variety in crops.

Evidence from Africa suggests that growing coffee plantations continuously over a century has reduced the topsoil by about a foot. Replacing and regrowing topsoil takes a long time, and using fertilizers to give plants the nutrients they need is expensive, so looking after healthy soil is important.

Solomon Islands soil

Solomon Islands has rich volcanic soil in the hills and mountains. Low-lying areas near the sea often have sandier soils with fewer nutrients that give smaller crop yields and may need more nutrients to be added. The fertility of the soil (how much can be grown from the soil) has gone down in many places in the Solomon Islands over recent years, due to shorter fallow times, erosion and over-use. This can be fixed by adding more compost and mulch to the soil.

Soil quality has also been reduced by the clearing of forest trees, which allows wind and rain to erode the topsoil. Combining crops with trees helps to improve the quality of the soil.

Soil and water

Plants need different amounts of water, so we need to think about what type of plants grow best with the rainfall and the soil's ability to hold water. Plants absorb water through their roots. They don't thrive if they cannot access enough water through the soil. But they can also be affected by too much water. Plants also need air through their roots and too much water can stop air getting to the roots.

Different soils hold different amounts of water. Heavy soils can become water-logged and don't let much air in. But when they dry out, they can become hard and stop water getting in, preventing plants from getting the water they need. Sandy soils let the water through too quickly, and plant roots cannot suck up enough water. The best soils have high organic content – rotted plant and animal material added regularly – and lots of microorganisms. The best soils are dark and loose. Because of their good structure, both air and water can move into pockets in the soil.



In high rainfall areas and times, good drainage is important to prevent waterlogging and erosion. Drains should follow the contour lines on hills, but they should not be too steep, otherwise too much soil will get washed away with the excess water. While roots like water, stems often don't. It is helpful to plant crops on a mound, so that the water drains away from the stem but pools in the area above where the roots fan out. During dry periods, good healthy soils, mulch and nearby trees all prevent the soil from drying out too quickly.

In the wettest parts of the farm, you can plant crops that need lots of water. The plants will thrive here, and they will take up excess water. Wetlands, or places where it is permanently wet, provide homes for birds, frogs and insects that can eat pests that harm crops.

Terracing

Farmers around the world have for centuries used terracing to keep water where it is needed and prevent soil erosion on hillsides. Creating terraces is a bigger job than making drains and may need the help of an agricultural extension worker or someone with experience of building terraces, but terracing helps to keep the soil stable, and can make harvesting easier. It creates sections of flat ground. The sides of the terraces can be stabilized using grasses (such as vetiver) or hedgerow crops.



Terracing for rice growing



Care of the watershed area

Water is an important issue not just for individual farms. A farm is part of a wider area called a *watershed*. This is the area where rain falls and collects into a river or stream. The watershed area may contain land that is not farmland, and provides important benefits, besides water for farms and houses:

- timber and food from forests
- medicinal plants
- regulation of climate, storing carbon in the soil and plants, clean air.

Soil management is important for the health of the whole watershed area. Animal waste or chemicals can pollute the water and move from one farm to another in a stream. Or poor soil management and felling of trees upstream can cause flooding downstream and the loss of valuable topsoil. The management of watershed areas may involve the whole village, or even work between communities.

Stop burning!

Burning is a traditional agricultural practice, but it is generally not good for soil. And since we want to keep forests to keep our lands healthy, we shouldn't be burning forests to create more agricultural land.

Ash can provide extra nutrients for plants, but it is just as good to use mulch rather than burn plant material. If it is windy or rainy, ash can blow or wash away, especially into rivers where it can upset plants and animals that live in the river.

Trees that are good for windbreaks don't thrive when the plantation is burnt. And good birds and insects are discouraged by fire. Burning a plantation also kills some of the organisms in the soil that we need to keep the soil healthy.

Burning also puts more carbon dioxide into the atmosphere, so if we stop burning, we slow down climate change.



Conservation Agriculture

Soil health is improved by using what is called *conservation agriculture*. There are three main parts of conservation agriculture:

1. covering the soil
2. no or limited tilling/digging
3. intercropping and crop rotation.

This guidebook looks at why each of these parts help the soil. It is important that all three practices are used. While each is good on their own, they will not be as effective as using them together. Conservation agriculture works because each of the three practices boosts the other ones.

Covering the soil

Bare soil is in danger of blowing or washing away, in high winds and heavy rainfall. And bare soil loses water quickly. Covering the soil is needed to prevent this. You can do several things to cover the soil:

- Use the left-overs from harvested crops (which you can leave in the field to slowly break down)
- Use mulch (from left-over, dead plant material such as straw and leaves)
- Use living cover crops, or green mulches.
- Plant trees or use forest trees for shade.

No till/less till

Using less digging (or tilling), or no digging at all helps in the following ways:

- Less digging keeps the soil structure, such as the tunnels worms make that allow for water flow.
- Worms and microorganisms are able to break down the mulch on top of the soil to add nutrients.
- The soil holds water better so heavy rain doesn't wash topsoil away and flooding is decreased.
- Soil is not washed into rivers and creeks.
- Less digging provides less opportunity for pests and weeds to start growing.



Instead of digging, you can simply plant seeds directly into mulched soil. A traditional way of planting in the Solomon Islands is to make holes for seeds with a sharpened stick. Otherwise, making a very narrow furrow is better for the soil than digging up all the soil in the field.

In a study of the health of the soils in fields in a part of Africa, scientists found that there was ten times as much soil eroded — either blown away or washed away — from heavily ploughed fields than from those fields where low or no tillage methods were used.

Intercropping and crop rotation

Intercropping is the practice of growing more than one crop at once, side-by-side in the plantation. Crop rotation is the practice of using multiple crops (at least three) in a seasonal cycle. There are many good reasons to do this, and they are used already in the Solomon Islands:

- Growing different crops provides multiple sources of income or food.
- The plants feed each other.
- Plants also have differing root lengths, so if you use a variety of crops, they take nutrients from different depths in the soil.
- Different crops also attract good insects and repel insect pests.
- By covering the soil and not leaving it bare, by planting another crop in a crop rotation cycle, weeds don't have as much chance to grow.

Another benefit of conservation agriculture is that more carbon is stored in the soil. Carbon feeds the microorganisms in the soil. Conservation agriculture also reduces the use of agrochemicals, so when using it, you are helping to reduce pollution in the soil and in waterways.



Sustainable Land Management Methods

Cover Crops

Cover cropping means growing low-lying crops to protect the soil from the impact of rain, wind, and human and animal activity. These crops are sown between key planting, or when land is fallowed, and can provide a secondary food source. Cover crops can also prevent weeds, improve soil health, slow erosion and help control pests.

Using cover crops contributes to making the garden more like a forest, where there are various plants. The tallest fruit trees occupy the upper storey, with other crops of varying heights forming the other layers. Each plant has its purpose. Low-lying plants help the soil retain moisture and provide compost, like leaf litter in a forest.

The use of legumes, or plants from the pea family, for cover crops is good because they add nitrogen to the soil. This may be useful following heavy feeders such as maize. One of the best cover crops in the Solomon Islands is Pueraria.



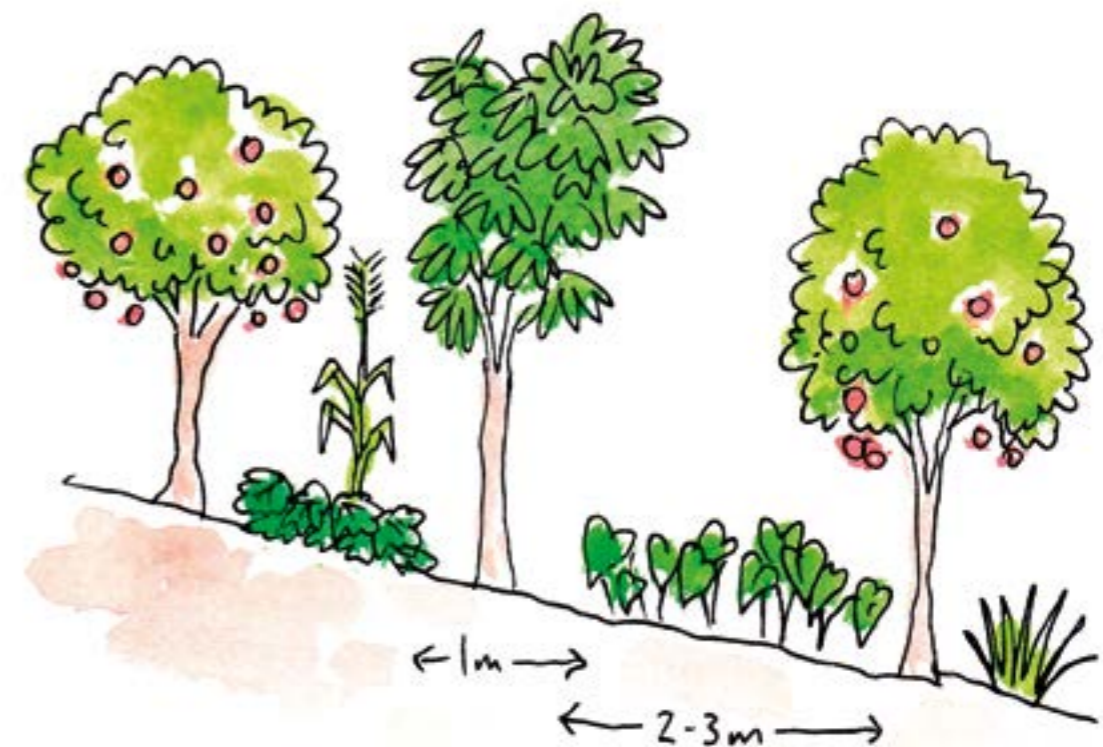
Plantation mixing crops and cover crops

How to plan your cover crop

You will need to choose a cover crop that fits into your current rotation or develop a new rotation to take advantage of the benefits of cover cropping. There might not be just one cover crop that is right for your use, so it is important to plan how you will use cover crops.

To plan where your cover crops will go and how they will be used, try the following exercise:

1. Look at your rotation and make a timeline on a piece of paper mapping out when you typically seed crops and when you harvest them over the course of several years. Make a space for each piece of land/block you farm.
2. Add in any extra information, such as when there is the most rainfall, which times are drier, when you use the most labour, and so on.
3. Now look for open times in each block and take note of less-used spaces throughout the year. You might notice that some spaces are unused over certain seasons; you can fill these with a cover crop.



Use spaces between trees for crops

An example of an unused space on your plantation might be between trees or tree crops.

Keep in mind that you can mix two or more species, or try several options in small areas. Note that when planting cover crops, some weeding may need to be done at first.

Cover crops take up nutrients from the soil that might be lost with runoff or erosion and return them when they are left to rot as green manure. This is in addition to these 'living mulches' providing year-round weed control and protection from soil erosion.

Pest and weed control benefits

Cover crops can reduce attacks by insects, weeds and diseases. By feeding your other crops, cover crops make them stronger and better able to resist pests and diseases. This system can minimise reliance on pesticides, which will cut costs, protect the environment and reduce your exposure to chemicals.

Cover crops can help keep the health of your soil while helping and encouraging good pest predators, such as beetles, lizards and birds. It is best to avoid practices that involve pesticides, tilling or burning so that your cover crop can encourage these predators. Cover crops cover weeds, blocking sunlight, which will slow down or stop their growth. They will also out-compete weeds for nutrients and water.

Which plants should I use?

Ministry of Agriculture and Livestock extension officers can advise on the best cover crops for your area. Possible cover crops include pueraria, mucuna and calopo, which are used currently in the Solomon Islands.



No-till and low-till methods

On many farms digging over or tilling is used to break up the soil before planting. This is done to loosen the soil so that seeds or seedlings can be easily planted, and to prevent weeds growing. Digging also stirs up nutrients so that they are available for plants to feed on.

But there are some disadvantages to digging. While plants may grow better the first year after digging, nutrients in regularly dug soil are quickly reduced. Digging can disturb or kill microorganisms in the soil, such as fungi and worms, that help to break down dead plant material so that plants can feed on it. Digging also destroys the tunnels worms and other organisms make in the soil that are helpful for keeping water in the soil and allowing roots to grow freely.

Digging loosens and dries the soil, which can then blow away easily. If the soil is loose it can also be easily washed away in heavy rain. Mulching and cover crops are better methods because they protect the soil from drying out or being washed away.

When digging, soil can be compacted, or squashed, by whoever is digging. When soil is compacted it can form a crust on top, which can prevent water from flowing into the soil and increases runoff that creates flooding and erosion.

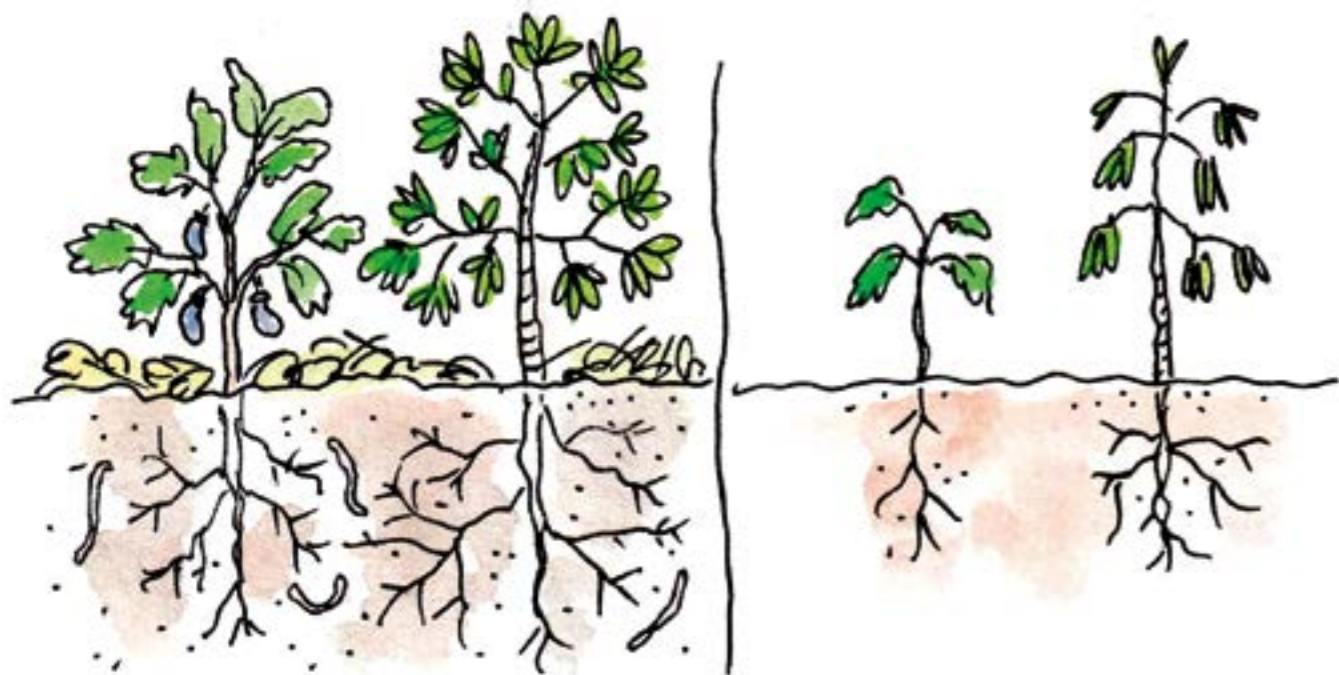
In the Solomon Islands some farmers use low-till methods when they use a digging stick to plant, rather than turning over all the soil in a garden. Furrows for seeds or seedlings should be small and should not disturb the soil of the whole garden. Mulch or cover crops can then be used in-between furrows.

Mulch

Mulching of the land means covering the soil with leaves, straw or other organic matter, to reduce weeds, retain moisture and keep soil healthy. Old plant material that has been cut in the plantation, or from the forest, can be used as mulch.

Mulching is a cheap way of improving soil quality and crop yield because you can usually use 'waste' plant material that is already in your garden or forest.

Weeds, shrubs and young trees can be shredded and used for mulch and compost. Rather than burning, an area can be cleared using a bush knife and the slashed plant matter can be left to cover the ground as mulch.



Use mulch to prevent drying of soil and plants wilting

Why use mulch?

There are three main purposes of mulching:

1. Mulch stops the growth of weeds. When the soil is covered with mulch, weeds don't get sunlight and can't grow through the mulch.
2. Mulch keeps moisture in the soil and keeps it cool. When the soil is covered by mulch, the hot sun can't dry out and heat up the soil, drying out plants and killing helpful microorganisms in the soil.
3. Mulch stops heavy rainfall from washing away valuable topsoil. When the raindrops hit the mulch, they are slowed down and gently trickle into the soil, rather than quickly running off and carving up the soil.



Using mulch on young plants

Additionally, decomposing mulch can add nutrients to the soil taken out by growing crops. Mulching the soil feeds the plants. Branches and leaves rot and add organic matter to the soil. This allows plant roots to gain nutrients and grow healthy and strong. Cover crops can be grown in the plantation and then cut down to act as mulch.

Organisms such as worms and fungi that live in the soil are protected and healthier under mulch. They then do a better job of feeding plants and digging holes in the soil, allowing for better movement of air and water in the soil and their use by plants. Using mulch in place of digging the soil to remove weeds can save labour time, and the soil is less disturbed. This means those microorganisms are better able to do their jobs, and soil structure is not broken.

Green manure

Green manure is a crop grown specifically to restore nutrients back into the soil. Green manure is created by leaving parts of uprooted or cut crops on the ground of your field and letting them rot. It works the same way as mulch does.

Compost

Benefits

Compost is organic matter that is broken down and used as fertiliser to improve your garden's growth. It can be added to garden beds, around vegetable crops or to the base of plantation trees to add extra nutrients. Compost adds nutrients to your plants and improves the health of your soil.

Making your own compost out of organic waste is simple, cheap and reduces waste. Composting can be made from weeds, the left-overs of crops after harvesting, household plant scraps and other plant waste.



Making compost

Compost should be made near the place that you want to use it. This means making a bay for your compost if you have the space to do so. Having a special place for your compost will protect it from animals and people. When choosing your compost space, it is important to think about:

- creating a storage area next to the compost for compost materials
- building a wall around your compost heap or using a living fence of trees or plants. If you create a living fence the trees can feed the compost and the compost can feed the trees
- putting your compost heap between the animal house and your garden. This will make manure easier to move to the compost heap.

There are many different ways to make compost, depending on what you have available.



HOT COMPOST RECIPE

INGREDIENTS

3 parts brown, 3 parts green and 1 part manure

▶ **Brown** – fallen leaves of trees, rotten coconut logs

▶ **Green** – green leaves, weeds (without seeds)

▶ **Manure** – pig manure, human urine, old compost

Extras – Seaweed, ash, fish waste (to provide essential nutrients that are lacking in the brown, green and manure ingredients)

EQUIPMENT

The only tools needed are a pitchfork, shovel or rake and a waterproof cover.

METHOD

1. Make a base 20cm high with sticks or coconut husks to help air movement.
2. Add a 25cm layer of brown materials.
3. Sprinkle two shovels of ash over the brown layer.
4. Follow with a 15cm layer (width of your hand) of green materials, including fish waste or urine.
5. Add some dark soil from the pig run and/or a sprinkling of old compost.
6. Sprinkle water over the layers so they are not dusty.
7. Repeat the brown and green layers, watering lightly after each layer, until the heap is 1 metre high.
8. Cover the heap with a tarpaulin or banana leaves or palm fronds (we want it to get steaming hot inside).
9. Wait for 2 or 3 days, then check the temperature by pushing a knife into the centre of the compost pile and testing the temperature of the blade against the back of your hand. The knife blade should be hot to touch when you pull it out.
10. Leave the pile to heat up for 1 week, then turn the compost every two days. Make sure the pile is not too wet or too dry – you should be able to squeeze a drop of water out of a big handful after 4 days.
11. By day 18 the finished compost pile should be the same size as at the beginning, but everything has changed to a dark colour, with fine texture (not too many lumps) and a slightly warm temperature.

Always wash your hands with soap and water after working with compost.



Brown:



DEAD LEAVES, ROTTING LOGS

Green:



GREEN LEAVES

Manure:

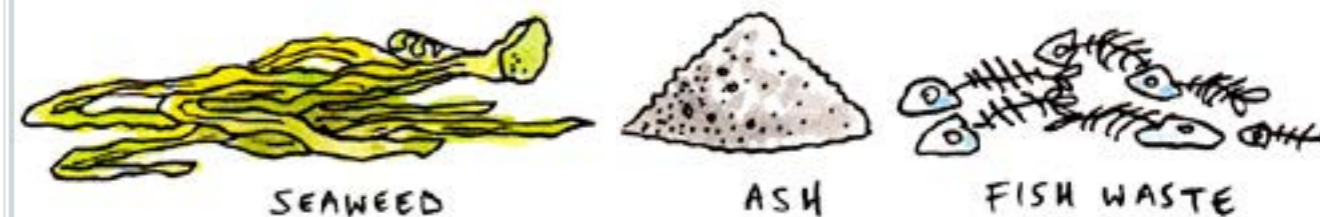


PIG MANURE

URINE

OLD COMPOST

Extras:



SEAWEED

ASH

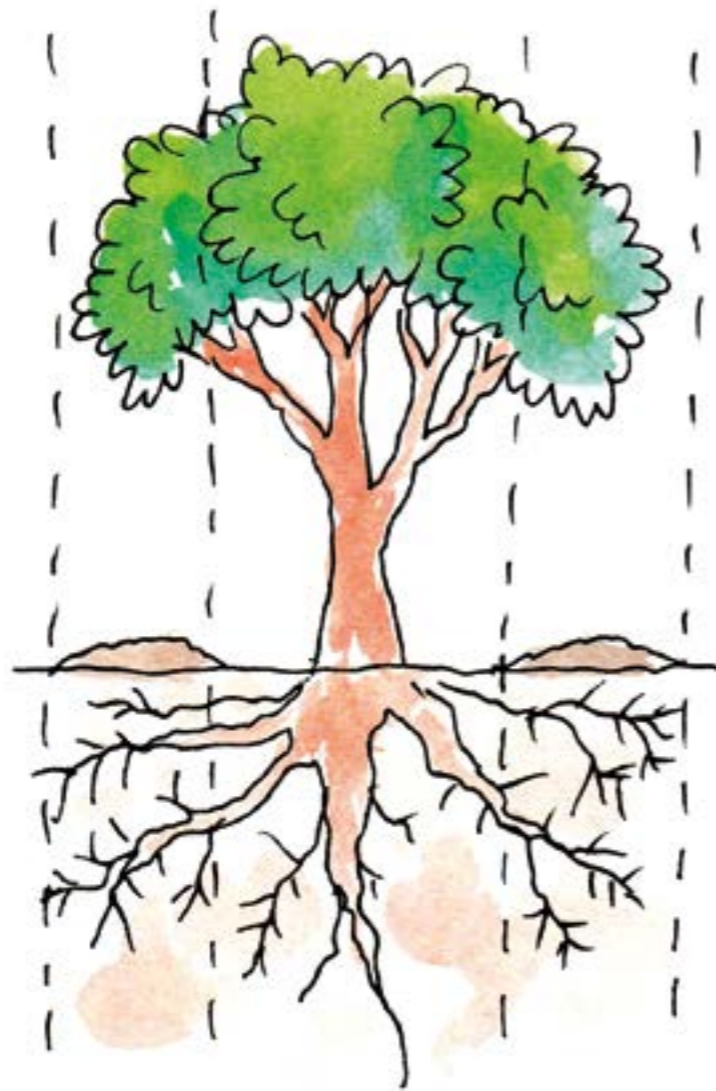
FISH WASTE

Using compost

Put compost on the ground two weeks before planting seedlings. This will give the compost time to sink into the soil. Then, wait two weeks after planting the seedlings before adding more compost.

A general rule is to apply two big handfuls of compost per seedling, and four big handfuls for each mature vegetable. If you are putting compost around trees, the best place to put it is directly underneath outer leaves, where the roots can be easily fed. Do not put it around the tree trunk. Compost and fertiliser can cause rot if placed too close to tree trunks.

To improve results, cover the compost with a layer of mulch. This will protect the compost and make sure it goes into the soil.



Place compost away from the trunk of tree or plant

Tips:

- Start a new compost heap when one heap is half ready. Planning ahead like this will make sure you never run out of compost.
- If the compost smells sour there could be too much manure. If plant material has not decomposed, there might not be enough manure or it is not moist enough.
- Anything that has lived before can be composted, so all organic materials can be put into the compost pile. Are they brown (dead, dry, like paper) or green (still a bit alive, wet, like green leaves and food scraps from cooking)?
- It is better not to put meat into the compost pile (it attracts rats or pests).
- No plastic can be composted.
- Animal manure is an important source of nutrients and organic matter. Chicken manure is the best due to the combined urine and waste in the manure, but all animal manure is useful. Make sure the animal manure has been left for some time (3 months for chicken manure) before using it in your gardens. Do not apply fresh animal manure, especially chicken manure, to your plants as this will burn the plants.
- Sun, rain and wind can decrease the quality of the manure. Rain washes out the nutrients in the manure, while wind and sun dry up the manure, killing the microorganisms and evaporating nutrients like nitrogen. It is important to keep the manure covered under a shelter and to protect it by covering it with mulch after putting it on garden beds.

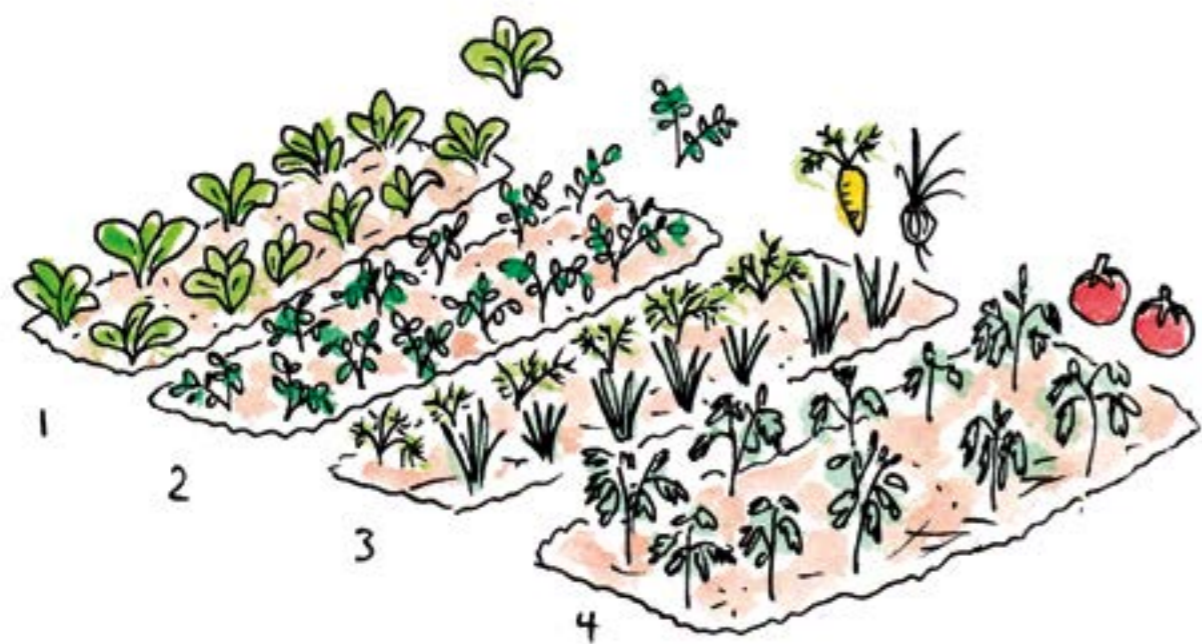
Crop Rotation

Crop rotation means growing a different crop each year or each season, in a cycle. This is usually done with at least three different crops, and with a different cycle for each block. This is a practice already used in the Solomon Islands.

Crop rotation is a way of using one crop to benefit the next crop, and to keep the soil healthy and with a balance of minerals. Rotation prevents soils becoming worn-out.

The types of crops chosen will depend on what they take out of the soil and what they put back in. Usually crop rotation includes one legume plant (such as peanuts and beans) to replace the nitrogen taken out of the soil by previous crops. Legumes do this by taking nitrogen out of the air with their leaves and putting it back into the soil via their roots.

In a rotation, land is usually left fallow for it to recover. This can be helped by growing another crop that adds nutrients to the soil (and offers another crop for cash or feed). Green manure crops – crops that can be chopped down and used as mulch – and compost to feed the soil for the next crop can be added into the cycle.



A rotation example using four crops



Crop rotation and intercropping on a Solomon Islands farm

Crop rotation is part of conservation agriculture, and should be mixed with cover cropping, no or less digging and attention to keeping the soil healthy. The benefits of crop rotation include:

- good soil structure, which is good for soil microorganisms
- less crusting of topsoil, which means water can penetrate the soil easier
- less compacting of the soil, which lets roots spread easier
- less erosion, meaning good soil is not washed away.

Additionally, with crop rotation, nitrogen is being added back into the soil naturally through crops rather than adding fertilizer. This removes the danger of excess fertilizer being washed into rivers and contaminating water supplies and fisheries. When plants in the crop cycle are replacing nutrients in the soil, these nutrients are also released more slowly.

Controlling pests

Rotation also helps to repel pests by not giving pests the same type of food each season. Growing the same crop over and over increases the numbers of pests that feed on that crop.

You can encourage a healthy mix of pest predators by rotating and mixing crops. Different pests like different crops, and those pests have different predators that like to eat them. These predators include lizards, birds, frogs and spiders. Many farmers also use their own organic pesticides. Some examples are included in the sections later in this manual.

Crop rotation examples

Rotation needs to be planned but it also needs to allow for changes when conditions change. Varying the crop cycles stops pests getting established. If a crop is not grown for two years, pests that use the plant as a home will be highly reduced in number.

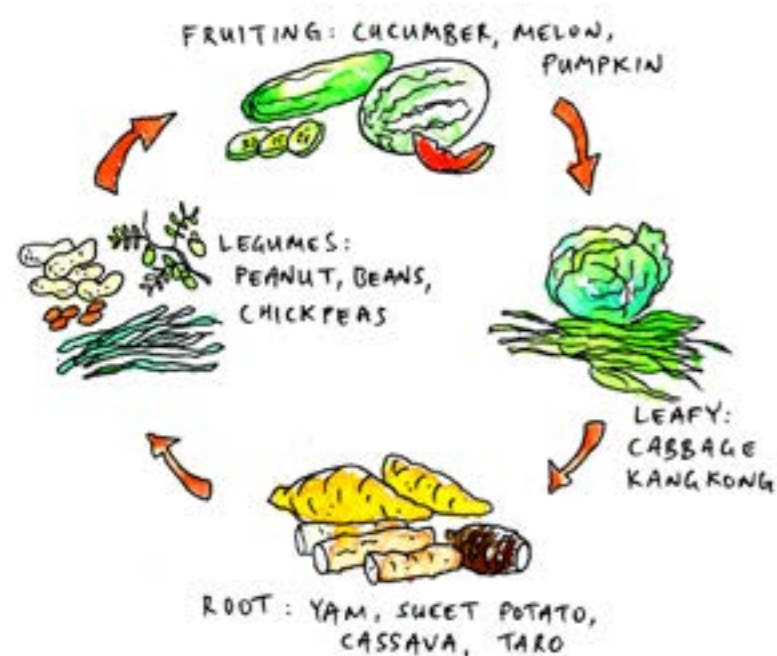
The many different varieties of plants are divided into plant families. A typical rotation used in the Solomon Islands is below:

Fruiting plants — cucumber, melon, pumpkin

Leafy greens — cabbage, kangkong

Root crops — yams, sweet potato, cassava, taro

Legumes — peanut, beans, chickpeas



When rotating crops, plants from one family should not follow plants from the same family.

Plants that take a lot of nutrients out of the soil should be followed by those that put some nutrients back in. Rotation and mixed cropping should include fallow periods where cover crops are grown.

It is good for the soil to have a mix of plants with different heights and root depths. This means nutrients are not taken out of just one level of the soil. And water needs of plants should be thought about. Don't plant crops for the dry season that will need lots of water.

Growing flowers and flowering vines around vegetables can help attract pollinating insects.

Mixed cropping

As well as crop rotation helping with healthy plants and soil, mixed cropping, or the practice of growing crops together, can help with pest management, more produce from the same amount of land, and keeping soil nutrients and soil structure.

Some plants grow well together. Following are examples of plants that can be grown together in one season. These can be grown in the plantation or garden.

Tomato, garlic, basil

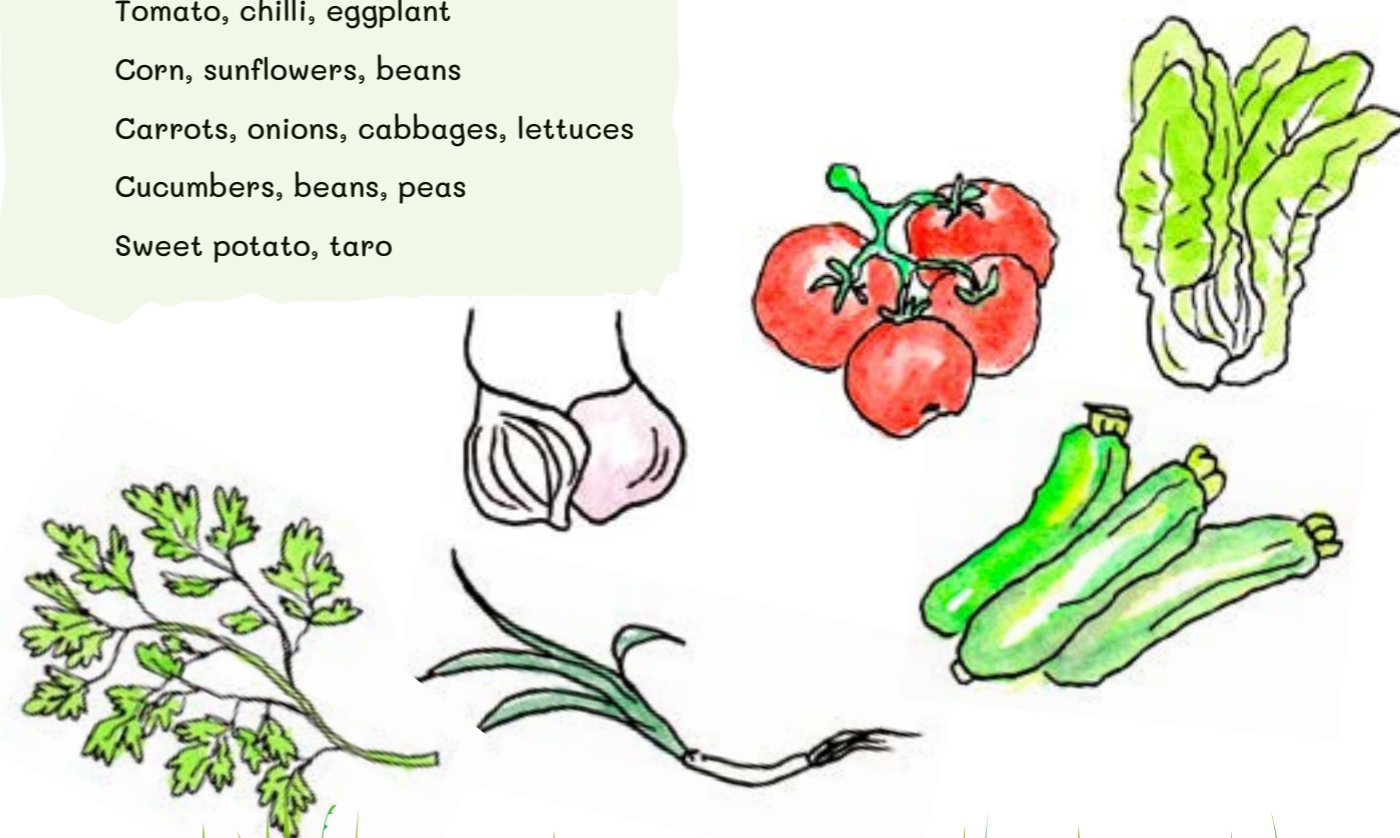
Tomato, chilli, eggplant

Corn, sunflowers, beans

Carrots, onions, cabbages, lettuces

Cucumbers, beans, peas

Sweet potato, taro



Intercropping and Alley Cropping

Intercropping is the practice of growing different crops together, so that the different crops can benefit from each other. *Alley cropping* is the similar practice of growing crops in rows. It usually involves using trees or shrubs in rows to reduce soil erosion from wind or rain, and to provide better growing conditions (microclimates), for the crops between the rows of trees. Like crop rotation, alley cropping and intercropping provide diversity in crops, to improve diet, income and spreading risk.

These ways of farming are already used in the Solomon Islands and are an important way to use available land, water and nutrients in the soil. As we have noted in the chapter on pest management, intercropping can also be a good way to reduce pest numbers.



Alley cropping example in a plantation

Intercropping

Intercropping works similarly to the practice of crop rotations, by allowing different crops to take out different nutrients from the soil. With intercropping, these crops are grown at the same time, and there are benefits in doing so:

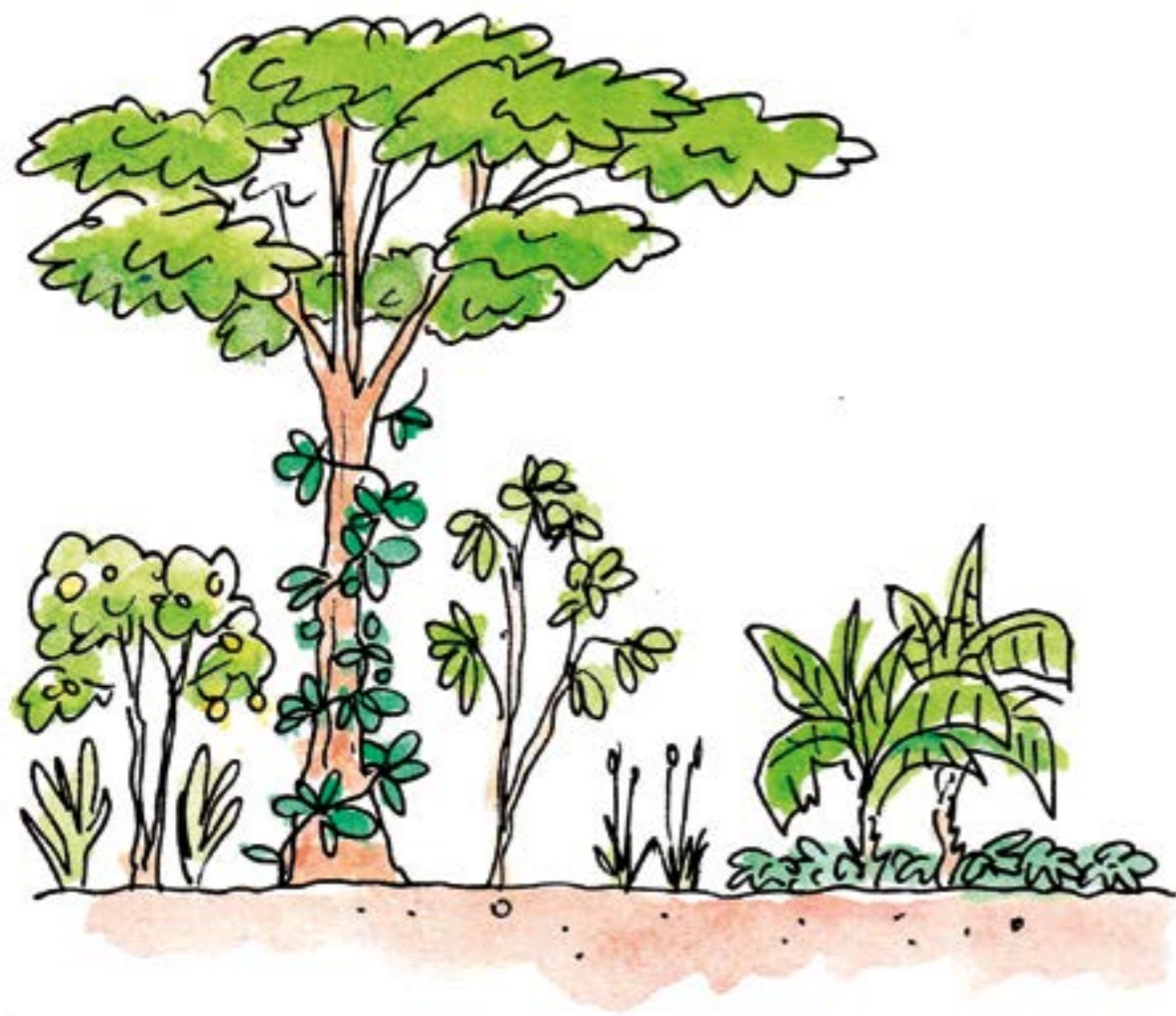
- Tall crops provide protection from sun and wind for smaller crops.
- When crops with different root lengths grow together, they take nutrients and water from different places in the soil.
- You can fit more crops into a block with intercropping.
- Different crops can confuse pests that judge edible crops by leaf shapes or scents.
- The smell of some plants can repel insect pests that are normally attracted to a companion plant.
- Companion plants can provide habitats and food for predators of pests.
- Companion plants can provide habitats and food for insects that pollinate crops.
- Plants that require full sun can provide shade for those that require less sun.

A variation on intercropping is *relay* planting, which is like a combination of crop rotation and intercropping. In some cases, it is good to plant a companion crop at a slightly different time in the season for the best growth of all crops growing together. For example, an earlier planted crop that can cope with heat may grow up to shade a later-planted crop that is less heat tolerant.

Crops grown together should have the same water needs. If you plant crops together that like very different levels of watering, it will be hard to give them the water they need!

There are many combinations of crops and trees that can be used in the plantation. One example is to plant legume trees with crops such as banana or papaya, and then plant grain crops or vegetables in-between. Another is to mix cassava with banana or papaya, with climbing beans in-between. Try different combinations and see which works best. Trees can be valuable crops in times of drought, when their long roots are better able to access water deep in the soil. You can also grow fruiting trees alongside other trees that can be harvested for wood.





An example of a mixed plantation

Trees can be a valuable part of an intercropping system, and it is good to think of them as part of a 'forest' on your plantation, with plants at different heights, just like in a natural forest.

A typical practice in the Solomon Islands is to clear brush around large forest trees, which often provide fruit and nuts, for growing crops. This is much better than chopping down the large trees. Living trees are valuable. As well as providing fruit and timber they keep the soil stable and encourage higher rainfall. They provide windbreaks and homes for helpful pest predators. Their roots work in combination with the tiny organisms in the soil to keep soil fertile.

You can plant your own trees, whether they be fruit trees for harvesting or legume trees to provide nitrogen to the soil. Small trees can even be used as living fencing. It is important that you judge which trees are best for the soil type and location.

Some things to consider:

- What type of fruit do I want?
- What time of year do I want my trees to fruit?
- How much water do the trees need?
- Is the tree resistant to pests in my area?
- Do I need the trees for firewood?
- Will the trees get too big and shady for other crops?
- Could this tree species become a weed?

If you are planting trees on a hillside, you can make the slope more stable by planting trees in a trench or by building a swale. (See the chapter in this guidebook on contour farming.) Remember that trenches and rock walls should be built along the contour of the slope, not running down the hill where they will encourage erosion.



Alley cropping

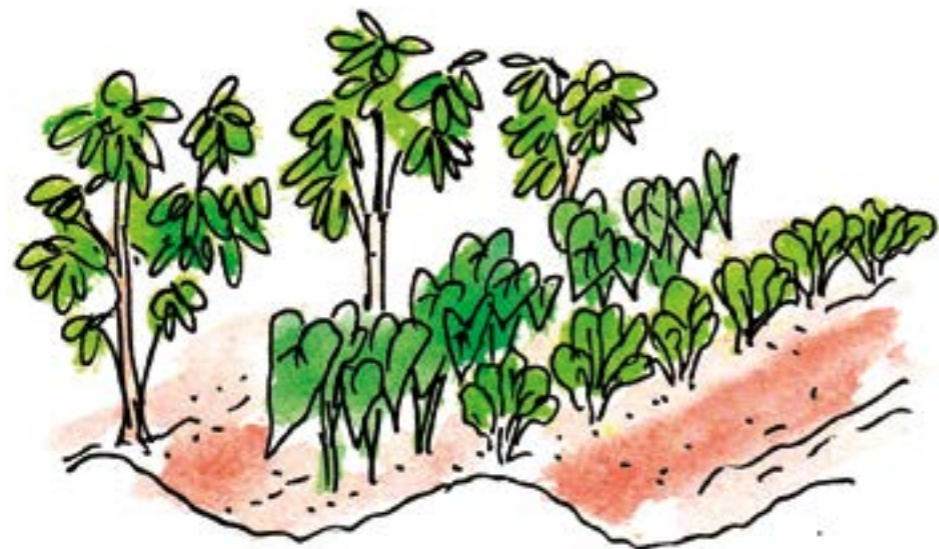
Like intercropping, alley cropping uses two or more crops growing together to help each other grow and to provide a variety of crops. It is important to think about the light, nutrient and water needs of the crops so they don't compete for resources. Alley cropping is done in rows for easy access to crops and for the protective benefits rows provide.

Alley cropping can be used as a part of contour farming, a way of keeping hillsides stable. (See chapter on contour farming in this guidebook.)

Planting trees or large bushes in rows between cropping land creates windbreaks. Windbreaks are valuable because reduced wind means:

- less stress on plants and better growth and pest resistance
- fewer broken stems
- less soil erosion (tree roots also keep soil in place)
- less drying out of soil
- more stable soil temperature
- more pollination, as friendlier to birds and insects.

One helpful method of alley cropping is to make mounds and trenches. The mounds, which drain well, are good for vegetables, grains and small trees, whereas the trenches can be used for more water-loving crops such as taro. Alternatively, in the dry season, you might need to use the trenches for growing vegetables so that they get as much water as possible.



Using mounds and trenches in alley cropping

Planting near water

An important part of the landscape is the strip of land next to a creek, river or dam. This strip of land is called the *riparian zone*. Sometimes this land is not suitable for crops that dislike growing in very wet soil. But it can be important as a homes for pest predators such as frogs, birds and lizards, and insects that pollinate flowers. Planting trees and grasses that can cope with very wet soil in the riparian zone can stabilize the soil, soak up excess water and provide homes for these helpful pest predators and pollinators.

ACTIVITY

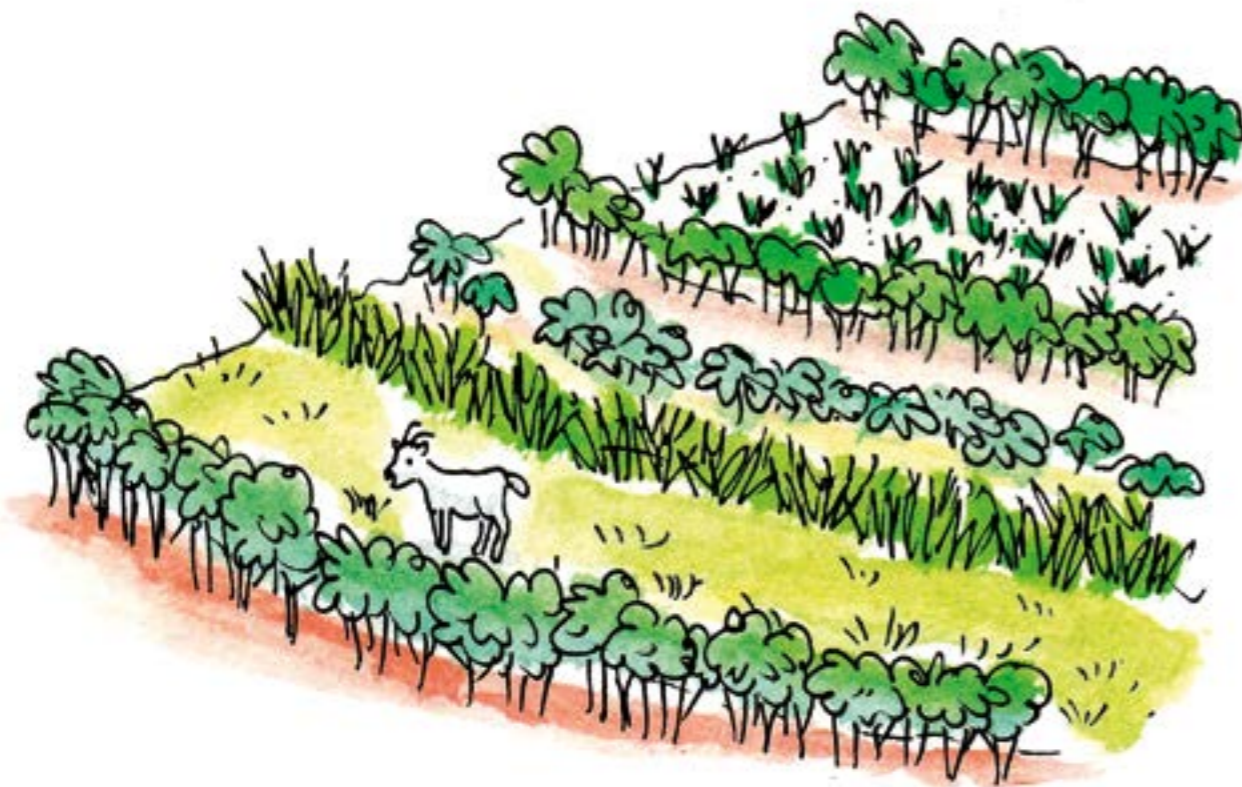
Make a list of plants and trees that you think you might be able to grow in an intercropping system. Draw a map or picture of how you could plant them in a block.



Contour Farming

Farming on hillsides can be difficult because heavy rain can wash away valuable topsoil, and damage crops. In the dry season crops can dry out because there is not much water held in the soil.

Contour farming is a way of farming on hillsides, a traditional method used across the world. It helps to solve the two problems of water loss and soil loss. This method can include building large terraces for crops and trees or rice paddies, or simply digging swales along a hill to make sure that water is collected and soil is not eroded.



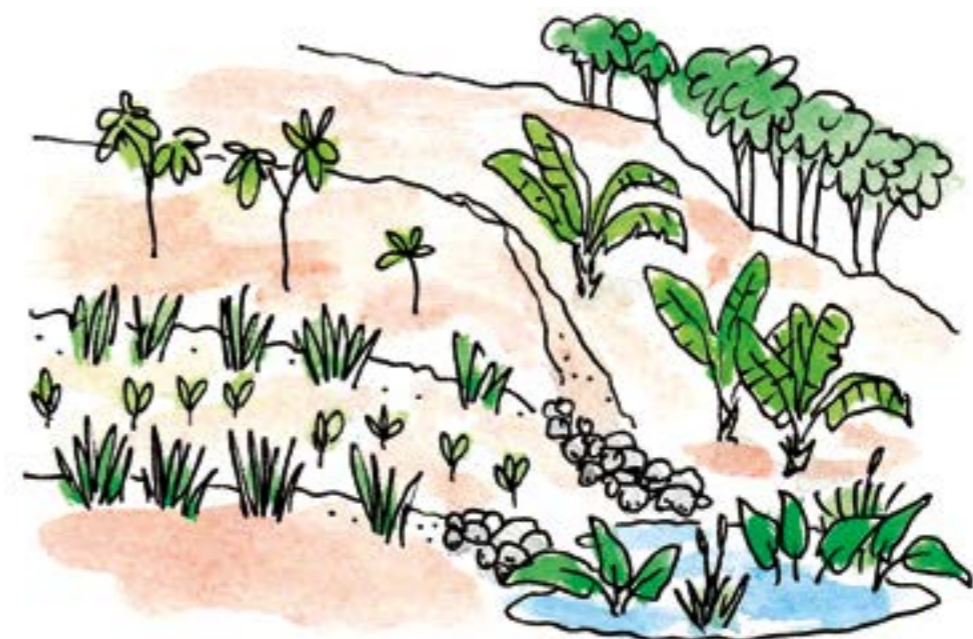
Trees can be planted on hillside terraces to help keep soil in place

Swales are trenches that are dug along the contour line, which means the trench line follows the same height, restricting water to the trench and not letting it run off, allowing it to soak into the soil. This also prevents soil being washed downhill. In heavy rainfalls and floods, overflow points can be made in the banks of the trenches, so water can be directed across the hillsides to where you want it. This can keep all parts of the hillside watered. Excess water can be directed into a pond or dam downhill, where it can be stored for use in the dry season, or into rivers.



Planting across the slope to keep soil in place

This is a way of extending the wet season into the dry, by maximizing the water held in the soil. When used with crop or fruit and nut tree plantings that hold the swales in place, microclimates can be created, encouraging better growth in crops.



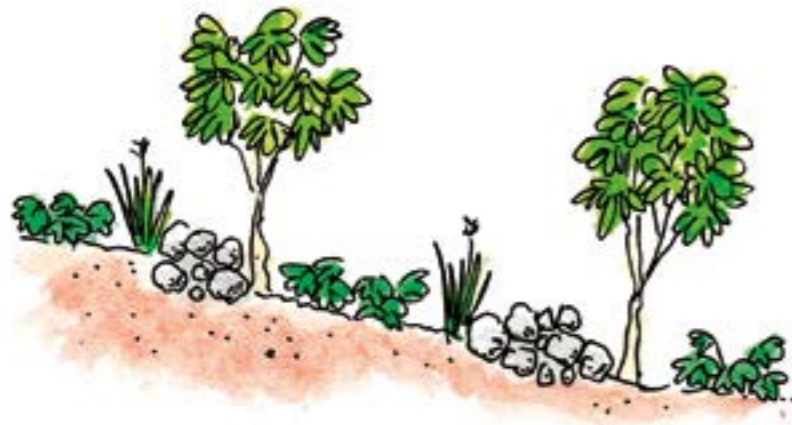
On a hillside, water can be directed into a dam

Methods

There are various ways to contour farm. The simplest is to map out the contour lines on the hillside (see below) and dig across the hill so that each furrow continues at the same height. This allows water to soak in when it rains.

When digging a trench and making a swale, rocks and dirt are dug out along the hill and piled up just below the trench. This makes a bank to contain water and soil, and makes the soil above the trench more level than before. It is important to dig the trench to the same depth so that the base is level, preventing water from flowing along the bottom of the trench.

On rocky ground, you can build the bank of the swale by piling rocks up to approximately knee-high. You can dig to level the ground in front of the rocky bank, but rainfall will also naturally, over time, push the soil against the rocks. This method of building a swale is useful when the land is difficult to dig, and when the slope is steep and needs extra reinforcing. Rocks can also provide places to live for insects and lizards that will eat pests.

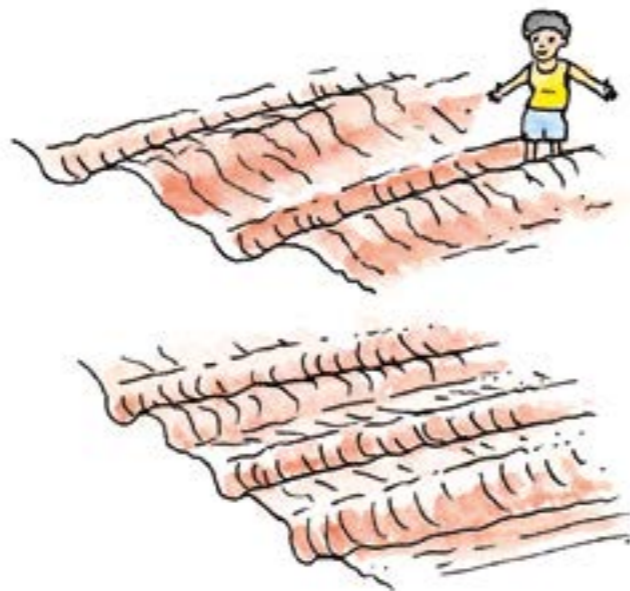


Use rocks to build up a swale

On a gently sloping hill, swales can be created 3–10m apart. On steeper slopes, they should be dug closer together, because water will flow with more force down a steeper hill. Swales may not be effective on very steep hills, however, as fast flowing water may shift or destroy the banks.

Make sure that the swales are the same distance apart.

Different plants respond differently to the type of swale you create. For example, sweet potatoes are happy growing around rocks, which you might use to stabilize the bank, whereas some plants, such as corn, require planting in the soil of the trench.

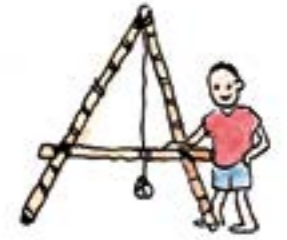


Put swales closer together on a steep slope

Measuring contour lines

There are various ways to measure the contour lines on a hillside (agriculture extension workers can help with this).

One method is to make an A-frame tool.



A-frame contour tool

- Using wood or bamboo, cut two legs, approximately 2 metres long, and tie them together at the top.
- Make a cross-piece of approximately 1 metre.
- Tie the cross-piece to the legs at the same height on each leg.
- Tie a string with a rock attached to the point at the top of the frame so it hangs down between the legs.
- Place the legs on level ground and mark where the string sits on the cross-piece.
- Turn the frame around and place the legs on the same spots on the ground as before. Again mark where the string touches the cross-piece.
- When the ground is level, the string will hang between the two marks on the cross-piece. (You can mark this centre point.)

When you place the A-frame on a hillside and the string hangs over the centre of the crosspiece, you know that the ground is level. You can then move the A-frame along the hillside to mark out the contour line. Simply place the back leg of the A-frame where the front leg was, as you move across the slope. Use small wooden stakes or some other method to mark the contour line. (Make sure each contour line is the same distance from the last one as you go, and before you start digging.)



Using an A-frame to measure contours

Using plants

It is important to plant along the bank as soon as the swale is created. The roots of the plants will stabilize the bank and prevent it slipping.

Trees can be planted along a swale at the base of the rocks (below the bank). This allows the rocks and soil above to push against the roots and trunk.

Pineapples or grasses such as vetiver or lemongrass are great for holding the top of the bank in place.

Legume trees can be planted close together, so the roots hold the soil firmly. They can be used as hedging, and regularly trimmed. The trimmed branches can be used for mulch. Legume trees that grow quickly can divide the land into sections for alley cropping.

It is also important to think about what trees can be grown at the edges of contoured fields. Trees can provide shade for crops, and fruit or nut trees can be grown for extra crops. The right trees will help to soak up excess water in the wet season and will help retain soil moisture when it is dry. Trees can provide extra material for mulching, and even be used as living trellises for fruit vines. Choose trees carefully, thinking about the best trees for the climate and the location.



An overflow point ending with a banana pit



Overflow points

Water-loving plants such as taro, bananas or some leafy greens can be planted below overflow points to soak up the excess water and prevent further erosion. Grasses such as vetiver can also do this job. Water-loving plants are also suitable at the bottom of hillsides where more water is likely to pool, or around dams or ponds.

Use rocks at the overflow points and the channels that drain the swales to further hold the soil steady and prevent erosion. A banana pit can be included in the design.

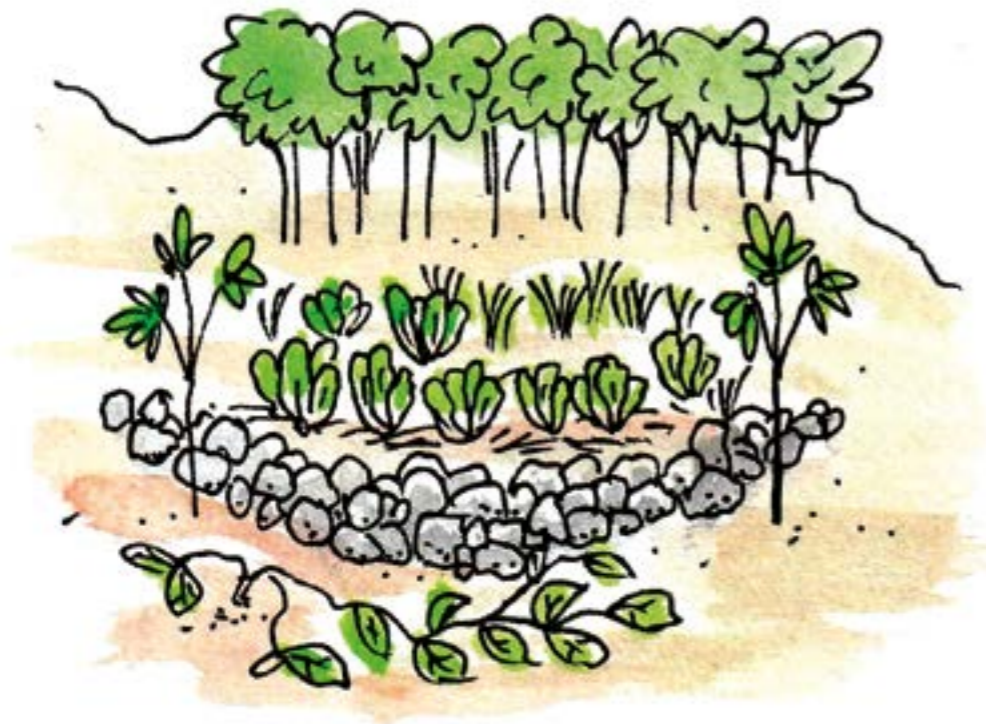


Flooding

Normally, you would make the swales as level as possible, but in areas prone to flooding you might like to make the swales slope gently. This will help excess water drain across the hillside and towards an outflow place that leads to a pond or river. This may also be useful if you want to collect water into a pond or dam for use in irrigation or for watering animals. But it is important to not make the slope of the swales too steep, otherwise water will flow too quickly and wash soil and plants out. You can build a swale like this using the methods described above.

Variations

Long lines of swales are not the only way to use sloping land. In small areas you can build a V-shaped swale, with the point at the lowest part of the slope. (Remember to include an overflow point so floodwater does not destroy the swale.) These may be useful around fruit trees, or as mixed vegetable beds. The shape naturally draws in dead leaves and other mulching materials brought down the slope by rain.



A V-shaped swale made using rocks



ACTIVITY

On a separate piece of paper draw a map or picture of a part of the land that might need contour farming. Draw in crops and trees that might help to secure the sloping ground. Add where a banana pit might be useful.

Agroforestry

What is agroforestry?

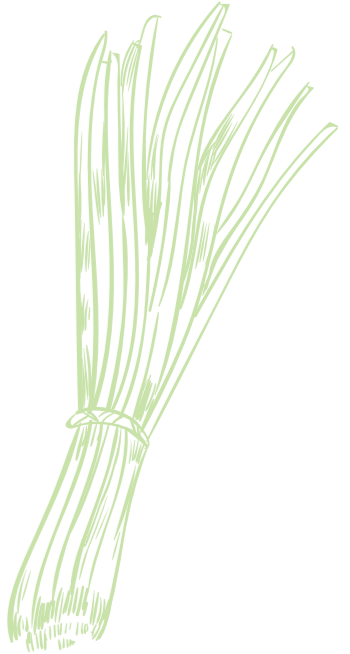
Agroforestry is the practice of growing trees for people to use. Normally, agroforestry uses a variety of tree species, rather than just one species, which happens in plantation forestry. Agroforestry is not logging. Agroforestry is often used with other crops and is a traditional practice in the Solomon Islands.



The benefits of agroforestry

Trees can be used for:

- food – nuts, berries, leaves, fruit
- medicine
- wood for building or craft materials, such as fibre for rope
- firewood
- cash crops – selling excess wood, fruit, nuts, etc.



Trees have other benefits for land and our environment:

- Tree roots hold soil steady and help water to slowly trickle into the soil.
- The living leaves of trees slow down rainfall and protect the soil.
- Dead leaves on the ground act as mulch, keeping water in the soil and preventing erosion.
- Dead leaves and roots provide nutrients for the soil.
- Trees cool the air and soil by providing shade and by releasing water into the air through their leaves.
- Trees produce oxygen and clean the air through their leaves.
- Trees make windbreaks, slowing down wind and reducing damage to crops and buildings.
- They provide homes for insects, birds and animals.
- Agroforestry can help conserve our natural resources.

In the Solomon Islands and the South Pacific there are a huge number of trees grown for these uses, including ngali nut, guava, lime, mango, breadfruit, avocado, pomelo, pawpaw, coconut, coffee and casuarina.



How to use trees in agroforestry

Agroforestry can be combined with other types of agriculture, such as alley cropping. Trees can be used for hedgerows, with crop rows planted in-between the trees. Branches and leaves from hedgerow trees can be used for mulch. Do not burn around trees, as this harms helpful organisms in the soil, as well as releases carbon into the atmosphere.

When using trees in an alley cropping system, make sure the trees are not planted too close to the crop. This may affect the quality of the crop. But don't leave lots of empty space between trees as this can encourage weeds to grow. Also think about the light needed for crops planted between trees - you could use a light loving crop when a tree is smaller, and a shade tolerant crop when trees are larger.

Traditionally, trees are used as borders for fields, providing protection from sun and wind. When legume trees are used, nitrogen is added back into the soil. Trees used as borders can be fruit trees, or trees harvested for timber, such as flueggea.

You can also combine agroforestry with keeping livestock. For example, chickens can browse under trees, eating insect pests and fertilizing soil with their manure. Or sweet potatoes can be planted under trees as another crop and to cover the soil. Agroforestry can be used in areas where there are trees from the natural forest.

Agroforestry is useful for steep hillsides where it might not be easy to grow other crops. An added benefit is that the trees will hold the soil of the sloping land steady and prevent erosion and landslides. Trees are also useful for swampy areas, to soak up excess water and to make the land more stable.



How to plant trees for agroforestry

When planting trees, the following need to be considered:

- How much water and sunlight does the tree need?
- Can I grow the tree from seed, seedlings or cutting?
- Is there enough space for this type of tree?
- What type of soil does the tree need?
- How much care/work does the tree need?
- Are there any land disputes that might affect planting?
- What competition will the tree have?
- What type of pests are in the area and will they affect the tree?

When judging how far apart to plant trees, it is helpful to know how big the variety of tree normally grows. Are there examples of mature trees in your area that give you an idea of how big they will grow? When trees are fully grown, the outer leaves of the mature trees should only just be touching, to provide shade, but not crowded together. This gives the individual trees the opportunity to grow strong.

At other times, you might be growing trees as a living fence. Then it is important for the trees to be planted closely.

When trees are young, it is good to cut or pull weeds from around the trees so that the weeds don't compete with the trees for nutrients or water from the soil. Don't burn the weeds – use them in your compost heap (pull them out before they seed).

ACTIVITY

On a separate piece of paper draw a map or a picture of the plantation or garden and note where you could add trees for agroforestry. Make a list of possible tree species.

Combining crop and livestock systems

Livestock (pigs, chickens, cattle) can be integrated (combined) with cropping systems to achieve many benefits:

- increasing the organic matter of soils, improving nutrient supply for crops, and reducing the need for additional fertiliser use
- increasing the good microorganisms in the soil
- reducing and managing weeds
- providing extra uses of land when it is idle or in fallow, increasing farm profits
- more ways of making a living
- more ways for food security
- better use of limited land.



There are different types of integrated systems. Perhaps the most well-known is a rice production system. In this system, paddy ponds are stocked with fish and used to grow water weed to feed pigs. Sludge from the ponds is used for fertiliser on rice paddies, or alternatively, rice is planted into the sludge. Ducks live in the rice paddy, where they control pests. The left-overs from the rice harvest are used to feed pigs, and their manure can be used in biodigestors to provide gas for cooking.

Integration can occur through:

- re-using the same land (e.g., crops grown, then left-overs used to feed livestock)
- at same time on same land (e.g., chickens roaming plantations)
- in different parts of farm system but with shared management (e.g., pig stall where manure is collected and used for fertiliser).

Animals can be kept in three key ways: in stalls/barns, free range and tethered.

In stalls, farmers require additional knowledge, skills and expenses for vaccines and treatment of disease, as well as labour for providing feed and collecting manure.

Tethering (tying up) animals stops them destroying gardens, provides an easy way to feed animals, and enables animals to be moved, but water still needs to be provided and animal pregnancy needs to be more carefully planned.

Free range does not require much animal knowledge or labour. In Samoa, chickens range free within pepper, yam, turmeric and banana plots, and cattle feed under coconut and cocoa plantations. However, free-range animals can be a challenge in gardens, given that they can damage young crops. In some cases, garden areas need to be fenced. For example, in Solomon Islands, free-range pigs have been reported as a significant problem. Free-range animals can also create the danger of over-grazing, which can result in loss of soil structure and quality, erosion and compaction.

One of the biggest considerations for livestock integration is the impact on crops. Grazing often makes plants grow quicker – yields in integrated soybean/cow systems in Brazil are higher than in systems without cows. However, integration can also cause water stress – plants that are continually growing require additional water and nutrients. Careful attention is needed to the number of livestock when drought is forecast.

Pest Management

What pests and diseases might be found on the farm?

Insects

Insect pests can usually be seen on plants or in the soil. They cause damage by chewing the roots, leaves, fruits or shoots of plants. They can also suck sap out of the leaves, fruit and stems. However, not all insects are pests. Insects like bees pollinate the flowers. Some insects and spiders feed on pests, reducing their number in your garden. It is important to know the difference between pest insects and helpful insects.

Common insect pests include:

- sucking insects, e.g. stink bugs, plant hoppers, aphids and thrips
- chewing insects, e.g. grasshoppers, beetles and caterpillars
- leaf rollers, e.g. banana skippers and aibika leaf roller
- burrowing insects, e.g. red banded caterpillars, weevils and taro beetles.



CHEWING INSECT - CATERPILLAR



BURROWING INSECTS - WEEVILS

Fungi

Fungi live above and below ground. Some fungi are good for soil health, but fungi can attack all parts of a plant. Signs that your plant has a fungal infection include rotten patches, black spots on stems or leaves, wilting due to rotten roots or a powdery substance under the leaves. Fungi can spread from one plant to another through the rain or wind or when soil is regularly dug or turned.



FRUIT DISEASES

Bacteria and viruses

Bacteria and viruses are not easily seen. They can cause plant rot in roots and stems, oozing, a change of colour in the leaves or stems and black spots. Bacteria and viruses spread through soil, water and affected plant materials.

Weeds

Weeds are plants that are growing in the wrong place. They directly compete with crops for sunlight, water, nutrients and space. Some weeds can also act as hosts for plant diseases and other pests.

Pests and weeds can occur for any number of reasons, including:

- monoculture – using large areas of land for only one crop
- after flooding, land clearing or fire
- being newly introduced to the area
- overuse of chemical pesticides, which can kill off pest predators and destroy their habitats
- changing seasons, e.g. pests brought on by the wet season
- climate change, which can create unusual weather patterns and place stress on plants, weakening their ability to compete with weeds.

Burning plant residue, tilling the soil and spraying agrochemicals are normally used for controlling pests and weeds. However, conservation agriculture takes a different approach. This is where Integrated Pest Management comes into play!

Integrated Pest Management

Integrated Pest Management is a natural, environmentally friendly approach to controlling pests and diseases in the garden. This method is cheap, and the materials needed are easily available. Integrated Pest Management:

- reduces the chances of pest problems happening
- reduces the size of the pest problem if it does happen
- uses natural treatments for problems that persist.

Different types of pest control can be used in your garden to manage pests and diseases:

BIOLOGICAL CONTROL:

Encouraging other insects and animals, e.g. spiders and ladybugs, to control pests.

CULTURAL CONTROL:

Using healthy plant cuttings and seeds (that are free of disease), removing any infected plants, crop rotations and planting more resilient crop species.

PHYSICAL CONTROL:

Using barriers to protect your crops from the movement of humans and animals, stopping excess watering and planting chillies and other strong-smelling plants in your garden.

CHEMICAL CONTROL:

Using fungicides, biological sprays or pesticides, an alternative to which is using natural environmentally friendly sprays that are plant based.

Pest management techniques

Good soil and conditions

The right growing conditions can reduce pest and disease problems. When plants are strong and healthy, they are better able to resist pests and diseases.

You can create the best growing conditions for plants by building up the soil with compost, by using cover cropping to protect the soil, and by using good plant spacing – leaving enough room for each plant to grow, but not too much room that weeds can grow.

Crop Rotation

If you plant at least three crops in a seasonal rotation, this gives pests and diseases less chance to multiply, because they will die off when their favourite plants are not being grown.

Companion planting

While some plants grow well together, others do not, which can result in slow growth. Knowing which plants grow well together can help improve productivity and increase the natural pest and disease control on your land.



Here is what companion planting can do for your garden:

- Kill root parasites and predators – Marigolds and crotalaria can be planted in your vegetable garden to reduce the number of nematodes (roundworms).
- Repel insects – Strong-smelling plants and flowers can repel insect pests that use smell to find the plants that they want to eat. You can plant marigolds, onions, garlic, ginger, lemongrass and daisies around your crops to repel pests.
- Attract predator insects and animals – Planting flowers around crops will help attract pest predators to the garden. Some of the best flowers to plant for this reason are sunflowers, hibiscus, dill, cosmos, marigolds, zinnias, daisies, legume shrubs and coriander.
- Slow down pests – Planting different crops together can reduce pest numbers and slow their spread. This applies to small family gardens as well as larger farms.
- Increase root growth – Different plants have different types and depths of root growth. This lets you grow plants and trees closer together, maximising your space. But note that some plants give off substances from their roots that can make it hard for other plants to grow near them (e.g. eucalyptus, wormwood and casuarina trees).



Building a habitat for positive predators

Chemical pesticides can kill the good bugs as well as the bad ones. Insects are an important part of our ecosystem. In balanced ecosystems, insect pests are kept in check by their natural enemies.

Natural predators to pests include birds, frogs, fish, praying mantis, spiders, lizards, wasps, ladybugs, mice, bees and dragonflies. You can encourage these pest predators in your garden by providing:

- small ponds or water containers for frogs, fish, birds, dragonflies, bees and wasps
- trees for bats, birds, wasps, bees and spiders
- rocks and rotting wood for spiders, lizards and mice
- small trees, vine plants and flowers for ladybugs, wasps, bees, praying mantis and spiders.

A mix of plants and natural habitats on the land can lead to a healthy mix of predators, resulting in natural control of your pests.



Intercropping

Intercropping can reduce pest numbers, disease and fungal problems by spreading risk across a variety of crops that are grown at the same time.

If a farmer plants only one crop on a large area (monoculture), there is a bigger chance for a particular pest or disease to spread. Varied crop species growing in one place will make pest problems much easier to treat, because one particular pest or disease will not be dominant, and there is opportunity for pest predators to be present for natural control.

Pesticide and herbicide use



Agrochemicals can treat pests and diseases quickly, but they can cause problems. They can kill off helpful organisms in the soil and insects that pollinate crops. They can pollute rivers and streams. Over time many pests, weeds and diseases can become resistant to chemical pesticides and herbicides, requiring new and stronger ones.

Agrochemicals can be harmful to humans and animals, causing sickness.

If you must use a pesticide or herbicide, leave some land with pests to encourage pest predators to stay. They will eat the pests you leave and will protect you from future outbreaks. Some crop damage due to pests is normal. Before using any type of pesticide, watch to see if pest predators are eating the pests and monitor if pests are increasing.

When using pesticides always read the instructions on the label and follow the precautions exactly. Do not use more pesticide than is recommended.

Safety during spraying

- When using chemical pesticides always wear the correct protective clothing.
- If it is windy do not spray near animals, prepared food or other people.
- Never blow or suck nozzles with your mouth.
- Do not overfill pesticide sprayers.
- Do not eat or drink near someone handling or using pesticides.
- Do not eat, drink or smoke while handling the pesticide.
- Once you have finished spraying make sure you wash the sprayer, yourself and your clothes before smoking, eating or drinking.
- If you feel sick after using a pesticide, go and see a doctor immediately. Make sure you tell them the exact name of the chemical that you used.
- Do not spray any chemicals or wash the sprayer close to a drinking water supply.

Safe storage

- Store chemicals in a safe place where they cannot be reached by children or animals.
- Chemicals should never be stored in the same room as food and drink.
- Always keep pesticides in the original container. Do not use other containers like beer or soft drink bottles.
- Check containers regularly to make sure they are not leaking.
- Only buy the amount of pesticide you will use in a few months, so that you don't need to store it for long periods.
- Dispose of chemical containers safely. Do not use them to store food or drink.

See the next chapter for natural pesticide recipes.

Natural Pesticide Recipes

In this collection of natural pest treatments, select the one(s) with the most accessible ingredients for you, and use as little as possible. Strong, healthy soil with lots of life and a variety of crops are always the best approach for managing pests.

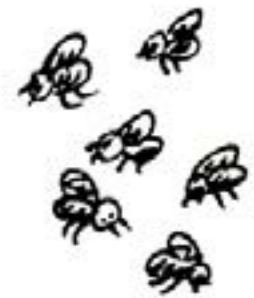
It is important to note that many natural pesticides will not immediately kill pests but will deter them or affect their reproductive system. This makes their use safer for helpful insects and organisms, as well as pest predators and humans. But many of the sprays listed here can still be harmful to you. You must still be careful when using all sprays and do not get the contents in your eyes. Wear protective clothing.

INSECT SPRAY

STEPS

1. Collect a handful of insects that are eating your plants.
2. Crush them and mix them into a small bucket of water.
3. Leave for 2 days.
4. Strain the liquid and spray onto affected crops.

The same type of pests as the ones in the spray will be repelled by the liquid. The remaining insect bodies can be put in containers and placed around crops. The smell of this will continue to repel pests. This spray works well for caterpillars, slugs, snails and various small pests. It is less effective for grasshoppers.



GARLIC AND CHILI SPRAY

Garlic is an insecticide, fungicide and pest repellent. Chilli is also an insecticide and insect repellent. The soap will help the spray stick to plants and pests. Use this liquid for aphids, caterpillars and moths. Garlic and chilli plants will naturally repel many insects.



STEPS

1. Combine 3 bulbs of peeled garlic with a large handful of chillies and boil in a pot of water.
2. Add a quarter of a block of grated soap.
3. Stir and leave for one day.
4. Strain the liquid and use 2 cups each time you spray.

PAPAYA SPRAY

This papaya spray can be used on aphids, termites, bugs and caterpillars. For termites, crush young unripe papaya fruit and collect the juice. Spray this directly onto termites and damaged wood. Papaya spray can also be used as a mild fungicide for powdery mildew

STEPS

1. Collect 1kg of papaya leaves (about 1 large plastic bag).
2. Crush into small bits and mix into 1 litre of water.
3. Leave for 1 hour.
4. Strain and add 4 more litres of water and 1 large spoonful of soap powder or liquid soap.
5. Spray onto insect pests.

TARO LEAF SPRAY

Taro leaves contain liscic acid. When insects eat this it feels like eating broken glass!

STEPS

1. Crush 10 taro leaves.
2. Place into 3 litres of water and stir well.
3. Spread onto plants using a palm broom.
4. Make sure every plant is covered well with this liquid.



GINGER JUICE SPRAY

STEPS

1. Grate a handful of ginger and put into a bucket of water.
2. Leave for one day.
3. Spray onto damaged plants to control larvae of worms and caterpillars.



GLUE SPRAY

Glue spray can be made from left-over water from cooking root vegetables.

Small insects will stick to the glue and eventually die of suffocation.

This spray is good to use for aphids, caterpillars and white flies and other small insects.

Mix left-over cooking water from cassava, taro or potatoes with some more water.

A good mixture will leave a thin white coating on plants once it has dried.



Natural Fungicide Recipes

DILUTED URINE SPRAY

STEPS

1. Combine 1 part human urine to 4 parts water.
2. Spray on plants damaged from vine mildew, powdery mildew and other similar fungus.



SWEET POTATO LEAF SPRAY

STEPS

1. Cut and soak 3 large handfuls of sweet potato leaf in 1 bucket of water.
2. Leave for 1 day, then use as a spray for fungus.



GARLIC SPRAY

STEPS

1. Dry garlic and crush into a powder.
2. Combine 1 large spoon of garlic powder with 1 litre of water.
3. Use as a spray for fungus attacking tomato and bean plants.



Helpful Websites

A list of publications (bibliography) used in the preparation of this volume can be found on our website <https://livelearn.org/>

The Food and Agriculture Organization of the United Nations (FAO) has resources available at <http://www.fao.org/land-water/resources/en/>

Kastom Gaden Association Solomon Islands has news and help for farmers and farmer groups at <http://kastomgaden.org/>

The POETCom (Pacific Organic and Ethical Trade Community) website has information about organic farming and the certification process <http://www.organicpasifika.com/poetcom/>

The Ministry of Agriculture & Livestock (MAL) offers resources and links on their website: <https://solomons.gov.sb/ministry-of-agriculture-and-livestock/>



Sustainable land management involves the use of land, soils, water, animals and plants for production in a way that ensures these resources can continue to be used into the future and that they can continue to keep the environment healthy.

Live & Learn Solomon Islands surveyed 180 village farmers from Choiseul, Guadalcanal, Malaita, Makira, and Western provinces in the Solomon Islands about their challenges and successes in farming. There was high interest in improving their knowledge and skills in the following areas:

- soil fertility and preventing erosion/loss of topsoil
- reducing the impacts of flood and drought on land and crops
- increasing crop mixes and yields in existing land
- agroforestry

This **Woakem land kam up gud fala** guide is the result of talking with the village farmers and Ministry of Agriculture and Livestock staff. It gives practical advice on methods such as cover cropping, mulching, composting and contour farming, which can be added to traditional methods.



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