

AGROFORESTRY

Sustainable Livelihoods
for Rural Youth Project



Agroforestry

Growing income for Solomon Island farmers



Russ Grayson

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for Rural Youth Project**

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**Russ Grayson
2004**

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PREFACE

Agroforestry is a manual for trainees in the Kastom Gaden Association Sustainable Livelihoods for Rural Youth Project.

The project was funded by AusAID between 2002 and 2004 to assist rural youth in the Solomon Islands establish income-earning projects as part of post-conflict reconstruction.

Agroforestry is a training module in the project. Other modules include pig farming and chicken keeping.



Introduction...

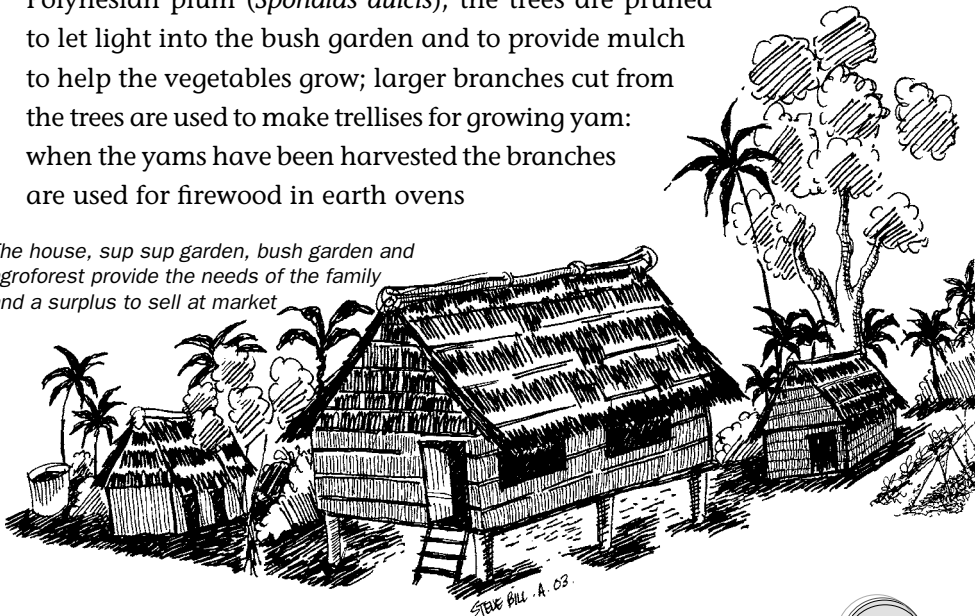
PACIFIC ISLAND AGROFORESTRY

PACIFIC ISLANDERS have grown agroforests for thousands of years. We can learn how to plant new agroforests and add introduced trees to feed our families and earn income.

Agroforestry in the Pacific islands includes:

- the planting of ngali nut and other fruit and nut trees by families in the Solomon Islands including cut nut, betel nut, breadfruit, bush apple, bush mango – these are grown in bush areas; useful trees are grown around houses, such as guava, five corner (Carambole), pommello, bush lime, coconut, pawpaw, bananas, cut nut, betel nut
- coffee grown under Casuarina trees that provide shade and mulch in PNG
- bush gardens in Tonga that have trees such as breadfruit, citrus, avocado, mango, Malay apple (*Syzygium malaccense*) and Polynesian plum (*Spondias dulcis*); the trees are pruned to let light into the bush garden and to provide mulch to help the vegetables grow; larger branches cut from the trees are used to make trellises for growing yam: when the yams have been harvested the branches are used for firewood in earth ovens

The house, sup sup garden, bush garden and agroforest provide the needs of the family and a surplus to sell at market



- in the Marquesas islands of Polynesia, home gardens include trees such as coconut, mango, kapok, breadfruit, banana, pawpaw, guava, lime, avocado, soursop, tamarind; the legume tree *Leucaena* (*Leucaena leucophala*) is found around villages and is used for firewood and for horse food (horses are used to carry loads).

*Information from: The Overstory #29: Traditional Pacific Island Agroforestry Systems;
<http://agroforestry.net/overstory/overstory/>*

Agroforestry in Asia

Agroforestry is also found in South-East Asia:

- in Indonesia, agroforests are planted around houses where food, craft and medicine trees are grown
- in Vietnam, home agroforests include coconut, banana, pineapple, vegetables, bee hives, pigs and ditches for edible fish; grain and fresh fish maintain a balanced diet and family health.

A small agroforest or tree garden near a house - Choiseul Province



WHAT IS AGROFORESTRY?

The word 'agroforestry' comes from two words – agriculture and forestry.

Agroforestry means 'agricultural forestry'.

Agroforestry is growing trees and shrubs useful to people.

Agroforestry can provide:

- food, building and craft materials
- timber, firewood, medicines and other products.

These can be used by the family or can be sold.

Agroforestry can include:

- mixes trees of different types
- mixes trees with crops.

Mixed agroforestry

In our definition of agroforestry we mean a mix of more than one type of plant.

The planting of only one type of tree, such as coconut or teak, is called 'monoculture'. A monoculture is different to mixed agroforestry.

Many types of plants together

Different types of trees are planted close together in a diverse agroforest.

A diverse agroforest produces products such as fruit, nuts, timber, bush medicine, bamboo, building material.

The mixed agroforest contains many types of plants grown together.

The plants provide fruits and nuts, building material, medicine and plants used to make rope and baskets.





In the agroforest

NEEDS AND BENEFITS

An agroforest can be planted over a large or small area of land. A small agroforest is like a tree garden.

A number of things are needed to plant an agroforest:

- land
- seedlings, seed, cuttings and suckers
- water
- sunlight – some trees need sunlight; others grow in the shade of taller trees

- space – trees need enough space to grow
- care and your time – checking for damage by insects or plant disease and weeding vines from the trees, probably the most time-consuming activity in starting an agroforest.

You will have to slash weeds and undergrowth to keep it away from young trees while they grow.

Agroforestry helps the environment

An agroforest is like the natural forest:

- it stops the soil from washing away when it rains (erosion)
- it improves the soil by bringing up nutrients from deep in the ground and giving the nutrients back to the soil as leaves grow, fall and rot
- it cools the air and keeps it moist
- it provides living space for birds, possums, insects and other life.

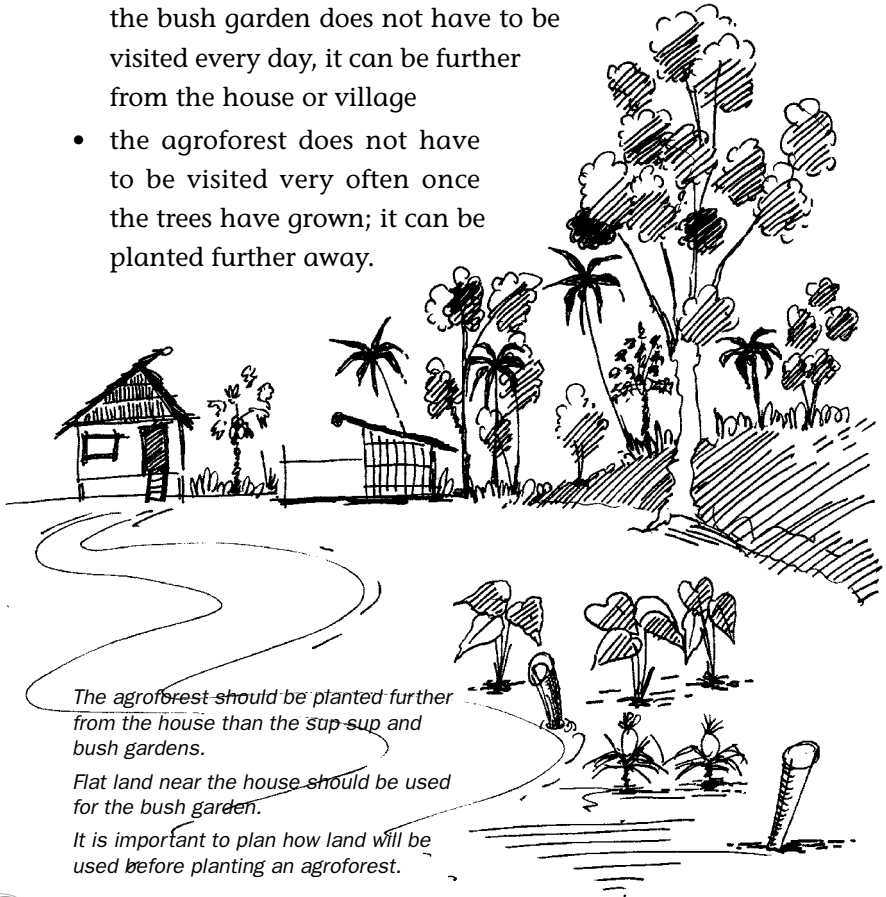
WHERE TO PLANT AN AGROFOREST

An agroforest can be planted on flat land or on hillsides.

Trees will be there a long time so it is very important for the family to plan the use of their land.

For example, a family can grow food in different gardens:

- a small nutrition or sup sup garden close to the house; this is for vegetables that are used every day
- flat land close to the village should be used for bush gardens; this is for staple crops such as taro, yam, pana and cassava; the bush garden does not have to be visited every day, it can be further from the house or village
- the agroforest does not have to be visited very often once the trees have grown; it can be planted further away.



The agroforest should be planted further from the house than the sup-sup and bush gardens.

Flat land near the house should be used for the bush garden.

It is important to plan how land will be used before planting an agroforest.

Agroforestry in bush gardens

The bush garden can grow agroforest tree crops such as Gliricidia, pawpaw, banana, fruit and nut trees as well as crops. When the garden is left the trees will grow up and eventually become a food forest.

Bush garden agroforestry:

- makes bush gardens more productive
- keeps the soil fertile.

Planting legume trees such as Gliricidia keeps the soil fertile.

Agroforestry on hillsides

An agroforest can be planted on steep slopes not suited to vegetable growing. The agroforest grows fruit and nuts, timber, bamboo, building and craft plants, coconut and betel nut, bush medicines and other trees and shrubs as well as root crops such as sweet potato.

A large agroforest can be planted over an entire hillside.

Small agroforests can be planted:

- as a tree garden or grove on top of a ridge
- as a tree garden or grove near the house
- along the banks of a stream; it will hold the soil together and keep the water clean.

Small agroforests can include a mix of trees such as fruits, nuts, sago palm and pandanus for building material and bamboo.

Agroforestry in swamps

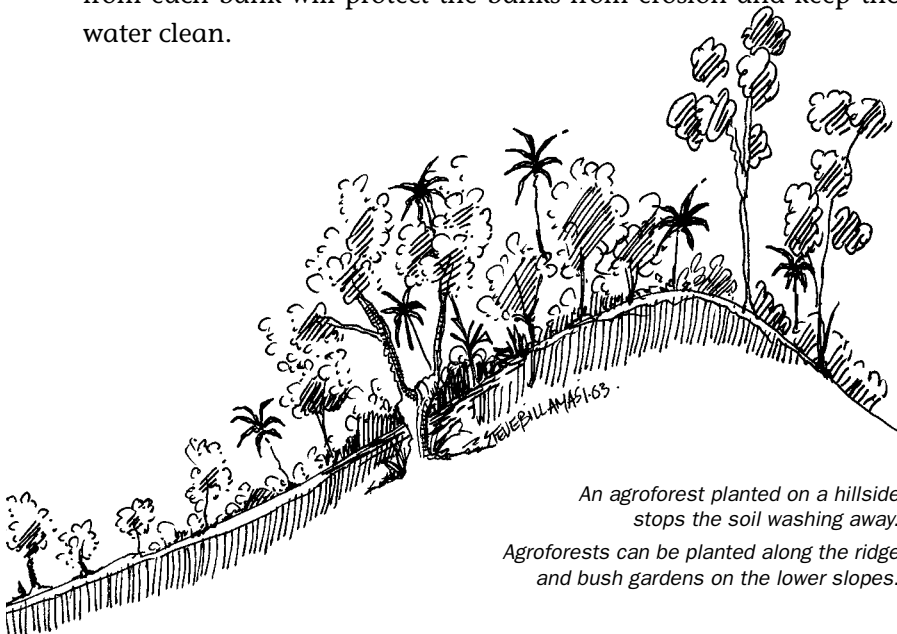
The agroforest can make use of swamp land that is not good for gardens. Many useful trees will grow in swampy areas.

Trees that will grow in swampy areas:

- sago palm
- swamp taro
- pandanus
- timber trees
- medicine trees
- bush ferns.

Agroforestry on river edges

An agroforest planted along the banks of a river to about 10 metres from each bank will protect the banks from erosion and keep the water clean.



An agroforest planted on a hillside stops the soil washing away.

Agroforests can be planted along the ridge and bush gardens on the lower slopes.



MIXING AGROFORESTRY AND CROPS

Agroforestry can be mixed with:

- food plants such as root crops and vegetables in bush gardens
- cash crops like vanilla.

Small groves or lines of pawpaw and banana can be planted among vegetables in the bush garden.

Crops like the wild yam vine (Nummalaria species) can be grown in the agroforest. They keep well in the soil and can be harvested from the same plant year after year.

Hedgerows

Hedgerows are lines of trees and shrubs that divide a bush garden into smaller areas.

Crops and vegetables are grown in these areas.

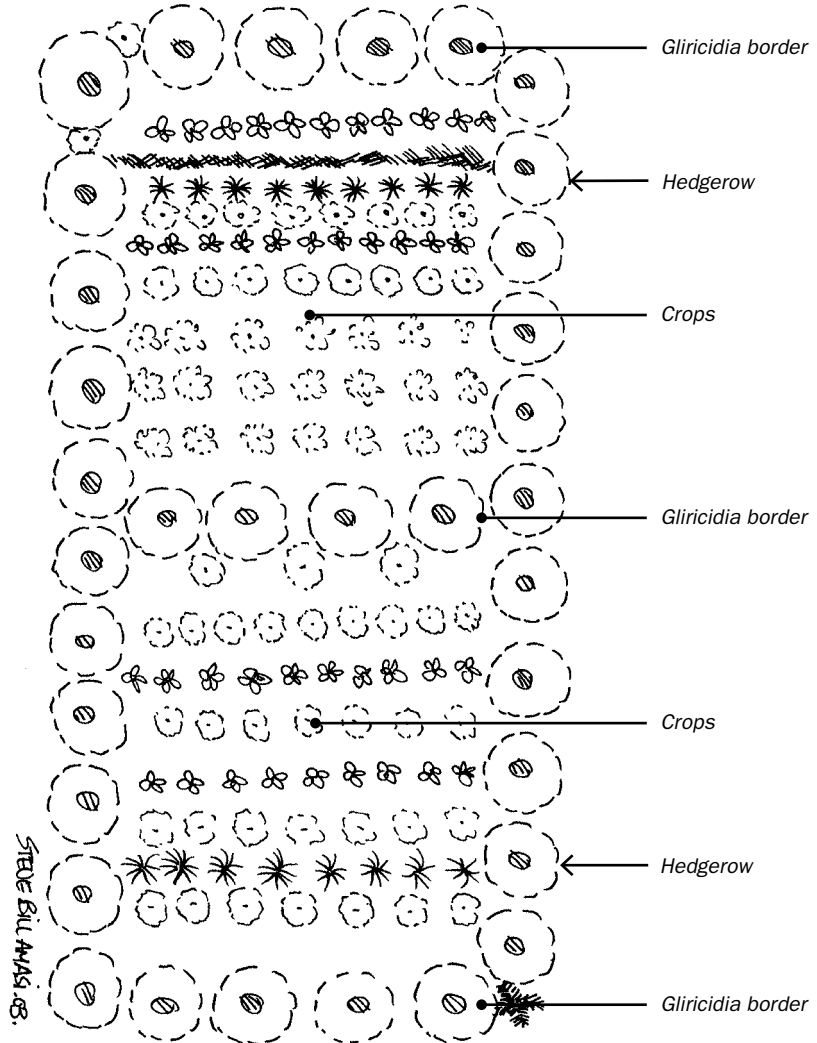
In the Solomon Islands there are many examples of traditional ways of planting small trees in gardens along the edge of garden blocks.

We can use these ideas and adapt and improve them:

- the hedgerows can contain legumes such as Gliricidia; Gliricidia is slashed to use as mulch on the vegetable gardens
- the hedgerow can include pawpaw, banana, sugar cane, small fruit and nut trees, young firewood and timber trees
- hedgerows can be planted around the boundary of bush gardens.

Hedgerows...

- a border of *Gliricidia* divides the field into small areas
- crops are planted in these areas
- the *Gliricidia* leaves are slashed and put on the ground to mulch the crops.



Alley cropping

Alley cropping combines trees, root crops and vegetable crops. It is used in many countries.

Alley cropping:

- can be used on hillsides and flat land
- includes legume trees to slash and use as mulch; this keeps the soil fertile; the legume trees grow back after they have been slashed
- legume trees are planted in lines and vegetables are planted between them.

To make an alley cropping system we work out:

- how far apart we plant the Gliricidia trees
- how wide we make the alleys where we plant vegetables
- how often we slash the legume trees for mulch in our vegetable alleys.

Joseph Kirio is a retired soil scientist and agroforester who lives on the shores of Suvu'a Bay in North Malaita. Joseph has developed an alley cropping system.

Joseph says to:

- plants Gliricidia five metres apart (six wide steps) in lines
- make the lines of Gliricidia are about five metres from each other; the space between the lines are the cropping alleys
- plant vegetables in the crop alleys; cassava, taro, sweet potato as well as tomato, greens and peppers can be planted here
- when the Gliricidia have grown enough leaf they are slashed; the Gliricidia is kept to the height of a shrub.

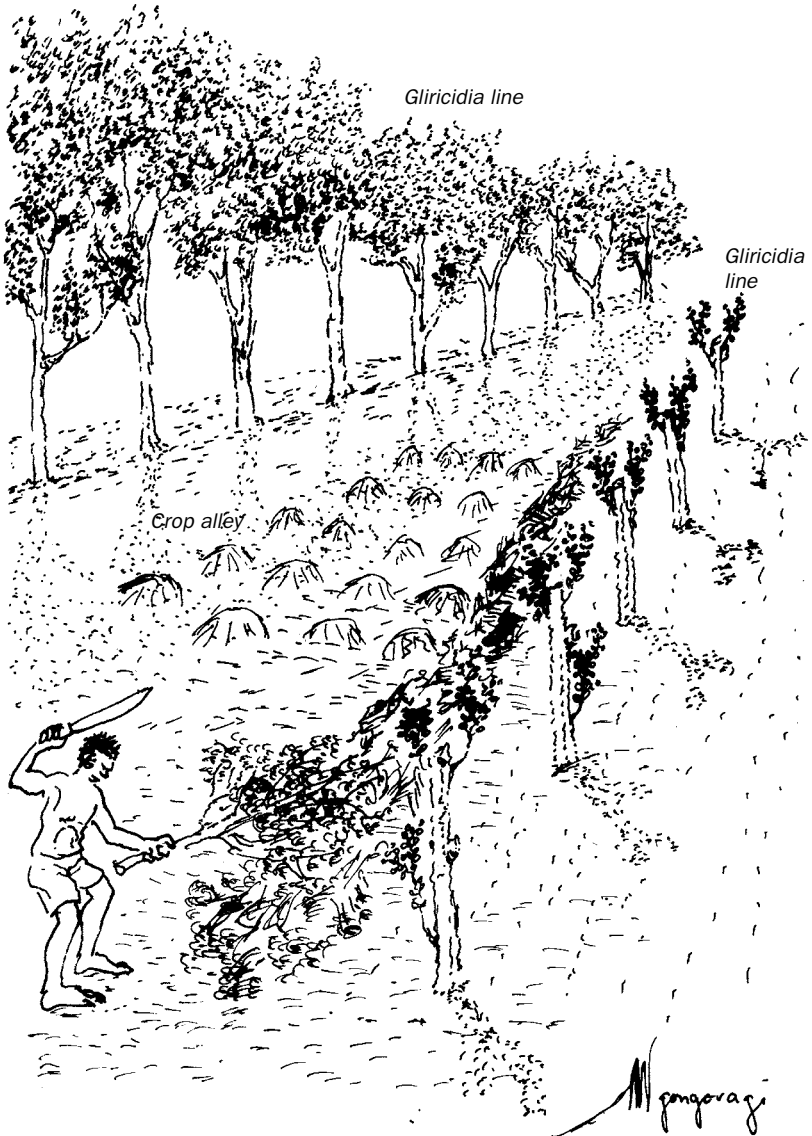
Other alley cropping farmers:

- plant Gliricidia as close as half a metre and plant them in a line in a zig-zag pattern
- they are slashed to keep them as small shrubs

Alley cropping...

- lines of *Gliricidia* are planted across the field
- crops are planted in the alleys between the lines of *Gliricidia*.

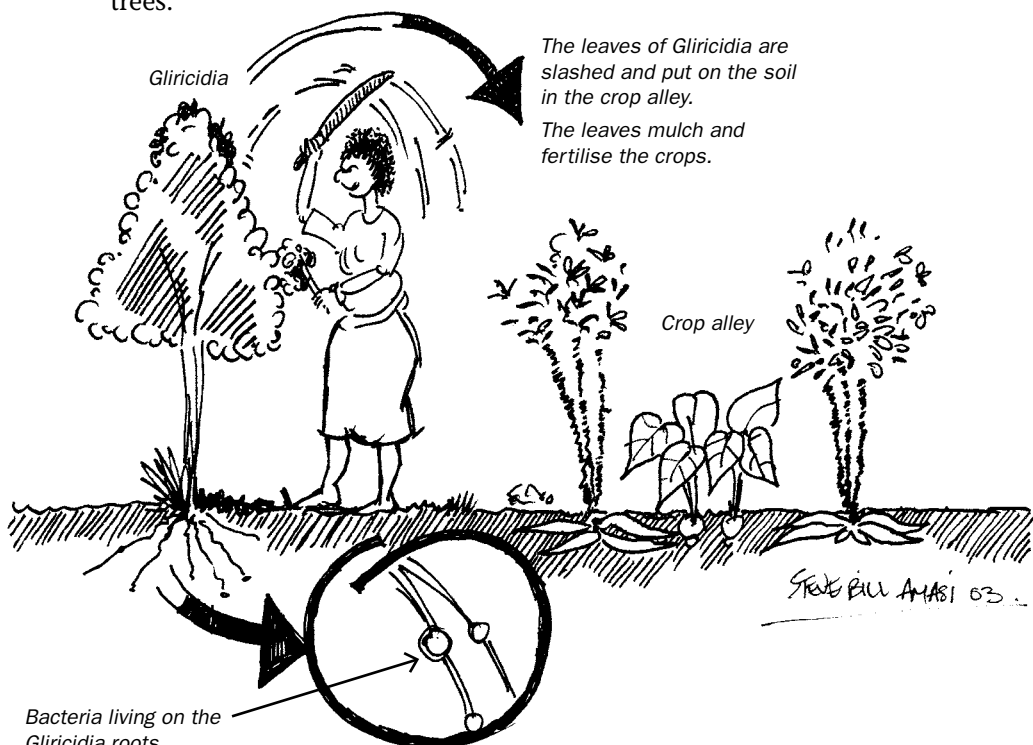
Slash Gliricidia to about a metre in height - thigh height - and place in the crop alley as a mulch.



- plant the Gliricidia rows at least six metres apart; they say that if the crop alleys are too small there will competition between the Gliricidia and vegetables for nutrients, water and light.

Managing the alley cropping system

- reduce competition between the Gliricidia and your crops by making your crop alleys wide enough
- slash the Gliricidia when enough leaf has grown after the last slashing; place the slashed leaf on the soil in the crop alleys; the leaves will break down into nutrients and feed the crops; the leaves will grow back on the Gliricidia - this is called 'coppicing'
- the Gliricidia are slashed so they grow as shrubs instead of trees.



The leaves of Gliricidia are slashed and put on the soil in the crop alley.

The leaves mulch and fertilise the crops.

Bacteria living on the Gliricidia roots...

Bacteria live on the Gliricidia roots, they are too small to see.

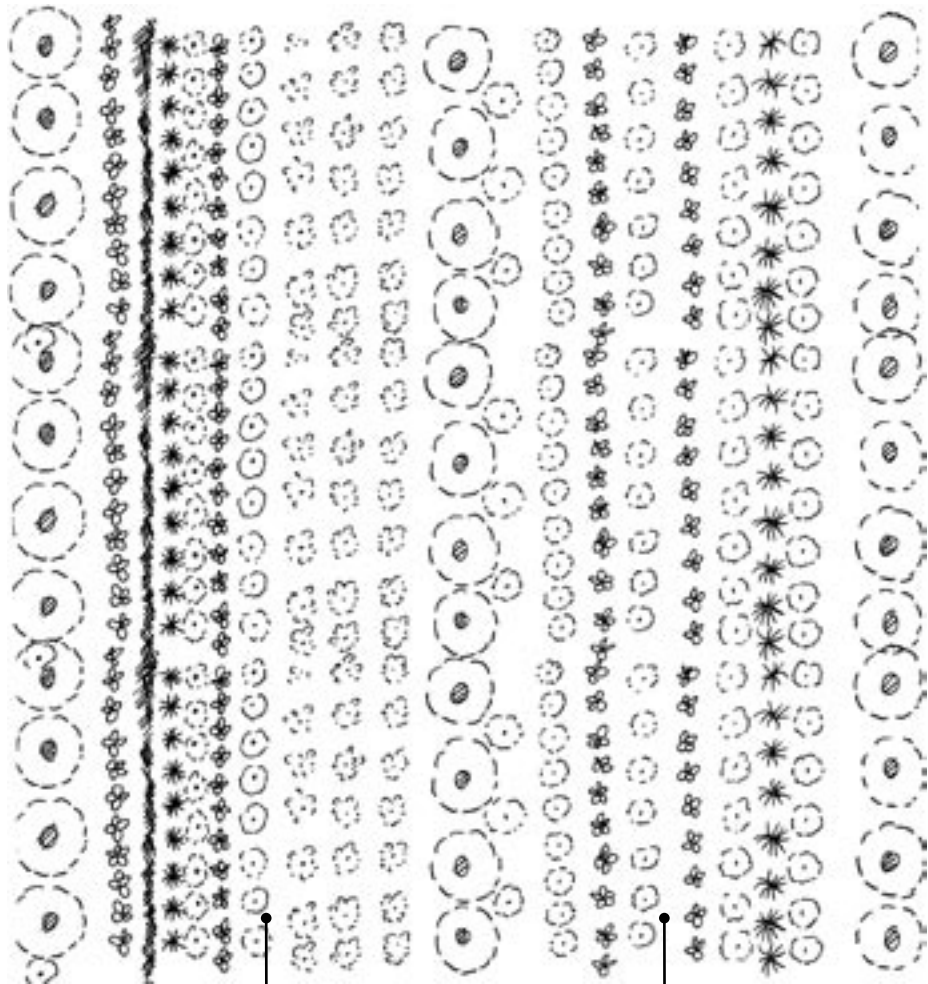
The bacteria make fertiliser from the nitrogen in the air trapped in the soil.

Alley cropping...

- lines of *Gliricidia* are planted across the field

- crops are planted in the alleys between the lines of *Gliricidia*.

Slash *Gliricidia* to about a metre in height - thigh height.



Gliricidia line

Crop alley

Gliricidia line

Crop alley

Gliricidia line



Joseph Kirio's alley cropping system. The line of trees behind the sweet potato mounds are Gliricidia. They are slashed to mulch the crop alleys.

Tree clumps in bush gardens

Agroforest trees can be grown close together in mixed groves in bush gardens or along ridges and hills:

- legume trees such as Gliricidia can be planted in the groves; they can be slashed to use as mulch to help young trees grow or used as mulch on food gardens
- fruit and nut trees can be planted in the groves; they can be eaten by the family and sold at market; a grove might include ngali nut, cut nut, breadfruit, bush mango, alite.

The tree clumps can be small or large:

- small clumps will not have big, spreading trees like mango that take a lot of space
- large clumps can cover larger areas of land such as ridges and hillsides; these can have larger, spreading types of trees; the number of trees planted depends on family needs.

Other ways to plant *Gliricidia*

- *Gliricidia* can be planted around the boundary of bush gardens.

The leaves can be slashed and used as mulch to help the vegetable crops grow.

- *Gliricidia* trees can be planted in clumps in the bush garden.

The leaves can be slashed and used as mulch to help the vegetable crops grow.



LIMITS TO AGROFORESTRY

There are a number of factors that may limit where an agroforest can be planted and how big it can be.

- **land ownership** – customary rights to land – may restrict the size of an agroforest; it may be better to start small to avoid land disputes
- **competition with bush gardens for land** – it may be better to plant the agroforest further from the bush garden; you can combine some agroforestry trees with the bush garden
- **competition** – for space, water and light if trees and shrubs are planted too close together in the agroforest
- **insect pests** – agroforest trees may provide living space for insect pests that attack crops; there will be fewer pests in a diverse agroforest with a large number of different trees and shrubs
- **labour** – the time a farmer has for planting and maintaining an agroforest; if a farmer cannot visit a young agroforest often, the seedlings might suffer from competition with weeds; plant only as much area as you can look after without taking time away from other important family and work commitments
- **time** – trees take a long time to produce a product such as fruit, nuts or timber.

Before planting an agroforest it is important to plan how land will be used in the future.



The jackfruit is one of many fruits that can be grown in the agroforest

PLANTS FOR AGROFORESTRY

Mixed agroforestry includes trees and shrubs to produce fruit, nuts, timber, edible leaves for cooking, building material (such as pandanus, bush palms, sago palm, lawyer cane and bamboo), bush medicine, firewood, bush ropes and fibres and trees to use for mulch.

Many trees are used for agroforestry in the Pacific islands.

Different island peoples use different trees and shrubs. They have different varieties of the same tree, such as banana.

These are some of the trees and shrubs grown by agroforesters in the Solomon Islands:

Fruits

- breadfruit
- avocado
- bush avocado
- mango
- bush mango



- citrus – oranges, limes, lemon, mandarin, pomello
- bush apple (*Syzygium*)
- Polynesian plum (*Spondias dulcis*)
- coconut (food, drink, building material, craft wood)
- banana
- pawpaw
- lime
- guava
- soursop (*Annona muricata*)
- custard apple (*Annona squamosa*)
- tamarind (food flavouring)
- sugar cane
- alite (*Terminalia* sp)
- edible types of Akwa (in Temotu).



Bananas in an agroforest near a house - Guadalcanal Province

Building material

- sago palm (roofing)
- timbers
- bamboo
- palms (for flooring)
- lawyer cane and other vines for rope.

Craft and household material

- pandanus
- kapok (a fibre taken from the pods and used to stuff pillows)
- bamboo
- coconut (leaf used for weaving).

GETTING READY TO PLANT YOUR AGROFOREST

Plant trees in the right place

Plant your tree or shrub where the soil is right:

- some trees might not grow well in sandy soil near the beach
- some trees will not grow in swampy soils
- some will not grow well in dry places.

Choose an area that does not flood regularly.

The soil should not be wet and muddy unless you are planting trees for a swamp garden.

Cut weeds

To prepare land for planting, slash long grass and weeds where you want to plant your trees. This will stop the grass and weeds competing with your tree seedlings for water and nutrients and smothering them.

It is not necessary to burn the cut grass and weeds. Burning can damage the micro-organisms that live in the soil and expose the soil to erosion. Leave the cut grass and weeds on the ground to cover the soil.

Visit the agroforest regularly after you plant your seedlings or cuttings. Slash long grass that is growing too close to the seedlings or cuttings. You do not have to do this when the seedlings have grown higher than the grass and have produced many leaves.

Plant sweet potato to stop weeds

A way to reduce the work of weeding is to plant a food crop, such as a sweet potato garden, in the same area you plant your trees. When you weed and harvest the sweet potato you can take care of your trees.

Some trees like shade while they are young. You might plant bananas to provide shade.

Growing and planting trees

Trees and shrubs grow from seed, cuttings or from suckers.

Trees from seeds

Seeds can be collected in the bush and planted in your agroforest.

It is best to plant the seeds in a nursery so you can care for the young trees. Plant them in the agroforest when they have grown enough.

The seeds are grown in a seedling box until they have some leaves. They are then planted in the agroforest.

Some seeds from the bush can take a long time before they germinate and grow. You may need to experiment.

Starting trees from seeds...

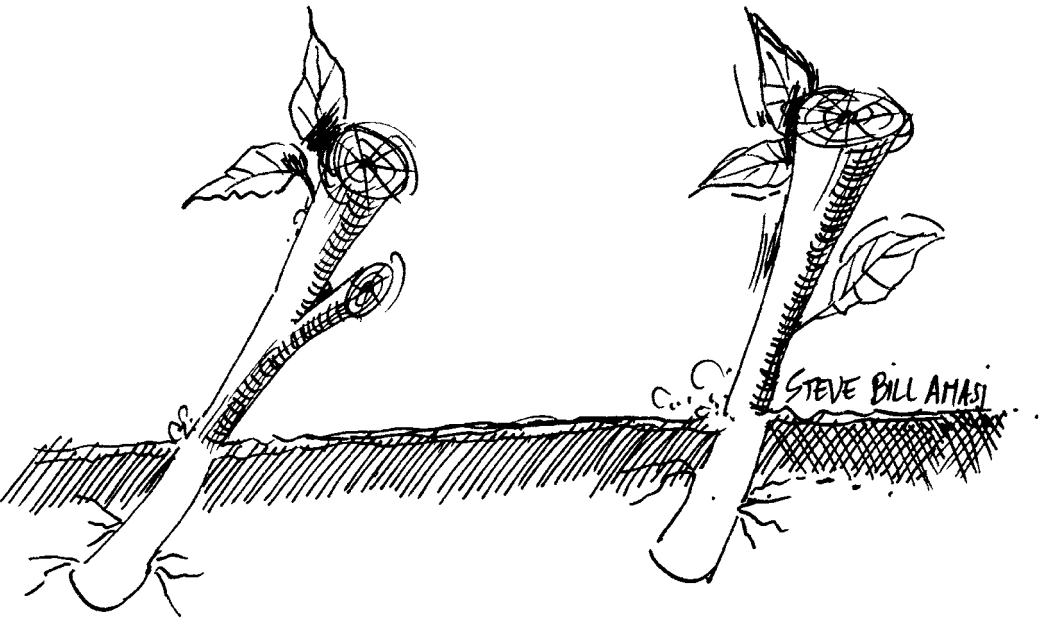
- make a hole twice the depth of the seed
- place seed in hole
- cover seed
- sprinkle with water.



Trees from cuttings

Cuttings are pieces of a branch cut from a tree.

The cuttings are planted straight into your agroforest.



Trees from cuttings...

- Take a cutting from a tree or shrub. Cut from the tree at an angle. The cutting should be about as long as your forearm.
- Make a hole in the soil about as long as an outstretched hand.
- Place the cutting in the hole at an angle.
- Put soil around the cutting.
- Water the cutting.

Trees from wild seedlings

You can collect seedlings to plant in your agroforest. These can be young trees from the bush or young trees growing under existing fruit trees and agroforests.

This is sometimes easier than collecting seed because you might not know when a tree has seed and miss the seeds when they fall.

Look for young seedlings as they are easy to pull out. Transplant them into a nursery or into bamboo or poly bags the same day you collect them or no later than the next day.

Be careful not to break off too much of the roots when you collect the seedlings.

Every time you go walking in the bush you can look for useful trees to add to your agroforest.

Trees from suckers

Suckers are new trees that grow from the roots of existing trees.

Suckering is not used for trees for agroforestry except for growing new banana trees, although breadfruit trees will grow from root cuttings that look like suckers.

START A NURSERY

Start a nursery to grow seedlings for planting in your agroforest.

Trees started from seed are raised in a nursery before being transplanted into the agroforest.

Not all trees have to be started in a nursery. *Gliricidia*, for example, can be planted directly in the agroforest as cuttings.

Growing from seed

Make planting boxes about a hand length deep with sides about as long as your forearm.

Fill them with scraped coconut mixed with soil.

Find old coconuts and scrape them into the planting boxes. Add soil and mix.

The coconut fibre holds water in the planting box. The soil provides nutrients.





*Planting boxes filled with scraped coconut and soil for young trees.
Start a nursery to grow young trees for your agroforest. It is easier to
look after young trees and shrubs in a nursery.*

Plant seed

- find a strong, productive and healthy tree to collect seed from
- allow time for the seed to dry if you think this necessary; some seeds are better not dried and should be planted straight into the ground – for example, jackfruit and breadfruit seed
- plant the seeds in a seedling box in your nursery
- allow them to grow until they have several sets of leaves
- plant them out in your agroforest.

SPACING THE TREES

Plant your seedlings or cuttings so that when they grow their canopies will almost touch. You will need to know:

- what shape each type of tree grows into
- how wide it grows.

Planting trees so that their canopies are close when they grow will reduce weed and grass growth.

If you leave big spaces between your trees you will have to do a lot of brushing of weeds in the spaces for many years. It may be better to plant more trees closer together. Later, you can thin some of the trees.

Thinning timber trees

Trees planted for timber, such as teak and akwa, can be planted where they will grow into tall trees. You need to know the type of environment the tree grows in naturally when it is young. Some timber trees like sun (eg. teak) while others will grow well in shade (eg. mahogany or bunie trees).

Another way is to plant them close together at the start. This can be as little as a metre and a half. Close planting will make them grow tall and straight and become good timber trees.

When they have grown to twice the size of an adult person, the trees can be thinned:

- mark the best trees that you want to grow for their timber; when they grow they should be about a canopy width apart; they should have straight trunks and grow straight from the ground and look healthy and strong
- cut out the trees between these; the timber can be used for fences and for building.

This is known as ‘thinning’.

HOW TREES HELP PEOPLE

Trees produce many of the things people need to live:

Food

- fruit – such as bush apple, mango, coconut, banana, pawpaw, inkori
- nuts – such as cut nut, ngali nut, alite
- staple foods such as breadfruit and king tree
- edible leaves for greens such as king tree and bush ferns
- mushrooms growing on rotting logs
- food for animals such as sago palm trunk and bush vines and leaves for pigs and seed from luecaena or pigeon pea for chickens.

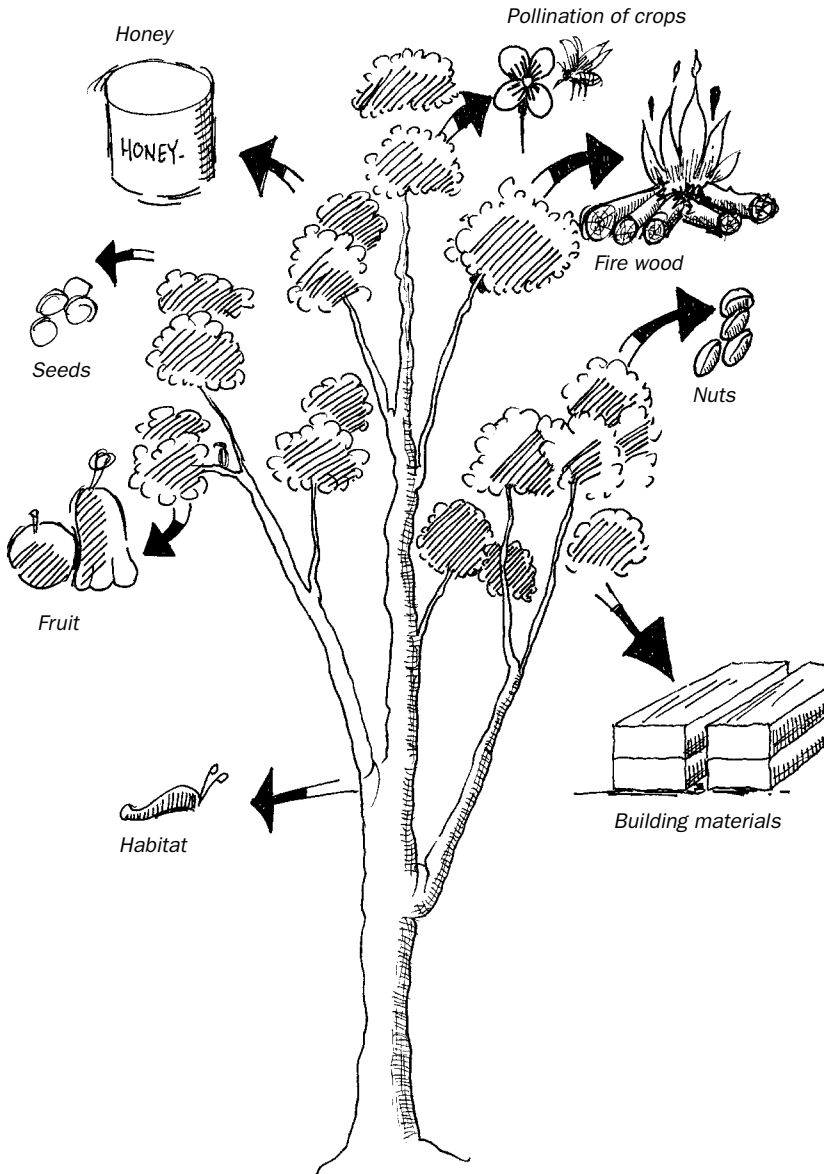
Building materials

- timber
- bamboo
- sago palm and other wild palms – for making roofs and walls
- vines to make rope for tying buildings and roofing
- palm trunk for flooring and battens.



*Building materials are grown
in the agroforest.*

The products of trees:



Cash

- the sale of surplus fruit, nuts, honey, firewood and building material brings income for the family
- timber cut and sold for income (growing timber trees is like a bank account for your children or for when you are old).

Herbal medicine

- for people
- for animals.

Useful materials

- fire wood to cook our food
- leaves for use as mulch on our gardens
- bark to make rope and twine
- flowers to attract bees to pollinate our crops and to make honey.

Trees provide shade to make our environment more comfortable and beautify it.

Trees produce these goods over a long period of time.

Solomon Islanders rely on a fire wood for cooking.

An agroforestry system can be an important source of fire wood.



HOW TREES BENEFIT THE ENVIRONMENT

Trees are important:

- to keep the environment in good condition
- to keep the environment productive.

Trees provide living space for animals:

- they provide living space for birds, insects, lizards and other animals; some of these animals help to control insect pests that eat crops
- trees with flowers attract insects that pollinate other plants to help them reproduce.

Trees prevent the loss of soil during heavy rain:

- heavy rain falling on the ground washes away the soil, it leaves less soil to plant crops in – this is called ‘erosion’
- the tree canopy breaks the force of heavy rain; the rain then drips slowly to the ground and is not strong enough to wash away soil
- tree roots hold the soil in place and stop it being washed away
- leaves that have fallen to the ground break the force of heavy rain drops and slow the water running over the ground; they reduce erosion
- trees release water from their leaves; they keep the air in the forest cool
- trees produce oxygen which people and animals need to breathe
- trees keep the environment around houses cool
- trees called ‘legumes’ hold nitrogen in their leaves; plants need nitrogen to grow; when the leaves die and fall to the ground they break down and release nitrogen into the soil; the nitrogen is taken up by the roots of plants
- trees help rain water seep into the soil and slow down rain water flowing over the ground; this prevents soil erosion and flooding further down the valley.

Agroforestry provides the same benefits as the bush

Trees do all of these things in the bush.

They provide the same services in agroforests.

Agroforestry improves the environment and produces materials of benefit to people.



When the hillside is planted with an agroforest the rain cannot wash away the soil. The hillside stays productive. Creeks are not blocked with soil that has been washed away.

Agroforestry on hillsides and along ridges keeps our village lands productive for generations to come.

HOW TREES IMPROVE THE SOIL

Trees make mulch

- leaves fall from trees and form mulch on the ground
- the mulch breaks down into nutrients - organic matter, minerals and nitrogen
- these are stored in the soil
- they are taken up by the roots of plants; they are nutrients that help the plants grow.

Legume trees provide nitrogen

- legume trees such as Gliricidia add nutrients to the soil
- nitrogen is an important nutrient needed by all plants to help them grow
- the nitrogen is produced by bacteria that grow on the tree roots
- planting legume trees such as Gliricidia in your agroforest will make the soil more nutritious.

Trees with deep roots provide nutrients

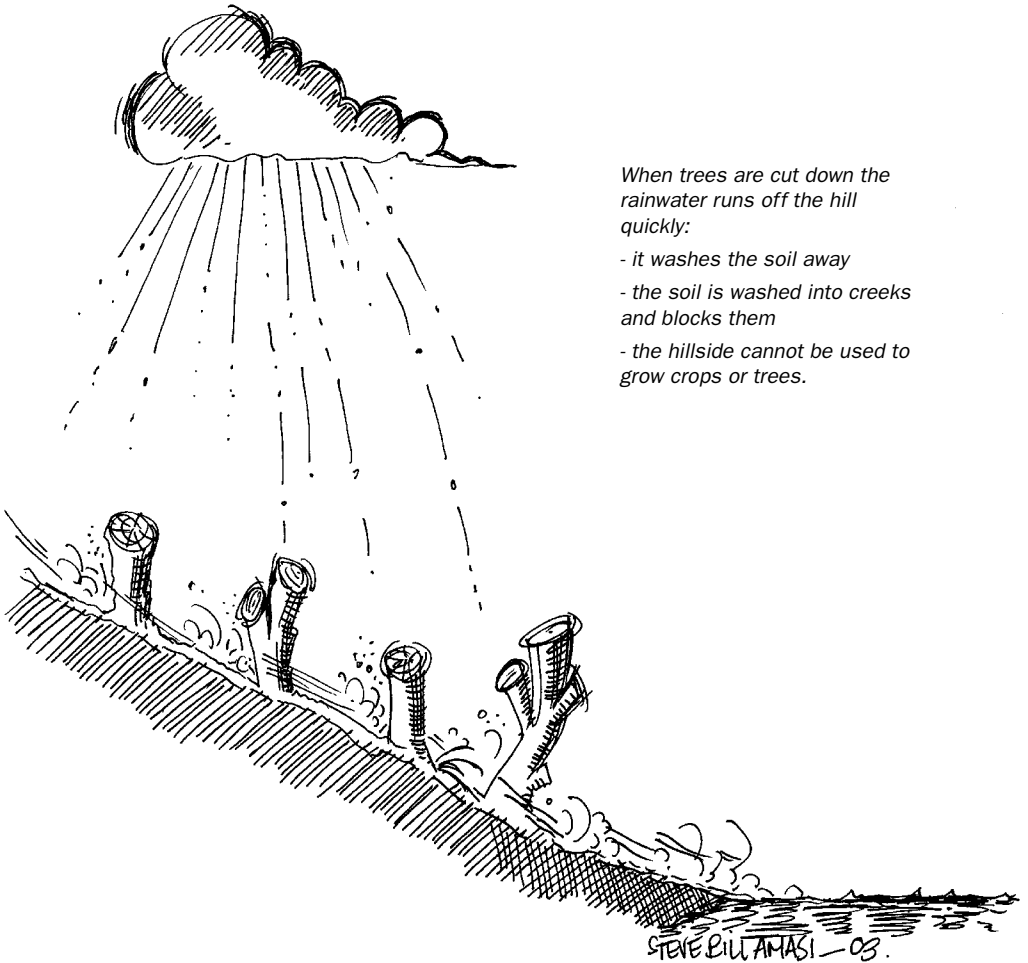
- trees with deep roots bring up nutrients from deeper in the soil
- the nutrients are turned into leaves and branches
- when the leaves and branches fall they break down into nutrients that are used by trees.

Trees provide shade

- shade cast by trees keeps the soil cool
- cool soil loses less water by evaporation.

Trees protect the soil from erosion

1. Tree roots and the mulch formed on the forest floor by fallen leaves slows rain water running over the soil.
2. Water that is moving slower has less energy to erode the soil.
3. When water is moving slower more of it seeps into the soil; it is stored here until taken up by the roots of plants.



When trees are cut down the rainwater runs off the hill quickly:

- it washes the soil away
- the soil is washed into creeks and blocks them
- the hillside cannot be used to grow crops or trees.

Tree roots become organic matter

- trees have small, fine feeder roots that take water and nutrients from the soil
- when the feeder roots die they break down into minerals and organic matter
- the minerals and organic matter become nutrients for plants.

Trees prevent flooding

- flooding occurs when forests in the hills are cut down
- trees in a forest slow down rain water running over the soil
- more water seeps into the soil
- this reduces flooding further down the valley.

How trees work

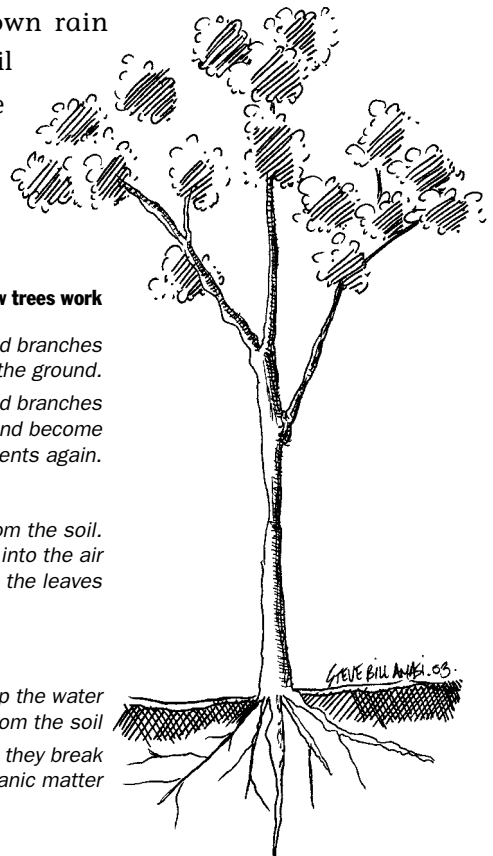
When leaves and branches die they fall to the ground.

Fallen leaves and branches break down and become nutrients again.

Trees pump water from the soil. The water escapes into the air through tiny holes in the leaves

The tree roots take up the water and nutrients from the soil

When the roots die they break down into organic matter



HOW TREES WORK

Trees need energy to live

Trees make energy from sunlight. This process is called 'photosynthesis':

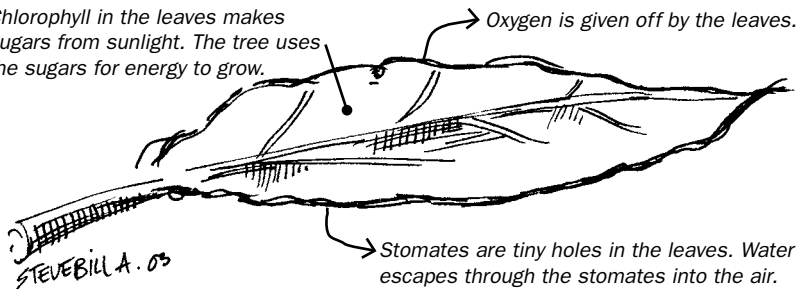
- sunlight combines with a green chemical called 'chlorophyll'; chlorophyll is found in the leaves
- sugars are produced; the tree uses the sugars for energy
- oxygen is given off into the air (we need oxygen to breathe).

Trees need water to live

- water falls as rain; it is stored in the soil
- water takes up nutrients from the soil, such as minerals
- the tree roots take up the water and nutrients from the soil
- the tree uses the water and the nutrients to make leaves and branches and to grow
- trees pump water from the soil; the water escapes into the air through tiny holes in the leaves – these are called 'stomates'; they are too small to see
- when leaves and branches die they fall to the ground
- fallen leaves and branches break down and become nutrients again.

The energy trees need to grow is made in the leaves.

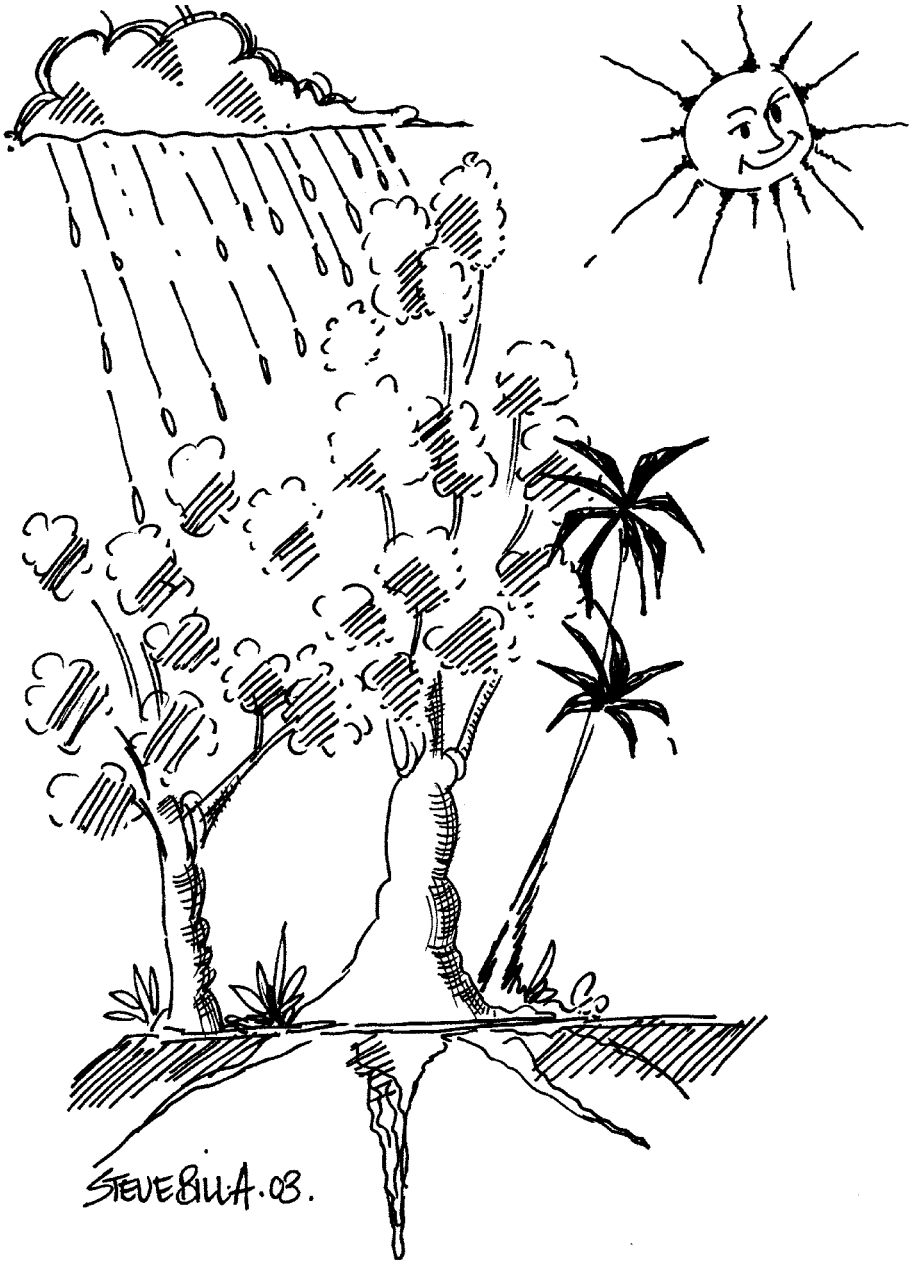
Chlorophyll in the leaves makes sugars from sunlight. The tree uses the sugars for energy to grow.



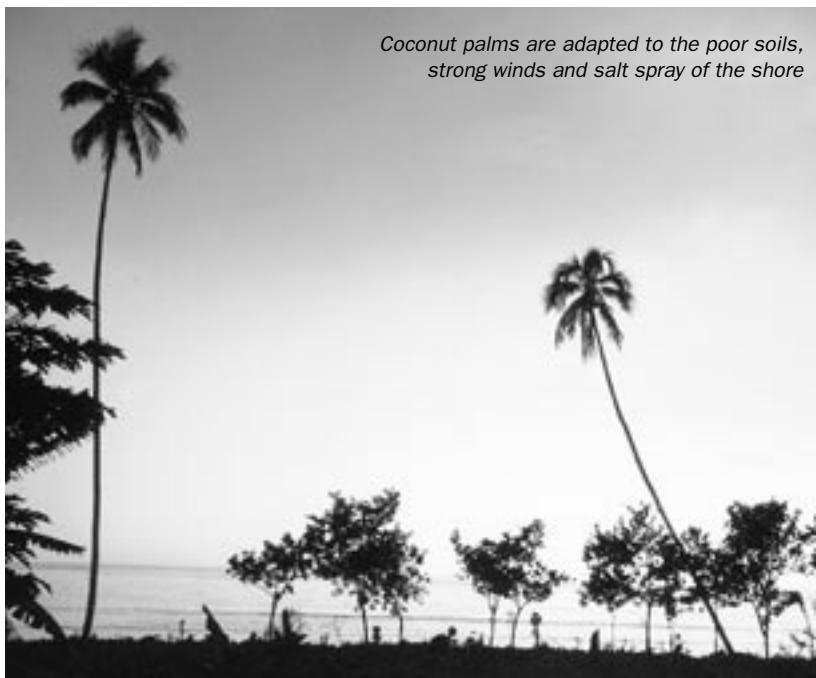
WHAT TREES NEED TO LIVE

To grow healthy and strong, trees need:

- water – to carry nutrients to the branches and leaves
- nutrients – such as minerals, nitrogen and the chemicals phosphorus and potassium; these come from the soil the tree grows in
- sunlight – to make energy in the leaves
- nutritious soil – to supply nutrients and soil water and to hold the tree up
- space - to grow; space under the ground is used to spread the roots
- shelter – some trees need protection from strong winds - they can be damaged by wind; other trees can stand strong wind, such as those that grow near the sea
- a diverse environment – plants of different types growing close together help trees stay strong and healthy and avoid plant disease and attack by insect pests; a diverse forest provides more space for the insects that eat those that damage our trees.



To grow strong and healthy, trees need sunlight, rain and fertile soil



Coconut palms are adapted to the poor soils, strong winds and salt spray of the shore

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AGROFORESTRY ON CHOISEUL, SOLOMON ISLANDS

Farmer

Gwendolyn Pitakaka.

Gwendolyn is a mother of three.

Village

Sasamuqa.

Approximate area of agroforest

Several hectares.

Choiseul agroforester, Gwendolyn Pitakaka



Land and home

Gwendolyn has family land consisting of a small, narrow valley. She shares this with her brothers and their families.

The land rises from the narrow valley bottom to steeper slopes on three sides. The leaf houses of the families are scattered along the valley bottom.

How land is used

Gwendolyn's home consists of a leaf house, a separate eating room and a separate leaf kitchen with open fire. This is a traditional arrangement.

Gwendolyn has planted trees near her sup sup garden. The sup sup garden is near the house. Gwendolyn has made sure that vegetables in the sup sup gardens are not shaded by the trees. The trees do not compete with the vegetables for nutrients, water and growing space.

Near the house:

- Small sup sup or nutrition gardens have been made close to the house; these produce vegetables used in cooking every day - Chinese cabbage, capsicum, tomato and others.
The vegetables grown in the sup sup garden make a mixed, nutritious diet when combined with root crops from the bush garden, rice and, sometimes, fresh fish.
- Taro is grown in the valley bottom where conditions are suitable.
- A small agroforest or grove (tree garden) is grown behind one of the sup sup gardens.

Here, Gwendolyn has planted cut nut, kapok and fruit trees and left some non-food bush trees.

- A large kokorako (chicken) house made of bamboo sides and leaf roof holds 26 kokorako in three rooms.

The kokorako are let out to forage for a short time every day.

Food for the kokorako comes from sorghum grown near the kokorako house and scraps from the kitchen and garden. This supplies a nutritionally balanced diet of body building (protein), energy (carbohydrate) and protective (vitamin and mineral) foods.

Bush garden

Gwendolyn's bush garden is located on steeper land above her house.

Here, Gwendolyn grows staple crops such as sweet potato and cassava and has pineapple, banana and pawpaw scattered through the garden.

Like most bush gardens in the Solomon Islands it relies on rainfall for water.

The agroforest

Gwendolyn has planted the agroforest to produce useful materials and as an example to her children. The forest is being developed in stages.

The agroforest occupies the slopes of the small valley and the ridge top. This is steep land with some natural bush that has been left in the agroforest. Gwendolyn has left a local tree that produces plenty of large leaves. She uses these for mulch.

The slopes were once planted to coconut. Most of these have been left standing because they produce useful products. The coconut trees make a tall canopy over the agroforest.



Steve Bill Amasi in Gwendolyn's agroforest

In the agroforest Gwendolyn has planted:

- a collection of cut nut, including varieties from other provinces of the Solomon Islands
- local bush fruit trees
- a local tree known as 'sandpaper' that has edible leaves and fruit
- mango
- guava
- betel nut.

One of Gwendolyn's brothers has planted a hillside to the valuable timber, teak. He has planted other areas below coconuts to 'bunie', a local timber tree.

When mature, this can be felled and milled into planks that can be sold as building material.

ALLEY CROPPING — NORTH MALAITA PROVINCE, SOLOMON ISLANDS

Farmer

Joseph Kirio



Joseph Kirio

Location

Shore of Suva'a Bay.

Approximate area of agroforest

Three football fields.

Land and home

The gently sloping land is family owned and about a kilometre by canoe from Joseph's village. It is on the shore of Suva'a Bay.

Joseph is a retired soil scientist who once worked at the Solomon Islands Agriculture Department and the Dodo Creek research station on Guadalcanal.

He is a trainer with the Sustainable Livelihoods for Rural Youth Project. Trainees visit his garden. Joseph has left some long branches on the Gliricidia trees so trainees can take them as cuttings to start their own alley cropping system.

History of the land

Joseph has gardened the same soil continuously for 12 years.

He has found the main benefits of alley cropping to be improved soil fertility and reduced soil erosion. Joseph does not slash and burn the garden and does not have to make new bush gardens.

He started the alley cropping system in 1991. Before that, the soil was exhausted from over-gardening and was not productive. It had been used mainly for sweet potato.

Alley cropping took three years to improve the soil.

How Joseph uses the land

The alley cropping system consists of lines of Gliricidia:

- about 10 metres apart; vegetable and root crops are grown in the space between the lines of Gliricidia; these are the crop alleys
- the Gliricidia are spaced about five metres apart in the lines
- the lines have been planted across the slope to reduce soil erosion.

Joseph slashes the Gliricidia leaves about every month.

The slashed leaves and thin branches are placed in the crop alleys.

They decay into plant nutrients including nitrogen. Nitrogen is one of the main nutrients needed by all plants.

The fruit Five Corner (Carambole) has been planted in a line along a side of the alley cropping system. It marks the boundary and produces fruit. Coconut are another boundary planting.

Other tree crops that Joseph grows are guava, ngali nut, breadfruit, betel nut, banana, pawpaw, rambutan, soursop and orange. They are grown outside the alley cropping system.

Joseph has built a low wall of stones to collect soil washed from the garden.

Crops

- fruit and vegetables are the main products from Joseph's garden
- taro is grown between sweet potato
- pineapple, yam, cassava and swamp taro (a large variety) are other crops.

Pests and diseases

Joseph has found a number of plant pests in his garden:

- sweet potato leaf-roll caterpillar, a seasonal pest that lowers crop yield
- black beetle on slippery cabbage; this pest causes a lot of damage; Joseph no longer grows slippery cabbage because of this pest
- infrequent disease on some varieties of taro
- fruit fly on the five corner.

Cassava and yam are disease free.

Management

Management activities consist of:

- pruning tree canopies
- slashing *Gliricidia* for mulch.



Joseph Kirio's alley cropping system... the people stand in a cropping alley. The line of trees behind them are Gliricidia. Lines of Gliricidia divide the area into cropping strips. The Gliricidia is slashed to use as mulch.

What Joseph has learned

- 10 metres between the Gliricidia lines is too wide; the crops in the middle of the alley grow less healthy
- next time, Joseph would try five metre spacing between the Gliricidia lines
- the spacing between the Gliricidia trees in the lines made too much shade; Joseph cut out some of the trees
- you need to assess the soil and land use and choose crops that are suitable for the soil
- use erosion control to stop soil loss from the garden.

Joseph Kirio's message

Joseph offered this message to agroforestry trainees in the Sustainable Livelihoods for Rural Youth Project and to other people:

Shifting cultivation

“Shifting cultivation is traditional in the Solomon Islands but is now not practical.

“An increasing population is producing pressure on the land. When family land is divided among children they get only a small area.

“Instead of waiting for nature to regenerate land in fallow (the time land is left to recover after farming) farmers can replant it and maintain the fallow.

“Land left to fallow can be planted to legume trees like Gliricidia, fruit, nuts, breadfruit, trees producing building material, sago palm, bamboo and others. These produce most of what a family needs for its livelihood and restores the fertility of the soil.

“Pigs and kokorako make use of wastes from the system but people are scared of making use of animal wastes. They think that wastes move through into the plants grown with the waste. This is not true.”

Alley cropping

“Alley cropping is easier than shifting cultivation. Shifting cultivation involves a lot of effort in cutting, burning and in walking to the bush garden. Fertile land has fewer pests and plant diseases.

“Mulching is easier for people to accept. You can burn when you start to get rid of stumps. But because you no longer have stumps in the garden you no longer need to burn. Crop residue – what is left over after harvest – can be used as mulch.”



AGROFORESTRY ON BOUGAINVILLE, PNG

Farmer/trainers

Bruno Idioai and Alfonse Pemuko.

Region

North Solomons Province – Bougainville, PNG.

Bruno and Alfonse are trainers with Paruparu Education and Development Centre (PEDC), a community development organization that started in 1991 with the Bougainville crisis, civil war and economic blockade imposed by the PNG government. That was when the Bougainville Revolutionary Army sought independence from PNG.

The blockade forced people to fall back on their own knowledge and resources. PEDC developed fixed garden site agriculture where there had been only shifting cultivation. They also introduced fish farming in ponds and mixed agroforestry.

The land

The region is located in the mountainous interior of Bougainville. It is steep ridge country and is forested.

Landuse management

The land developed for agroforestry varies from flat land to steep slopes.

Crops

Crops grown include:

- **short-term vegetable crops** – kau kau (sweet potato), tapioca, banana, taro and yam
- **medium-term crops** include fruit and nuts – guava, ngali nut as well as other local and exotic varieties
- **long-term crops** – timber grown with fruit, nut, medicine and other forest trees; the agroforest makes use of different layers of the tree canopy.

Bruno and Alfonse report no plant diseases. Trees that produce a strong odour are planted among the crop trees. Pests are repelled by the smell.

Fixed site food gardens

Use of Gliricidia

Gliricidia and local legume plants are used as fertiliser plants in a type of alley cropping system around food gardens:

- Gliricidia are planted five metres apart in lines
- there is three metres between the lines of Gliricidia
- the Gliricidia are pruned and the prunings used as mulch.

Soil fertility

Soil fertility is maintained by:

- nitrogen-rich mulch from Gliricidia slashings
- compost produced by stacking leaves and grass and turning it every two weeks

- moving crops about – this is called ‘crop rotation’; legume vegetables such as peanut and bean are planted after other vegetable crops have been harvested
- planting cow pea and peanut as ‘cover crops’; they are left on the soil as a ‘green manure’; they decay into plant nutrients and improve the fertility of the soil.

Agroforestry – the Integrated Bougainville Crisis Mini-Forest

PEDC developed the Integrated Mini-Forest during the Bougainville crisis.

The Integrated Mini-Forest consists of:

- a permanent vegetable garden at the centre; this may be managed by alley cropping and crop rotation
- a mixed, multiple-purpose mini-forest is planted around the edge of the garden.

The mini-forest makes a series of rings with:

- short term - mainly vegetable - crops in the central permanent garden
- medium-term tree crops in the middle ring – fruit and nuts, Gliricidia
- long-term crops such as timber in the outer ring.

Each clan has three clusters of mini-forest, which is enough for family needs.

The Gliricidia in the medium-term ring is slashed for use as mulch in the short-term garden.

The mini-forest is maintained using organic gardening techniques.

The oldest mini-forests have been farmed for more than 15 years.

Characteristics of the Integrated Mini-Forest:

- they are mixed forests that grow food, medicine, timber, animal fodder, firewood
- multi-layer – a canopy of large trees, an understorey of smaller trees, shrubs, ground covers and vines; kokorako (chickens) forage in the understorey
- they provide environmental benefits such as soil stabilisation, wildlife habitat, windbreak, stream protection
- the mini-forests are located close to villages or on the outer boundary of fixed gardens, some have been planted on the banks of streams.

Some species planted in the Integrated Mini-Forest:

- galip nut
- pau nut
- mango
- breadfruit
- avocado
- guava
- five corner (Carambole)
- orange
- mandarin
- bush apple (lau lau)
- rambutan
- pineapple
- betel nut
- indigenous bush foods.

Maintaining the Integrated Mini-Forest

- during the first three years, creeping vines that might smother the young trees are cut regularly
- slash and burn farming is discouraged and replaced by slash and mulch.

Benefit to the clan

The Integrated Mini-Forest helps the clan by providing:

- fuel for cooking
- bush medicine
- food
- animal fodder for chickens
- management of pests by diverse plantings.

What has been learned

Bruno and Alfonse say that among the things they have learned from the development of the Integrated Mini-Forest are:

- the need to be flexible and multi-skilled
- copy natural systems in the mini-forest
- experience has validated the mini-forest as a productive model.

Their advice to Melanesian youth is to:

- respect nature
- restore natural systems
- think of the future.

Other PEDC work

During the Bougainville crisis, PEDC increased the food security of communities cut off by the blockade.

With the Integrated Mini-Forest, other developments made up an integrated food production system. This delivered a diverse range of food that provided a nutritionally mixed diet.

Fish farming

Fish were produced in ponds between 10 and 50 square metres in size (10 x 10 metres; 50 x 50 metres).

The ponds were fed by water diverted from streams. The water was returned to the streams after use. The fish ponds provided protein during the crisis.

They were stocked with silver perch, tilapia, carp and local fish.

The fish were fed with termites, African snail and bush fruits.

Villagers used the fish for food and for selling. Kastom Gaden Association adviser, Tony Jansen, says that fish earned around the same income as keeping chickens.

Chickens

Kokorako (chickens) are used for food and for selling.

Kokorako houses are made from local material such as bamboo.

The kokorako are allowed to free range outside their house and pen for a limited time. They are kept in pens overnight to ensure regular feeding, easy egg collection and protection from predators.

They are fed on bush and garden foods such as dried, scraped coconut and ground-up sorghum.

Gardening

PEDC helped people change from slash-and-burn to fixed-site gardening. The vegetable gardening was a part of the Integrated Mini-Forest.

Raised bed vegetable and root crop gardens were successful. These were used to grow the main staple crop, kau kau (sweet potato).

The raised gardens:

- were 1.5 to 2 metres in width (two long paces by three long paces)
- had long trenches a half to one-metre in depth along the side; there were for drainage in the wet climate
- produced increased amounts of vegetables
- were usually made across the slope so the soil did not wash away
- sometimes had a barrier across the slope below the gardens; this caught soil washed down the slope; the soil was placed back on the gardens
- were gardened using crop rotation and green manuring.

After harvesting the kau kau, the crop residue – the stems and leaves that were left over – were left on the raised garden bed.

Soil and organic matter were cleaned from the ditches and placed on top of the crop residue on the garden bed.

A rotation crop such as peanut, soy bean or a local legume was then planted.

The raised gardens were also used to grow corn, bean, upland rice, aibika (a local legume) and peanut.

These fixed-site, permanent gardens have been cropped for more than 15 years.

IMPROVED TEMOTU TRADITIONAL AGRICULTURE, SOLOMON ISLANDS

Improved Temotu Traditional Agriculture (ITTA) was developed in the 1980s by Jasper Maike Bonie, Senior Field Officer, Agricultural Extension Services, Temotu Province.



Agroforester, Solomon Islands

Temotu Province is made up of the Reef, Duff, Ndende and Santa Cruz islands. They are distant from the rest of the Solomon Islands, far to the south-east.

ITTA was developed as an alternative to shifting agriculture. The population increase of recent times has put pressure on the land and soil fertility and farm production have declined.

ITTA:

- is an intensive, multiple-cropping system growing up to 23 different plants on the farm
- is low cost and high-output
- once the tree canopy forms, there is less need for labour and maintenance
- is a tree-based, multi-storey agroforestry system with shade-tolerant plants growing under taller trees
- includes traditional root crops, trees and vines

- is a permanent, fixed-site system farming the same land year after year
- copies the natural forest and provides the same benefits
- maintains cool conditions within the agroforest to suit the crops
- uses legume crops to provide nitrogen-rich fertiliser
- provides mulch from fallen leaves and organic matter
- is resistant to insect pests and plant disease
- is a diverse system.

ITTA agroforestry

The purposes of ITTA agroforestry include:

- increasing the amount of food
- improving the quality of food
- providing better nutrition by growing energy (carbohydrate), body building (protein) and protective (vitamin and mineral) foods for a mixed diet
- producing income through the sale of nuts and other foods
- restoring the ecosystem; the ITTA agroforest is like the natural forest and produces the same benefits
- preserving planting material by growing different varieties of traditional crops
- improving the soil
- intensifying existing tree-based cropping systems; non-food trees can be removed and food trees planted in their place.

Make a whole-farm plan

Bonie recommends that farmers make a whole-farm plan when they set up the improved traditional agriculture system.

A whole-farm plan shows where the different parts of the farm will be placed.

Trees and other crops must be put in the right place where they will grow well.

Grow food and non-food crops separately

Food and non-food crops are grown separately in a similar multi-storey arrangement. This allows trees used for building materials and fire wood to be felled without damaging food trees.

The non-food agroforest can include root and vine food crops because they do not reduce the production of the trees.

Bonie developed a grid (a series of lines in two directions that cross each other) to guide the planting of tree and other crops:

- trees are planted in lines with the different types of tree mixed
- space between trees is important; this depends on tree width and height
- selection of crops is important; crops are chosen to provide the three food types (energy, body building, protective) for families and to sell
- legume trees are placed in selected positions.

Use many activities to produce food and income

Bonie says that farmers should include as many subsistence and income-earning activities as possible to provide a livelihood.

These include:

- build a house and kitchen; this can be a separate kitchen as is the tradition in the Solomon Islands
- make a piggery with three to four sours (female pigs) and a boar (male pig); plant a garden to grow food for the pigs; this can be a little under one hectare in size
- keep kokorako and ducks for eggs and meat; make a house divided into two rooms, one for kokorako and one for ducks
- keep goats – five female and one male; these will provide meat and milk
- plant a single-crop growing area for annual and short-term crops for sale
- plant an area to building materials, fire wood and medicine plants
- make an area for ITTA agroforestry.

Crop varieties

The varieties of tree crop that can be planted in the ITTA agroforest system include:

- mango
- Polynesian chestnut
- sea almond
- pandanus
- breadfruit
- oceanic lychee

- galip nut
- Malay apple
- avocado
- banana
- pawpaw
- butterfruit
- kingtree
- cut nut varieties
- giant taro and other root crops
- vine crops.

Temporary (short-term) crops

Tree crops take a number of years to grow before they produce.

Bonie recommends making use of the agroforest while the trees are growing by planting:

- short-term vegetable crops
- banana
- pawpaw.

These are planted among the young, long-term trees and shrubs.

The amount of short-term crop that is planted will change as the long-term tree crops grow. The trees will shade out the short-term crops as they grow.

The purpose of growing short-term crops is to grow food as early as possible for the use of the farming family, to sell and to reduce weed growth.



*Peter Kaoh,
Farmer's Support Association*

AGROFORESTRY IN VANUATU

Farmer/trainer

Peter Kaoh, Farmers Support Association, Vanuatu/Melanesian Farmers First Network.

The Farmers Support Association started work after independence in 1982. It advises and trains Vanuatu farmers on subsistence and cash crop farming.

The Association has provided training in the growing of vanilla vine and spices as cash crops.

Region

Vanuatu, Melanesia.

Landuse

The fallow period in Vanuatu shifting cultivation has been reduced to as little as three years. This makes the change to an improved farming system important.

Alley cropping

Details of the alley cropping system promoted by the Farmers Support Association:

- garden size: 500 to 800 square metres; this will feed an average family of five
- two new gardens are set up during the year in addition to an existing three

- Gliricidia is planted at 50 centimetre spacing (two and a half hand lengths) in rows on eroded soil; the spacing is one metre on flat land (one long pace); the time to plant Gliricidia is in August at the start of the rainy season
- the rows of Gliricidia are planted five metres apart
- slashing is done when the Gliricidia has reached two to three metres in height (a little taller than a man); it is slashed just before it sets seed
- Gliricidia is slashed about every two months; slashing is carried out monthly between August and December, less frequently at other times
- cash crops of vanilla vine are grown in the Gliricidia mulch.

Peter says that the land can be burned when first cleared from the bush. This burns the tree stumps. After that there is no need to burn again.

Cropping

The first crop in the alley cropping cycle is yam.

According to Peter, yam uses a lot of nitrogen. The planting of Gliricidia is important to supply the nitrogen.

Spring onion, vegetables and taro are planted at the same time.

Slippery cabbage (*Hibiscus manihot*) is planted between yam crops.

Yam is harvested in April and May and is followed by sweet potato.

Products of alley cropping

The main products of the system are:

- root crops
- vegetables
- wild yam
- timber
- fruit.

Benefits of alley cropping

The main benefits include:

- increased crop yield - this is the main benefit
- soil improvement, especially on slopes
- reduced soil erosion
- fire wood from legume trees after the fallow period.

Most garden production goes to subsistence use by families. Surplus is sold at market.

Peter says that it can take three years for the soil to improve in a new alley cropping system.

The traditional system takes crop residue away from the gardens. The Farmers Support Association is encouraging farmers to leave the crop residue on the gardens.

The Network is also encouraging the use of boundary plantings of fruits, sago palm and pandanus trees.

Wild yam growing in the forest and as a boundary hedge has been found to be resistant to pests. It is useful for food security after cyclones and can remain preserved in the ground for five to six years.

Pests and diseases

African snails eat the leaves and growing tips of slippery cabbage. Hand picking is used as a control. A predator of the snail has been released by the government.

The fungal disease, root rot, is present.

So is taro beetle. Peter says that taro is healthy when planted in swamps.

Two types of taro are used – dry land and swamp. The dry land variety can be stored for a month and the swamp variety for three days.

Learnings from alley cropping

- the use of an A-frame has been adopted so plants can be established along the contour of the land (a contour is a series of points all at the same height); this is a means of reducing soil erosion
- the collection of *Gliricidia* needs to be improved; it is important to make an angled cut when taking cuttings.

Peter's message to young Solomon Island farmers

Peter has the following message for young Solomon Island farmers:

“The increase in population makes it important to have qualified farmers. Farmers today need to be clever and better educated.

“You should not look down on agriculture as a livelihood. Farming should have higher status as a livelihood.”

Other agroforests in the Solomon Islands

BUSARATA, CENTRAL MALAITA

Information provided by Bruno Idioai and Alfonse Pamuko, Paruparu Education and Development Centre, Bougainville...

The agroforest is situated in the grounds of an agricultural training centre.

The land is flat to gently sloping with vegetables established on the flat areas. Those grown include: sweet potato, cassava, pineapple.

The tree crops include:

- breadfruit
- pawpaw
- five corner (Carambole)
- cut nut
- coconut
- mango
- banana
- teak.

Gliricidia is used as a mulch crop.

Insect pests and a fungal disease have been reported.

Flowers are grown between the vegetables to control pests.

Compost and mulch are used to fertilise the soil.

PANARUI, CHOISEUL PROVINCE

Salathiel Sore, from Choiseul Province, has established a small agroforest on the coast.

The agroforest measures 10 by 30 metres. He plans to expand the forest in future.

Plants grown include:

- cut nut
- fruit trees
- teak
- local timber and canoe trees
- ngali nut
- others.

Salathiel showing sweet potato planted among young trees



Salathiel's agroforest is planted to mixed tree species.



