

CLIMATE CHANGE ADAPTATION

A manual for villagers

**Climate Change &
Sustainable Gardens
in Papua New Guinea**



Supported by the European Union



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Line Art – Takus David, used with permission – (Chris Gard).



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Coping with climate change in our gardens – our training program

Proposed Training Program – (four full days- you may need more!)

Time	Day before	First Day What is happening in our villages?	Second Day Managing our watershed, Erosion control	Third Day Organic material – crucial in our gardens	Fourth Day Improving fallows – Green manure legumes
08:00→08:30h		Welcome (Devotion)	(Devotion)	(Devotion)	(Devotion)
08:30→1000h		Getting to know each other What can we expect from this training? If time, first big question – population...?	Understanding forests	What, why, how regarding organic matter and organic material.	What does fallow mean? How do forests care for soil – how do we care for soil?
10:00 →10:30		Break	Break	Break	Break
10.30→12.30		Forests, water shed and Village mapping exercise – Let’s take a walk?	Managing heavy rain - discussion	Practical outside – weather dependent	Using green manure legumes – establish a trial.
12:30→13.30		Lunch	Lunch	Lunch	Lunch

Coping with climate change in our gardens – our training program

Time	Day before	First Day What is happening in our villages?	Second Day Managing our watershed, Erosion control	Third Day Organic material – crucial in our gardens	Fourth Day Improving fallows – Green manure legumes
1330→1500		Village mapping	Managing heavy rain, erosion – practical in gardens.	Practical outside, weather dependent – Trials regarding mulch.	Using green manure legumes, using trees in long term fallows. Practical work outside.
1500-1530	Gather	Break	Break	Break	Break
1530-1630	People travel and gather	Summarising the day, Questions, Suggestions, daily evaluation. What of climate change is happening to us?	Summarising the day, Questions, Suggestions, daily evaluation.	Summarising the day, Questions, Suggestions, daily evaluation. How important are totally clean gardens?	Summarising the training program, where to from here? Questions, Suggestions. Program evaluation.
1630 on	Fill in survey for M&E purposes	Informal Discussion	Informal Discussion	Informal Discussion	Head home on next day?



Training Topic 1 –God, Creation and Beauty?



God made a good world

- Creation is good
- ?
- ?

Discuss together



Population is growing very rapidly

When we look around us, we see the land is full of men, women and many children. What can we do about this?

- How do we make more land?
- Is God making more land?
- Is sea level rise reducing land available?
- Do we need to encourage family planning? What stops us?



First big question – Population!

- Is the earth full up with people?
- What should we do about ‘planti man nameri’ in our towns and villages? Is this a problem now and if so, what should we do?

Discuss together



Climate change – What is happening?



Weather – what is changing?

- Discuss together what changes your village is seeing that you call climate change. Is your cropping calendar needing to change?
- (Please think about fires, insect pests, floods, droughts, frosts and other changes that you are experiencing).



Thinking carefully about – Past, Present and Future - Village mapping exercise



Three maps → A long time ago, Present, Future

- Start by drawing in mountains and rivers – things that are the same for each map. Fill those in on each map.
- Now work on the village as it is. What is here now? Schools, bridges, roads, trails, gardens, churches... Take time to get the big picture items in first to keep things looking right – (to scale).
- Then make a map of what it was like when the oldest person was just a child. Maybe there was more forest and fewer houses?
- What else needs to go into the map?
- Think about what you would like the village to look like in twenty years' time. Water, timber, fruit, hunting, gardens – etc.

We will come back to the maps towards end of training, so this future map does not need to be finished today.

Let's go walking! Visit forest or old fallow garden

A map?



Walk to old gardens and forestd.

- How healthy is the forest? Is there good hunting and fruits and nuts and leaves that will help look after people in a drought?
- What are the temperatures like under the trees, compared with out on the open road or in open garden land?
- What is the difference between garden soil and forest soil? How can your garden soil become more like this forest soil?
- Is forest disappearing? Are people cutting trees for commercial sale?



Choices – which way next? Is change needed?



Sustainable ← ?

? → Sustainable?



Training Topic 2 - Water shed management

Introduction

This is a ‘big picture’ or ‘big idea’ day. The big picture of how your village fits into the bigger picture of rivers and mountains, gardens and forest, people, housing, schools, churches, roads and businesses.

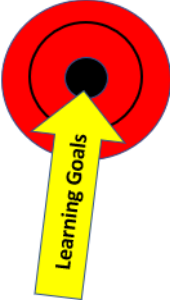
Healthy land is one of the fundamentals to living well. Villagers know this. But villagers are often following gardening practices of their ancestors. Those practices were good with just a small population.

With far more people needing to garden on scarce land we must think of necessary changes to gardening techniques. There are also new pests and diseases that cause new problems.

A watershed is a series of inter-related items – big items – forests, mountains, roads, rivers all the way to gardens with Organic matter, livestock, erosion, mulch – trees and more – all are important.

People in their village communities are at the heart of the Melanesian watershed.

Learning goals

	<p>You will →</p> <ul style="list-style-type: none"> • Know what a water shed is – and how your village fits into the watershed. • Understand how important forests are in helping manage water so that your village gets enough but not too much water. • Be aware of how precious clean water is, and how to look after it. • Know how to reduce erosion in your gardens and take steps to reduce erosion (of precious top soil) that occurs during heavy rain. • Understand how important organic matter is – and how organic matter is both lost and improved in their gardens’ soil- and take steps to manage and improve organic matter in your own gardens. • Realise that fire needs very careful management. Fire is both good and bad. • Create community agreements around fire management – especially during dry or drought periods. • Know how to prepare for fire that threatens to destroy your home – or that of your friends. • Know the steps to improving fallows – when garden land is
---	--



Villager Handbook – Day 2 – Water and Erosion



	<p>recovering fertility Short term with green manure legumes and Long term with trees. You will have planting material and establish improved fallows in your own gardens – as examples for others.</p> <ul style="list-style-type: none"> • Understand the crucial roles livestock play in sustainable gardens. • Understand the good and bad of nitrogen fertiliser.
--	--

Water is crucial

Water is crucial to life – everyone’s life, including everything growing in your garden.

Today we think about the whole watershed – gardens, trees, livestock – everything in our villages and beyond →

- Sometimes we have too much water and that ends up in flood and erosion.
- Sometimes there’s too little water – and we end up hungry and thirsty,

Sometimes, for some people it is too cold and frost kills our crops!

Forests play a special role in protecting our village water supply

Forests play several crucial roles in our watersheds. They are like guardians for our villages, providing protection from floods, providing food and much more.

Some people are finding outsiders have arrived and with large bull-dozers, diggers and fires – destroying forest and planting single use crops. There’s much to discuss here – some gains but many precious things are lost...

Forests protect villages and gardens from flood and drought

Forests protect soil in our gardens from floods and from droughts – by managing heavy rain. A healthy forest can trap great amounts of water in the soil and litter above the soil and in the moss and lichens that grow.

Healthy forests release water slowly – reducing the intensity of floods and helps to keep small creeks flowing, even when rain stops falling during drought.

But the opposite is true also. When forests are cleared for gardens, there is often very little to keep the water in the ground. Heavy rain washes away fertile top soil exposing sub-soil that has few nutrients AND is not good at holding water.

Forests store nutrients

Many tropical forests look healthy and people think the soil below is very rich and fertile. It may not be.

In a tropical forest, most fertility is in the living trees, leaves and insects (including microorganisms). So, when a villager cuts the trees and burns everything to create new



Villager Handbook – Day 2 – Water and Erosion



gardens the fertility is lost to the atmosphere in the fire and the remaining fertility is stored in ash. Heavy rain can quickly wash away lots of that ash. There can be a massive loss of nutrients.



David Kulimbao remembers going to school where birds of paradise flew, and large forest trees grew. Now the land is degraded, eroded and topsoil is gone. Yellow, infertile subsoil clay is left.

Kunai grass is the main plant.

In the past this system of shifting agriculture worked well when the forest recuperation / fallow phase was long enough for forest to re-grow. **Slash and burnt was a beautiful cultivation in the past when the population was low and a lot of bushes found around where the leaves litter was burned for gardening.**

This isn't the case now. Often gardens only rest for a few months or year or two. This means soils are depleted and erosion may add to topsoil loss.

Forests provide a home (habitat) for birds and animals

Habitat is an environment where plants and animals live harmony where food and shelter are sufficiently available. ~~is a small word with a big meaning. It involves protection and food.~~

Animals are enjoyed for their beauty and at times because they provide meat and skins. There's much to be lost when a village fails to protect and manage forest.



Provides fruit, nuts, timber, vines and more

Forests also provide medicinal plants and cool spaces to enjoy. Forests filter water and clean air for us to breathe.

Managing heavy rain – reducing erosion

Erosion removes the top soil which contains nutrient and water. Top soil is crucial to healthy crops. Most PNG gardens have periods where the soil is too wet and vertical drainage ditches are commonly dug, to get rid of excess water. Great. BUT, when heavy rain comes lots (and lots) of fertile top soil is carried away during heavy rain. Protecting top soil is very important.

How important is top soil?

Grow fifteen corn plants –

- 5 in a bucket with just sub-soil;
- 5 in a bucket filled with fertile top soil and
- 5 more in a bucket with top soil plus some animal manure.

Use photos of these to help show farmers the importance of caring for top soil.



Pineapple garden, with no barriers to slow down top soil loss. Most topsoil is gone. Infertile sub-soil remains



Look at the photo here – it shows a garden that has had two or three years of cultivation. Most fine topsoil has been washed away.

Only coarse, sub-soil portions are left.

How productive is this garden?



You know you have a problem when... topsoil is washed away



Insert an erosion photo here



The photos tell an awful story of heavy rain and soil being washed away.

Here's a sweet potato (kukau) garden with no topsoil left. Corn, if planted into soil like this will try and set corn cobs when less than 30 cm tall. A useless crop is the result. Topsoil matters!

Topsoil matters! This garden – all topsoil is lost.

Protect precious top soil!

Talking is not good enough. Make trash barriers to slow soil loss. Then discuss what stops villagers doing these things in their own garden?



Villager Handbook – Day 2 – Water and Erosion



Insert new poto with farming on a steep slope showing eroded soil eg pictures from a places like Gembogl.

Barriers in drainage ditches to conserve soil loss from erosion.



This poto can be replaced

Heavy rain water coming down the slope at a very high speed carrying with it the top soil . Barrier will slow these waters by trapping the soil and only the water will go down. ~~Most PNG gardens have periods where the soil is too wet and vertical drainage ditches are commonly dug, to get rid of excess water. Great. BUT, when heavy rain comes lots (and lots) of fertile top soil is carried away during heavy rain.~~



Trash and staks can be used as barrier



Protect your top soil!

1. Visit a garden and look at what happens during rain.
2. Discuss together what is acceptable. Is losing top soil acceptable?
3. How will your children feel about making gardens where top soil is gone?
4. Is a trash barrier untidy? How important is 'tidy'?

Don't just talk. Create some trash barriers to collect soil during rain.

Create simple barriers to slow down soil erosion.

Yumi,
noīnapmauswaranating!

Let's not just talk about this... rather, let us become -
doers!

How can farmers keep that top soil in their gardens?

Barriers between sweet potato (kaukau) mounds.

Some people in PNG make large kaukau mounds and the intermound area becomes a place where a lot of soil is lost as water runs freely during heavy rain.

Remember, fast flowing water carries soil. Slow it down!





Villager Handbook – Day 2 – Water and Erosion



Look carefully! See how farmers have dragged dry grass as trash to build barriers between the kaukau mounds – those grass barriers will help hold soil when heavy rain comes.



Forage peanut – no seed but slow growing, effective ground cover. Can help control erosion, can be grown under bananas for instance.



Villager Handbook – Day 2 – Water and Erosion



Why is the boy asleep? What is he thinking?

- Think together... Where has the top soil gone?
- What kind of garden can you grow where the boy is sleeping?

What could be done here? Is it already too late for that ground?



Make some barriers

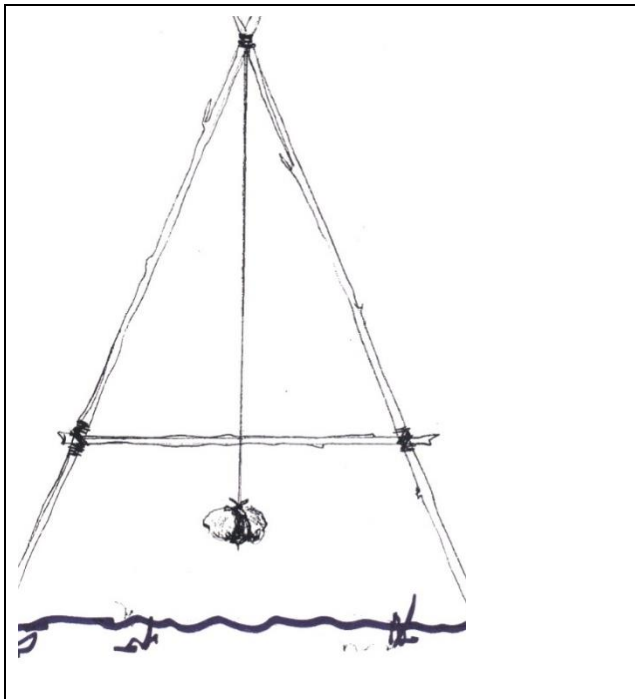
- Collect some trash, and some sticks to push into the soil to hold the trash
- Make barriers between mounds and/or
- Make barriers in ditches.
- After heavy rain — look and see how much soil has collected up stream of the barriers.



Trashlines, Contour planting and using A-frames

DKs work photos here

Making an A-Frame for planting on contour lines



1. Take two poles, the same length, about the height of a person. Tie them with a short cross stick (approx 1 m) using rubber or vines as shown.
2. Tie a weight to a piece of string and make sure the weight can hang down beyond the horizontal bar, but will not touch the ground.
3. Now, on a flat surface let the weight settle and mark the horizontal bar where the string touches the bar.
4. Pick up the A-Frame and turn it around so that the legs are in the same two places as before. Now mark the horizontal bar again where the string touches the horizontal bar.
5. Half way between these two marks, is horizontal. Make a big mark or cut at that (halfway) point. When the legs are placed on a hill side so that the string hangs on the half way point, the legs will be following the contour. This is where you are going to plant vetiver, or lemon grass or pit pit etc.
6. By walking the A-frame across a hill side it is possible to mark out where the horizontal contour is. This is the line where you can plant soil erosion controlling plants, or throw away all kinds of rubbish to help control erosion.

Some trainers will have heard of Vetiver grass as an erosion control plant, used with an A-frame.

What are the local plants that you can use to plant on contours that will help slow soil erosion AND may provide you and your livestock with food?

Here's a resource freely available. <https://gutpela-png-gaden.net/library/record/view/id/45> - it describes farmers in ENB using A-frames. An A-frame is used – you may have worked with one – to allow a



Villager Handbook – Day 2 – Water and Erosion



strict contour line to be planted. Try this technique with a farmer or two who are particularly interested. Some farmers really understand the importance of slowing down soil loss. Top soil is precious.



In Enga farmers are learning to use a local plant called Muku as a food plant AND erosion control plant- which can be planted with the help of A-frames.

Make use of plants that have multiple uses. Vetiver grass is useful at stopping erosion and in roofing material for a home. It has no food value. Maybe muku, pineapple or local plants you know of are worth trying?

How valuable is your topsoil?

This exercise is designed to help you control erosion on your land, while growing some useful plants, like pitpit, valangur, pineapple, sugarcane, aibika, vetiver or lemon grass. (refer to page 57 for photos of these plants).

Look at the photos below to give you an idea of what you are going to achieve.



Case Study- From Rapolo Village, Rabaul District

Feb-
A-frame to help in establishing contour lines. Note the bottom row of vetiver and valangur is at Mr Bomai's feet. He is holding the A-Frame. .



Planted in Feb
vetiver grass

Growing in May
Lemon grass and valangur



The soil in photos above isn't normal garden soil. These slopes were covered a few years before in a thick coating of volcanic ash, that grows plants well... but erodes very easily. Controlling erosion was a priority.



Wokabout long ples

- Go to a garden which is on some sloping land, looking at the traditional ways in which erosion has been managed- eg Trash-lines.
- Are traditional ways of controlling erosion present in every sloping garden, or only some?

What else can be done?



Villager Handbook – Day 2 – Water and Erosion





Villager Handbook – Day 2 – Water and Erosion



Working together

- Make an A-frame
- Collect range of plants, cuttings.
- Using the A-Frame, mark out lines across the slope. Each contour line should be about twice the height of a person apart.
- Plant lines using plants that local farmers are happy with- those that give food may be best.



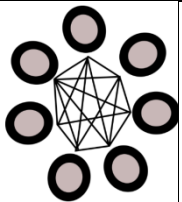
Farmers work together to learn about ways of controlling erosion- what else can be done?



Discussion in groups

Look at the photos above.

- Why don't we do more to reduce erosion?



Discussion about Erosion

- Either complete a SWOT analysis (page 22) or the question below
- Discuss together the good and bad points relating to erosion control in your gardens- see below.



Villager Handbook – Day 2 – Water and Erosion



Time for discussion?

Good things that happen if we reduce erosion?

Are



Villager Handbook – Day 2 – Water and Erosion



Using SWOT Analysis on various ways of controlling or reducing erosion.¹

	Strengths	Weaknesses	Opportunities	Threats
Barriers in drainage ditches				
Using plants like white or Kenyan clover and forage peanut to slow water				
Trashlines across the contour				

¹Make this table on a large sheet of paper for group discussion.



Villager Handbook – Day 2 – Water and Erosion



<p>Using A-Frames and live fences on the contour</p>				
<p>Other ways that you use to control erosion- list here</p>				



Live fences/Hedge rows

- What are the characteristics you are looking for in a live fence?
- Live fences may be useful as a way of reducing kaukau weevil in new gardens.
- A well planned and well managed live fence may help you to manage livestock.



Try to find live fences that are →

- Planted from stakes,
- Nitrogen fixers – legumes,
- Produce edible leaves or fruit for farmers to enjoy and sell,

You won't find all these characteristics in one live fence plant.

What works well in your village?

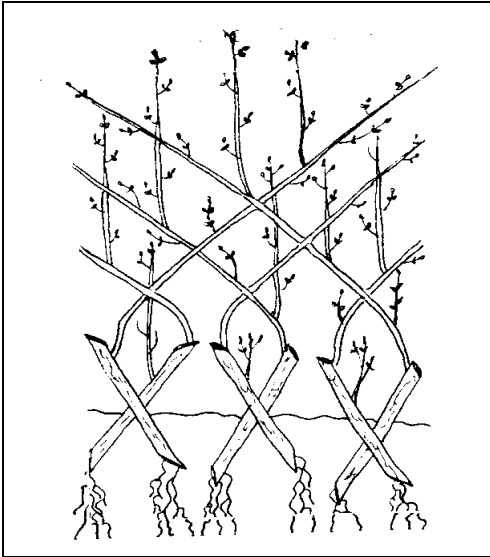
Instead of vetiver, consider (smelkumu) – lemon grass as it has uses in the kitchen.

You may have multiple species in a live fence. Right at ground level, white clover (cold areas), Kenyan white clover (cool areas) and forage peanut (hot areas) maybe useful as ground covering plants slowing erosion by slowing water.



Background

- Live fences may be a good and cheap way to control animals that often destroy gardens.
- They must be established and grow strong before livestock are able to reach them.
- Live Fences may also help stop theft- esp if thorny bougainvillea is used. (Photo refer page 57)



Live fences can be effective- but the stakes need to be planted very close together so that branches that grow can be twined together.

Trees that can be used include Rosewood, quickstick (*Gliricidiasepium*), willow, balbal (*Erythrinasp*), bougainvillea, tanget, mulberry and a range of native species- pitpit, bamboo kalava, valangur and others

A very good live fence- cuttings have been planted very close together- during a training in May 2004, Kerevat.

Note Valangur, MarMar and also vetiver have been planted, to make a strong fence to help keep unwanted animals out of the area.



Working together

- Plant a live fence and manage it so that any gaps are re-planted.



Flemingia planted in contour lines – stops soil erosion



Remember, caring for topsoil cares for your children!

These photos are from hills in the Philippines. On the left, 400 t/ha of soil were lost each year in a traditional garden. On the right less than 2 t/ha of soil were lost each year, by planting rows of legumes on contour lines.

Check photos of Flemingia and other legumes – page 57.

Strip gardening on slopes

What is strip gardening? This is a technique used in other countries to slow down top soil loss. Instead of contour rows, part of the hill side is left in fallow plants. As heavy rain falls, this 3-5 m wide (un-gardened/uncleaned) area of fallow plants captures and holds precious top soil.

Might this help your garden? Might this help to protect your precious top soil.

Top soil matters!
Now and in the future



Make a simple experiment

Maybe villagers can agree to try this technique?

- If some people are starting a new garden, you could help them for a while, discussing the possibility of leaving some land in a strip on the contour ie across the hill side to protect the soil from erosion

Discussion together –

- List good and bad points relating to strip gardening.
- What stops villagers from using strip gardening or any of the other techniques to protect top soil from erosion?



Could strip gardening have been used in this garden?



Discussion questions

Relate the discussion of water resources in a water shed back to the changes that have occurred over the last 50 or so years using memories of those in the room.

- Look together at your maps
- How far has the forest receded from the village in last 40 years?
- What are the key issues learned today about water and how to manage it well?

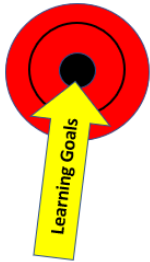
Write your answers and discuss together

Biosand filter – Clean water for our family



Training Topic 3 - Organic matter – crucial to healthy soil

Learning goals



Farmers will →

1. Know what organic material and organic matter (humus) is and why it is so important.
2. Be able to manage organic material to benefit their soil and garden produce.
3. Have changed attitudes to fire – knowing how good and how bad it can be.

This topic is crucial. Plenty of organic matter is the foundation (holds soil nutrients and moisture) on which we build healthy crops. Healthy soils can provide the right environment for food plants to grow and villagers and livestock rely on these for life and growth.



Wasting organic matter. Wasting mulch. How else might this be used? Why do we burn? What are the consequences of burning? These are questions at the heart of today's discussions.



Villager Handbook – Day 3

Organic matter, mulch and fire



Your training started (Day 1) by encouraging men and women to think together about your village and the ways the village has been changing. You have considered the way the climate is changing and how this hurts our gardens.

On our second day together, we thought about and discussed the big picture of water sheds and the importance of top soil and reducing erosion.

Today on our third day, we 'dig' into a whole new topic – how to care for the soil we live from. This requires us to think about and discuss the importance of organic matter.

Back when there were few people and lots of forest to cut and burn villagers didn't have to plan or think too much about garden fertility – the forest built fertility during a long fallow or resting period of 15 or more years.

Now with lots of people and very few villagers able to cut and burn old forest, each village family needs to learn →

1. what organic matter is,
2. the importance of organic matter,
3. how organic matter is lost and gained,
4. special roles for mulch, and
5. fire – a story of good and bad,
6. how to manage compost and kitchen gardens and
7. what role our animals play in soil fertility, building healthy families and gardens?

What is organic matter?

Put simply organic matter is anything that was alive, is now dead and starting to decompose. Leaves, kitchen waste, dying roots from plants. Anything that can rot.

The layer under a forest is rich in organic matter.

We have two components to consider →

1. **Organic material** are the leaves, twigs, sweet potato peelings, banana skins we throw on our gardens- or make compost with.
2. **Organic matter** is this organic material that has been decomposed into relatively stable humus.



Villager Handbook – Day 3

Organic matter, mulch and fire



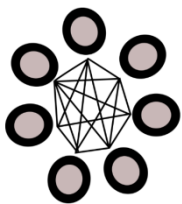
Corn here is flowering when still tiny.

Why?

What does this tell us?

Why is organic matter important?

In addition to providing nutrients and a place for small and tiny organisms to live in the **soil**, **organic matter** also binds **soil** particles into aggregates (small chunks) and improves the water holding capacity of **soil**. Most **soils** contain 2-10 percent **organic matter**. However, even in small amounts, **organic matter** is very **important**.



Organic matter –critical issues

- Holds water in our soils - this is critically important when rain stops and drought sets in.
- Having mulch (organic material) on the soil surface protecting soils from sun AND lots of organic matter in the soil helps to keep soils moist.
- Organic matter holds nutrients needed for crop growth. They are provided as slow release nutrients. Wonderful.
- Just by being there and helping to bind soil together, organic matter helps reduce erosion during heavy rain. Great!

Without organic matter farmers tend to have to rely on chemical fertilisers for their crop growth. Chemical fertilisers are great – but only if used wisely – little and often is a reasonable way of operating.

But we are much better to rely on organic matter and sustainable garden systems with fallow plants and animal manures providing most nutrients.

Nitrogen fixing plants are a much better way of getting Nitrogen into our gardens – but... wait, we are getting ahead of ourselves. More on this later.

Burning wastes organic matter



Over cultivated soil, then heavy rain forms crust



Do you see soil that is so cultivated that when it rains it forms a hard crust on top? This soil needs organic matter. It needs mulch.

How is organic matter lost and gained?

We start by thinking about organic matter- and the way in which we can use it or lose it!

The quickest way to lose organic matter is to burn it. We must continually add organic matter to keep soils healthy.

How else do we lose organic matter from our soils? We lose organic matter when we cultivate the soil for a garden. Then add hot tropical temperatures PLUS moisture and we have an oven that literally cooks up organic matter. It is gone quite quickly. So, we need to maintain and look after organic matter.

David and Anna say

We must not burn our leaves and garden trash. This is precious mulch to feed our soil.

How do you as a village family learn the value of mulch?

You make your own simple →

1. with mulch and
2. without mulch experiments to show the effect of mulch.

Special roles for mulch

Mulch and mulching are absolute keys to improving food resilience and food security in challenging times.

Let's go over what we know →

We have many people. We have few areas of forest left to make gardens in. We must learn from rain forest ecosystems. We must learn from key features of how rainforests work.



Villager Handbook – Day 3

Organic matter, mulch and fire



One key feature is rainforests protect the soil from heavy rain and hot sun – with leaves above and litter or mulch on the soil – protecting it.

Let's see. Can we protect our garden's soil in the same way with our crops above and LOTS of mulch on our soil? The answer is yes.

The following pages show you some simple with and without experiments that have shown the benefits of organic matter.

During the last drought in PNG – 2015/16 weevils caused massive problems. They found the kaukau tubers in the ground by making use of open cracks in dry soil. As you know, weevils are not a big problem during wet periods.



Wild sunflower as mulch to protect from Weevil.

Does this help reduce weevils?

We don't know yet, but it will help keep moisture in the soil and reduce cracking.

It will reduce weed seed germination and reduce erosion... so yes it will help in many ways.

So, one way to reduce weevil damage may well be to add organic matter on the mound surface.



No mulch. People like tidy, bare soil... BUT lots of soil is lost when heavy rain falls AND soil dries out, cracks, allows weevils to destroy



Testing mulch on a new kaukau mound.



Villager Handbook – Day 3

Organic matter, mulch and fire



kaukau during droughts.



Lots of mulch protecting garden from rain and sun- ready to plant, without burning.



This photo shows the end point of a test of two mounds of soil and the same amount of water as heavy rain falling (village watering can).

On the left – the soil was covered with the leaves you can see. Almost no soil moved off that



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Organic matter, mulch and fire



mound.

However, on the right, the heavy rain fell on bare soil... and lots of soil washed away. This is a powerful demonstration showing how important leaf cover/mulch is to protect soil during rain.



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Organic matter, mulch and fire



Photos below are from Wetar in Indonesia – where *Gliricidia sepium* (Quickstick) leaves were laid on the soil surface in between shallot plants – like bulb onion.



The leaves helped reduce weeding – especially important as most weeding is done by women in PNG.

The leaves used as ground cover were from *Gliricidia* – quickstick. The crop was shallots – like onion/garlic.

The leaves did a great job of reducing weeding. The leaves shaded the soil surface. This shade reduced weed seed germination = less weeding. Great.

Mulch
reduces
weeding



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Organic matter, mulch and fire



The grass in this photo was thrown into a smelly pit to rot and pollute ground water with nutrients that make water unhealthy to drink. Not good.

But it gets worse! It was a total waste of needed organic matter in gardens. Where might this grass be put?

Each farmer has a choice... What do our family do with mulch?
Dru leaves and litter.
Don't just burn it



Where to put mulch?

This is a question for us all. You may like to put mulch under bananas, taro, and around corn plants. Almost anywhere is good! You can easily make a simple test - with and without mulch.

Nut grass is a serious weed of gardens in PNG. One possible help in a small garden?



On left – many layers of newspaper on top of nutgrass. Then lots of dry mulch to hold the newspaper down. This aims to keep the nutgrass from getting light. Without light, it isn't going to grow well.



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Organic matter, mulch and fire



No herbicide used. Much less weeding. That sounds great. Worth trying?

Here's a photo of organic matter/mulch material which has been used well. That same mulch was put on top of nut grass in Vudal's University gardens (back when it was called Vudal).



Without mulch

- cabbage doesn't grow well
- many big weeds

With mulch –

- cabbage grew bigger
- weeds are only small



Villager Handbook – Day 3

Organic matter, mulch and fire



What about making a garden and testing mulch

Fire – good and bad

In tropical gardens one of the biggest challenges is fire. Matches. People sweep leaves and instead of putting them in a hole to plant African yam for example... they burn them. Burning leaves is bad for smoke and air quality – but also a silly loss of organic matter.

Organic matter is simply too precious to just toss away and burn.



Make two lists together – the good and the bad of fire in our gardens.

Good things that fire does for us?		Damage that fire does?
1		
2		
3		
4		



Beware – thinking about fire



- ❖ We all know that fires do lots of work for us, cleaning up the ground, killing insects and diseases, helping to get ready for a new garden.
- ❖ But fires also burn organic material that we need for the slow release of (gris) soil fertility, to grow good crops.
- ❖ Fires also destroy lots of good timber and trees, and may get out of control, destroying gardens and houses.
- ❖ When drought starts, then is a crucial time to manage fire very carefully.




Villager Handbook – Day 3

Organic matter, mulch and fire



Compost and kitchen gardens

	<h3 style="background-color: #e0e0e0;">International Experience</h3> <ul style="list-style-type: none"> • Many people in cold countries take their mulch (green and dead material that will rot) and in a special place, make compost. They use wheelbarrows to shift it to their (small) vegetable gardens. • But, most of us have large gardens and we can't make enough compost to make a real difference in these large gardens.
	<h3 style="background-color: #e0e0e0;">Compost or Green manures?</h3> <ul style="list-style-type: none"> • We need lots of mulch to make lots (and lots) of compost to help our soils. It is very hard to do this in traditional compost heaps. • Later on we are going to plant green manure crops. These produce lots of mulch for us. • These green manure crops (cowpea, snake bean etc) will also provide some food for us, and for our animals. <h3 style="background-color: #e0e0e0;">Using Compost for seedlings</h3> <ul style="list-style-type: none"> • For nursery seedlings of fruit and vegetables some compost is helpful. See below.

Making compost:-

Mix 7 spades of green leaf material, 2 spades of good soil, 1 spade of banana trunk material that is chopped up, and 1 spade of dry leaves. After mixing, put these all into a compost heap and keep adding material in a similar ratio. The amounts are not too important. Make sure that the material is moist- if need be add water. Stand on the material to get it compacted. Add more until your heap is full and cover with leaves or even some plastic. Keeping rain out is important. Within a few days the heap should be hot, which is good- as it will help to kill weed seeds and the green plant material that must rot to form good compost.

After about 2-3 weeks it is good to open up the compost, turn it over with a fork or spade and put it back to finish working.

You can use your compost to grow good seedlings and young fruit trees. Of course, you can use it in your garden!

For gardeners without wheel barrows, compost takes a lot of time and is hard to shift from a heap to a garden. Maybe consider doing what some people now do. Dig a small hole. Fill it with kitchen scraps etc. Then cover with soil, plant an African yam. Dig another hole and repeat.

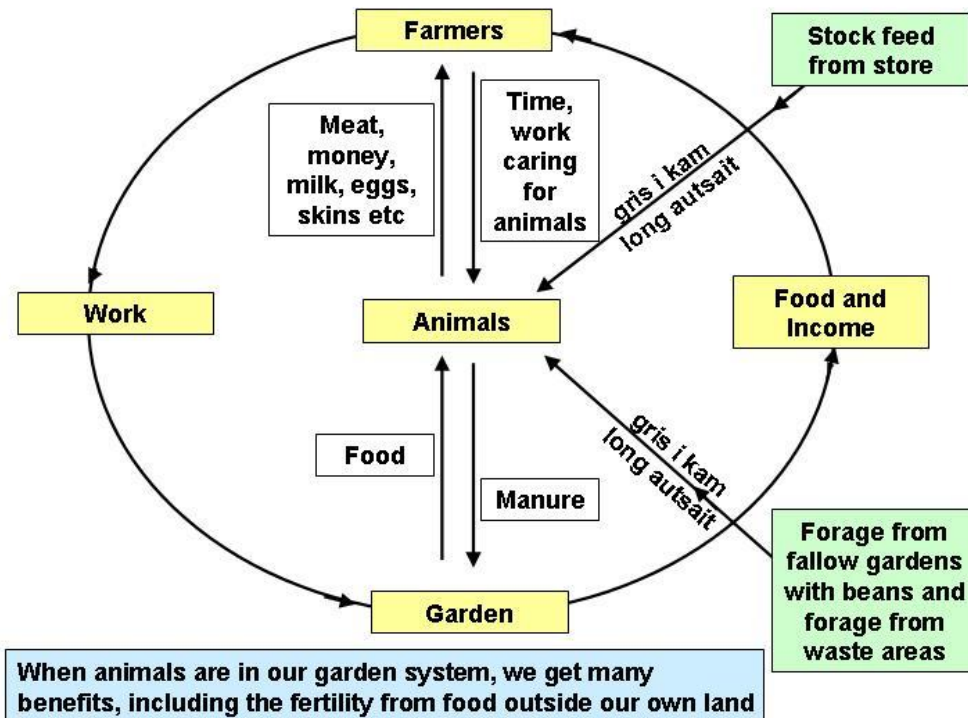


Villager Handbook – Day 3

Organic matter, mulch and fire





Role of animals in soil fertility and family well-being



The diagram above, and the picture below, helps to show the way animals can help us in our gardens. When we grow some legumes in our resting or fallow land, these legumes provide food for our animals, and our animals provide manure for our crops as well as protein for our families and some income.

This topic maybe a step too far for this training course. Keep it in mind! Animals can be powerful and helpful in food resilience.





Collect some manure and make a simple experiment with a crop like pakchoi or corn.

Chinese cabbage, with manure and without manure

Farmer fields, Eastern Highlands, October 2018



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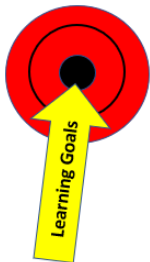
Organic matter, mulch and fire



1.3 m high with no added fertiliser or manure.



Mix of rabbit and goat manure – almost twice as high.



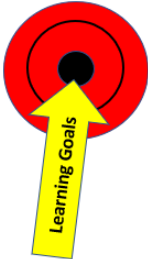
Summary →

1. Refer to today's Learning goals
2. Discuss together – what have you learned that you will put into practise in your own garden
3. What might stop you doing some new things in your garden?



Training Topic 4 Improving fallow

Learning goals

	<p>Farmers will →</p> <ul style="list-style-type: none">• Understand change. There are now many young family members wanting garden land.• Understand how to improve fertility of soil.• Go home and plant legumes under young corn to see the value of crop rotation and improving fallow.• Take every opportunity to help their fallow land so that soil has plenty of fertility for the next crop of onions, yam, kaukau or... That is your choice.
---	--

What does 'fallow' mean?

Gardens always need rest periods. A fallow is a resting time for your garden's soil.

Years ago, many gardens rested for years. Tall forest trees grew during fallows. Times have changed! ~~There are still parts of PNG on very weathered, nutrient poor soils, with few people (eg Fly River catchment in Western Province) where villages still shift, and new gardens are made from old growth forest. But those people are often gaining most of their food from hunting, sago and bush foods.~~

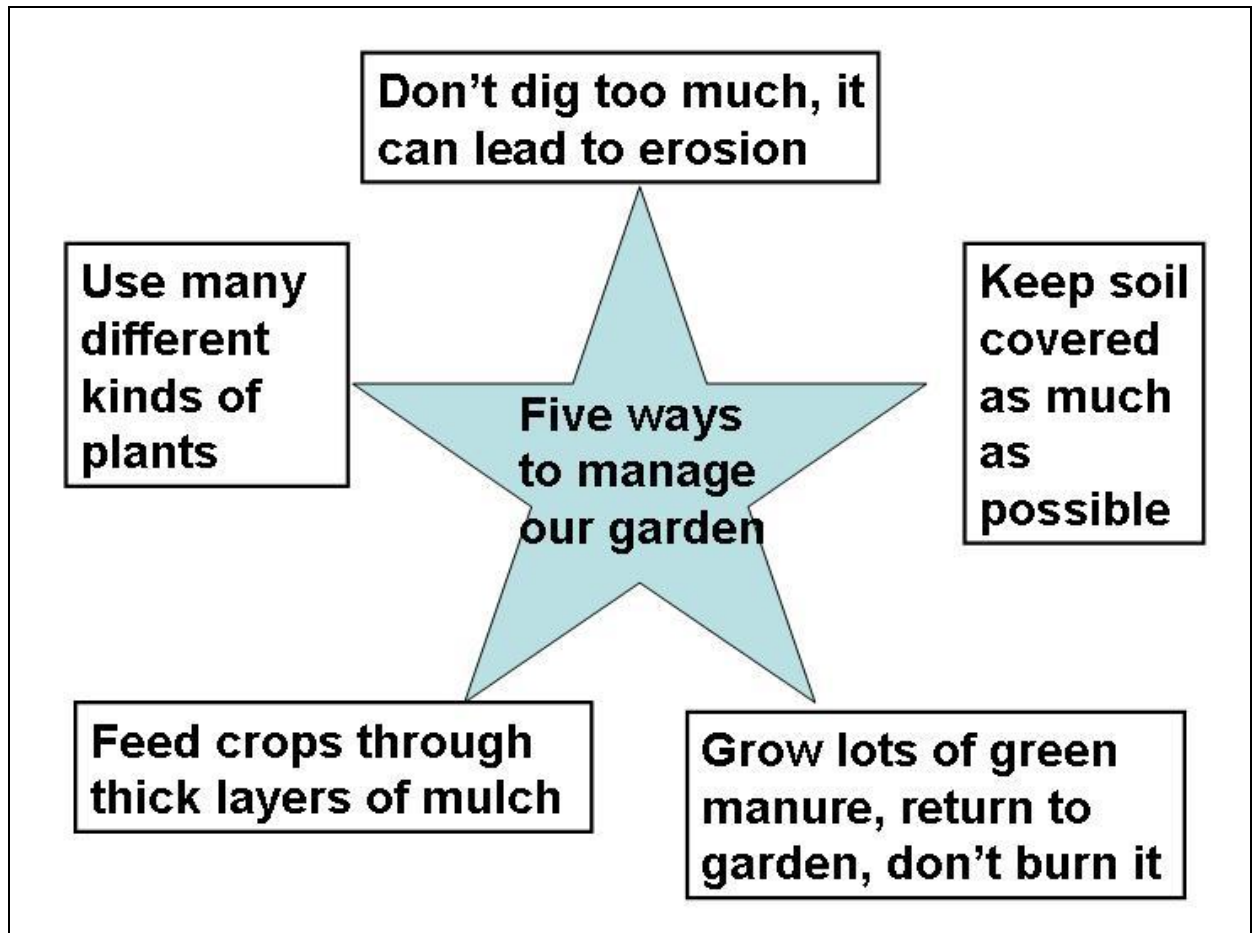
Most villagers don't have enough ground for long fallows **due to high population growth**.

One of the problems of a natural fallow of weeds and grasses is the amount of weed seed that causes problems in the new garden. A fallow of legumes can reduce the weed seed problem and increase soil fertility – as well as providing legume forage for feeding animals like pigs, chickens and rabbits or goats.



Five ways to care for garden land

Most of the items below copy the way **forest covers, protects and cares for the soil.**



Caring for soil is worth doing!

Managing fallow land

How is land used? Take a walk.



- Think about the maps you drew.
- Look at different gardens – Identify new gardens, those being harvested, those that are resting. Maybe pigs are grazing in there?
- What else do you see?
- Today we think about how we as a village might look after our land better to improve soil fertility AND provide food for animals



Villager handbook – Day 4

Improving fallows



AND reduce weeding for those who weed in a new garden.

Many fallow gardens grow lots of weeds. These weeds produce seeds that cost gardeners lots of time in weeding. So, this isn't just about fertility. It is about the work of those who weed – and often this is women.

Managing fallow land

Things to think about together: -

Less work	<ul style="list-style-type: none"> • Reduced weed seeds in the next garden- through reductions in weed seed bearing plants in the fallow, • Cultivation will be reduced because of the large amount of green manure that has grown on your land,
Better water holding capacity	<ul style="list-style-type: none"> • Reduced burning of organic matter, which helps to reduce erosion losses of soil and nutrients, and increases water holding capacity of soils,
Less erosion	<ul style="list-style-type: none"> • Increased cover of your soil because you have planned your fallow,
Improved yields	<ul style="list-style-type: none"> • There will be more mulch with a high level of nitrogen to help in growing your next crops.
Food for animals	<ul style="list-style-type: none"> • Animals can get food from our gardens- legumes are high in protein and this is good for our animals.



Using Green manure legumes

What is a legume?

Legumes are plants like

- Beans, peas, peanuts, soybeans, mung beans
- shrubs like pigeon pea (there's lots of others)
- some rambling plants like cowpea,
- and climbers like snake bean, winged bean, Dolichos lablab, Lima beans and Everlasting beans.
- Trees. For example balbal, marmar, lamtoro, rosewood, rain tree, Albizia, Acacia.

Some legumes may bother us – these include Calopo, Pueraria, Desmodium (Greenleaf and Silverleaf) (refer to page 57 for photos). They do increase soil fertility but are hard to manage without goats or pigs.

Legumes are used all around the world. White clover is known as the best forage food for animals.

Legumes take nitrogen from the air and turn it into protein

All legumes take nitrogen from the air and through small lumps or nodules on their roots, they turn that nitrogen into protein. This protein is what helps make legumes good for us and our animals.

The nitrogen that they 'fix' from the air also helps to build soil fertility.

Green manure legumes

These are beans and other legumes that grow easily, normally providing food for people and our animals. They :-

- help build soil fertility.
- provide food for people, (snake bean, soybean, peanuts)
- provide food for animals which in turn provide food and meat/eggs for us.

Look again at the diagram on page 42- it helps to show how animals eat plants from road-sides or fallow areas, or stock feed from a store and their manure then helps the garden grow well.

Legumes as food for people

Before eating dry legume seeds they should be →

1. Soaked in water for at least 12 hours – throw that water away
2. Boil with other food and enjoy when cooked.

Even peanut seeds should be cooked (roasted) to make the protein good to eat!



Villager handbook – Day 4

Improving fallows



Some people allow the legume seeds to sprout- (start to grow) before eating them. This also helps to make the protein easy to digest for people. It is a good way to eat legume seeds. Once sprouted they can be eaten raw or cooked.

Learning from International Experiences

- Thousands of farmers in other places are using short rotations of legumes as fallow- to reduce weeds and to increase yield of next crop.

Let's try this together and see for ourselves if it is helpful.

Make a simple experiment with legumes



Tumbunapasinbilongyumi

Remember that in taimbipo there was plenty of land for everyone and fallow periods were long, allowing trees to naturally regenerate. Now, there is less land and we have to put some effort into making each fallow period a really useful fertility building time.

Learning from our ancestors is always worthwhile.



Working together

In half of a garden that is almost finished- ready for taimbilongmalolo- plant seed of plants like velvet bean, Dolichos, snake bean, cowpea under the old food crop (photos starting on page 57).

Leave the other half of the garden to rest in whatever grows there- weeds, grass etc.

Leave both parts of the garden for about 6 months.



Later

After 6 months, plant corn in both areas, to see what effect the legume has had.



Discussion

List good and bad points relating to adding legumes to your garden system

What stops us from planting legumes under a maturing crop?

How can you make use of legumes and animals to help your food security?



Case studies of Green Manure legumes

1. Tomatoes at Vudal, ENB - cowpea or weeds planted.



These two photos were part of one garden at Vudal- growing tomatoes. The farmer left the left-hand side as we normally do, to let weeds grow during the rest or fallow period. On the right, the farmer planted some cowpea seeds at the base of the dying tomato plants. They grew well as the photo shows



Discuss together

- Which is the best system?
- Why?
- What stops you doing this on your land?

2. Rice and Calopo- PNG, WesternProvince

The photo on the next page shows how a green manure legume can help the next crop of corn.



Villager Handbook – Day 4

Improving fallows



After green manure legume
(Calopo)



Corn after weeds



Corn was much better after Calopo

Corn growth
was very
poor
after
weeds

Photo was taken at Tabubil, Western Province. Corn plants were grown either after a short fallow of legume (Calopo) or after a normal weed fallow.

NARI researchers are continuing to test these systems.

You can try this on your own land.

Use cowpea, dolichos, lima bin, everlasting bin. Refer page 57.



Storing seeds

- Seeds must be stored in a dry and rat/insect proof place.
- Even plastic drink bottles can be a safe, insect proof place to store seeds.
- Remember, dry the seeds very well.
- Bite the dry seed. If it squeezes it is not dry. If it breaks it is dry.
- Now put them in a bottle with a lid on. Store out of sun. Look the next day and the next. If there are signs of moisture on the side of the bottle – the seeds are not dry enough.



Improving long term fallows

Long term fallows normally involve trees – forest trees. In many areas close to towns in PNG, tenant farmers are not allowed to plant trees because of potential problems when the trees are mature. Who planted this tree becomes an important statement of ownership... so landlords say to tenant farmer/gardeners – no tree planting.

Background Information

Rainforests are the best ways we have of re-building soil fertility after a gardening cycle.

If we have a long fallow planned, then we can plant our last food crops and young tree seedlings together. This allows us to care for the tree seedlings as our food crops grow.

Tumbunapasinbilongyumi

- Remember that in ‘taimbipo’ there was plenty of land for everyone and fallow periods were long, allowing trees to naturally regenerate. (They established by themselves).
- Our ancestors knew the value of trees in rebuilding soil fertility. We all know this.
- However, our garden fallows are becoming shorter.

Now, there are more people. We must plan our land use, so there will be good soil and good timber for our next generations.





Wokabout long ples

Take a walk around the village looking for gardens that farmers know will be in fallow for more than 2-3 years.

- How long will this garden rest before it is planted to a new crop?
- What will happen to this land during the time it is in fallow?
- Can we improve this fallow- so that the next crop grows better, with fewer weeds to bother the person doing the weeding?

Learning from International Experiences

In other places, both in PNG and elsewhere, farmers actively establish trees for various reasons. Many of us already plant trees. This exercise is designed to help us think about planting lots more trees for our needs and the needs of our children.

	<h4>Working together – an exercise to do at home after training</h4> <ul style="list-style-type: none"> • Go to a garden that has recently been planted in food crops. The new garden should be the last garden in this area for some years. • Plant many seedlings of trees you know will be good – for the purposes you know are important to you. Firewood, timber, poles, soil fertility building and so on. • Trees and food crops can mix, so long as your land is going to rest in a few months, for a long time. • Break or prune side branches off the trees if they start to grow too strongly. • When the food crop is finished, the trees will be able to grow above the grasses and weeds, shading them out. This will mean that fire won't kill the trees, because there won't be much grass to make a hot fire. <h4>What might stop a farmer trying this?</h4>
	<h4>Many people say that our land is full of trees. There is no need to plant more trees.</h4> <ul style="list-style-type: none"> • What do you think about this? • What do you think your children are going to say about this, when they are older, looking for timber to build their houses?



Extra resources for you

Using Fertilizers bought from stores?

Background Information- Using chemical fertilisers

Issue	What can we do?
Fertiliser is expensive and the phosphorous particularly may be held tight by clay particles in our soil	<p>We need to:-</p> <ul style="list-style-type: none"> • feed our plants through green manure legumes, mulch and other organic matter and compost, • Fertiliser, if used, should be added in the mulch (litter, rotting leaves) layer, so that the fertiliser is mostly available to our plants.
Fires concentrate nutrients in ash, a bit like chemical fertiliser	<ul style="list-style-type: none"> • When we burn organic material, most of the nitrogen is lost in the fire. The ash is rich in P and K and other nutrients, but like chemical fertiliser it is easy for it to get washed away by rain.
Fertiliser from stores may be hard to get in our village	<ul style="list-style-type: none"> • Think about sharing costs with some other farmers • Remember that there are other kinds of fertiliser- animal manures, mulches and green manures.
Sometimes we have a particular deficiency that is best overcome with fertiliser.	<ul style="list-style-type: none"> • This is particularly the case with trace elements like Boron which is often needed for good tree growth. Only small amounts of fertiliser will be needed in these instances. You will need to seek advice of extension officers and scientists with organisations like NARI.

Our best fertiliser is always mulch and manure.



Wokabout long ples

- In your village- take a walk looking for gardens that may benefit from fertiliser- especially crops that are going to be sold- things like capsicum, tomato, watermelon, corn etc.



Learning from International Experiences

- Many people are finding that mulch and animal manure is better than chemical fertiliser.



Working together – Yumi train

- Set up a small experiment with a food crop-
- half of the plants receive one matchbox full of fertiliser (see next page) – suggest you try with NPK fertiliser.
- and the other half of the plants get no fertiliser.

It is best to test fertiliser on high value crops like capsicum, watermelon, aibika, tomatoes, corn etc. We suggest you don't try fertiliser on kaukau as that may not need the fertiliser.

Timing and Applying fertiliser

- For vegetable crops, you can apply half the fertiliser at planting, and then another half once the crop has established.
- Apply fertiliser on some leaf litter, and cover with either soil or more organic waste.
- If nitrogen fertiliser is not covered, much N will be lost, as ammonia gas when hot sun hits the fertiliser.

Write down what you did so you can remember what areas were given some fertiliser.-



Later

- Come back to the garden and see how the fertilised and unfertilised crops are growing.
- Can you see a difference?

Was it worth spending the 6 toea buying the fertiliser for each of the plants you used a matchbox weight of fertiliser on? See next page for costs.



How much fertilizer should I use?

If you are going to apply fertilizer to your tomatoes, capsicums etc, you need to answer some more questions- what kind and how much?

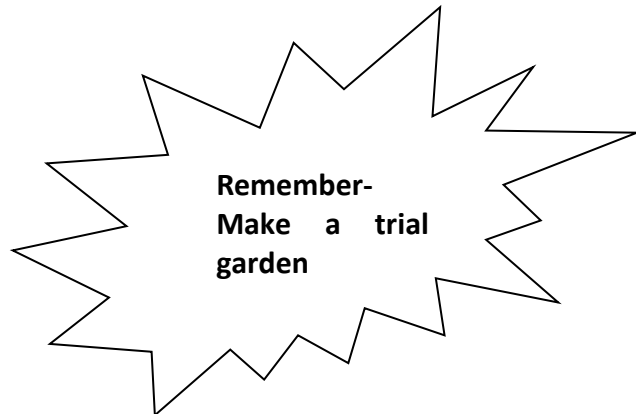


If 40 kg of fertiliser cost	A matchbox (20g) of fertiliser would cost the farmer	A lid of fertiliser (7 g) would cost
K60	3 toea	1.1 toea per lid
K80	4 toea	1.4
K100	5 toea	1.8
K120	6 toea	2.1 toea per lid

If four farmers each bought $\frac{1}{4}$ of a bag of fertiliser which weighed 40 kg and cost K120 by the time it was transported to their village then-



- ☞ They would have to pay K30 each for their 10 kg.
- ☞ They would have enough to put 20 g of fertiliser on 500 plants.
- ☞ That means each of the 500 plants receive 6 toea of fertiliser, weighing 20g in a matchbox container.



For cocoa, farmers often use about 1 tin fish can (approx 400g of fertiliser) and from the table above, if the bag of fertiliser cost K100, then that tin fish can would cost the farmer about K1 for each cocoa tree.

Fertiliser and organic farming

Many farmers want to farm in an organic manner- not using fertilisers or sprays. This is good.

However, remember that when a plant takes up Phosphorous (P) into its roots, it doesn't really care if the P came from organic material or from a fertiliser bag.

You may also like to think of the ash from a fire being a little like a fertiliser from a store. Both are concentrated forms of plant nutrients (except the store fertiliser will normally have lots of nitrogen and the ash has lost most of its nitrogen in the fire). Both can easily be washed away in heavy rain. It is best to rely on organic forms of fertiliser- green manures, composts and animal manure.



Photos of less well-known plants useful to farmers

Note this section only provides photos of plants that are not common in ENB, or that may be unknown by some of the readers. Plants like snake bean are not shown as they are common and can be learned from people in most villages of Papua New Guinea.

Photos are listed alphabetically, by common name.

<p>Calopo (<i>Calopogoniummuconoides</i>) Green manure crop, not very palatable to animals, see how hairy it is.</p>	<p>Cowpea, <i>Vigna sinensis</i> This is one of the best cover crop, fallow plants. Refer photos and text pageUsing Green manure legumes on page 47</p>
	
	
<p>Cowpea at Vudal, UNRE Ralph Yamb, Isaac Taraken.</p>	<p>From http://www.southernexposure.com/queen-anne-blackeye-pea-southern-pea-cowpea-28-g-p-208.html Cowpea – lowland bean, climbing (almost). Great food crop. Great fallow land fertility building crop.</p>



Everlasting bean
Phaseolus coccineus

Casuarina- DiwaiYar

Useful especially in atolls, to provide firewood, timber and organic matter from the fallen leaves.

Dolichos (*Dolichos lablab*)

The almost mature pods are picked, boiled and seeds enjoyed once boiled. Sort of like peanuts.



Erythrina- BalBal

Tree, edible leaves, legume, can be used as live fence, but remember this grows large. Some short to very short thorniness.





Three women, holding pods of Dolichos, the woman in centre is holding a bottle with dry seeds of Dolichos to store for later planting under half mature corn, in a garden that will rest for a while.

Forage peanut (*Arachis spp*)

Low growing creeping ground cover,
tolerates lowland heat and rain.





Flemingia (*Flemingia macrophylla*)

Shrub legume, used elsewhere as contour plant, reducing erosion on slopes



Kalava

Shrub, useful as food for people, forage for animals and erosion control.



Mulberry – a live fence AND forage for animals and fruit for us?



MarMar- Gliricidia – Quick stick.



Peuraria (Peurariaphaseoloides)

Twining legume, common in waste ground, and under balsa

May not be wise to plant this as it is a vigorous climber, and spreads rapidly. However farmers need to know it is useful and can be used for animal forage.





Pigeon Pea (*Cajanuscajan*)

Shrub, food for people and animals



Rosewood

Pterocarpus indicus

A most wonderful legume tree, rabbits love eating it, can be grown from sticks, useful live fence tree. Glorious timber when milled.



Snake bean

Useful lowland feed for people, animals, and short rotation green manure, no need for photo.

Valangur

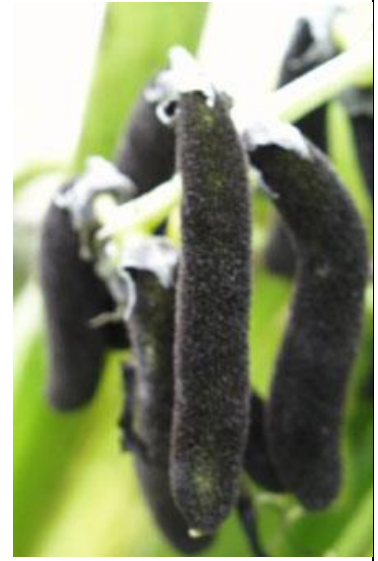
Live fence, food for people, forage for animals?





Velvet Bean
(*Mucunapruriens*)

Short lived climbing bean, has toxins in mature seed-beware.



Vetiver grass- your DPI or NARI or private trainer can help you get some of this grass. It can be used for thatching houses, and some people believe its roots can help to repel insects like bed bugs or cockroaches.



White clover (*Trifoliumrepens*) High quality forage, erosion control, grows in cold areas of highlands.



Kenyan White clover (*Trifoliumsemipilosum*)
as above, but can tolerate more heat, and has purple flowers.

Winged Bean, also called 'as bin'. (*Phosocarpustetragonolobus*)



Teak. High value timber. An opportunity for many villagers, to grow this for their own needs or for sale? Rosewood might be wonderful also.



Action Plan

This is a summary exercise. There are different ways you can do this. You may break into groups and have each group summarise parts of the training.

You may like to do the exercise below, or if the weather is fine, you could all take a walk outside and identify in each garden, the kinds of things that can be done, to improve management of soils.

Discussion



During the training and village activities you have seen and talked about many kinds of gardens, and ways of managing your land.

- In groups, list the ways you can improve land-use practises on your land. Write all these good ideas on cards (about 10 cm x 5 cm).
- Now draw a large map of the village on a very large sheet of paper, and tape the cards to the places where they fit.
- This becomes a plan – a village plan to improve land-use and help to provide for future needs of people in the village.
- It is now over to you.







Evaluation

What are some things you really enjoyed during this training?

What things did not help you?

What things are you going to go home and do in your garden?

Remember – share the things you learned with others – please.



Photos of key plants mentioned in this manual
