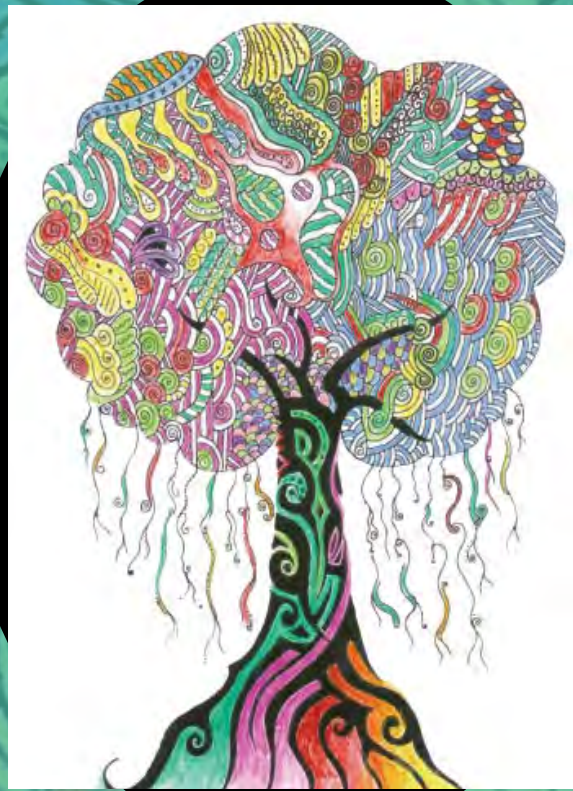


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Hadomi Ba Ema,
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from East Timor

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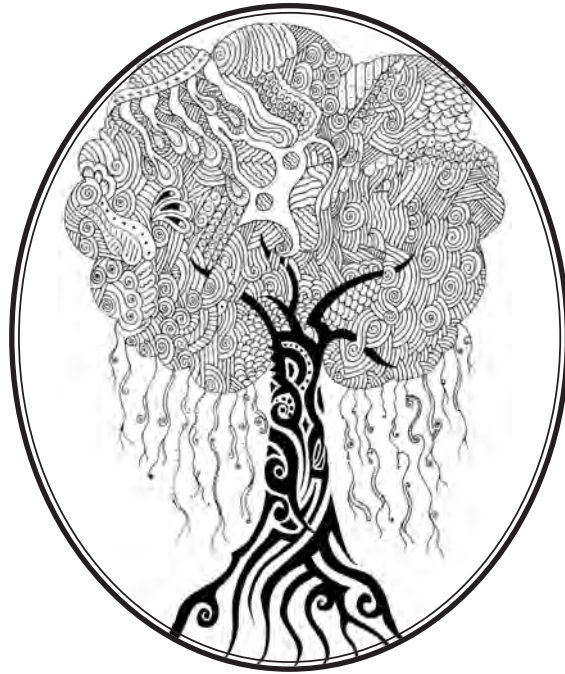
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Kuidadu Ba Rai,
Kuidadu Ba Malu,
Ho Futuru Timor Leste



A Permaculture Guidebook from East Timor

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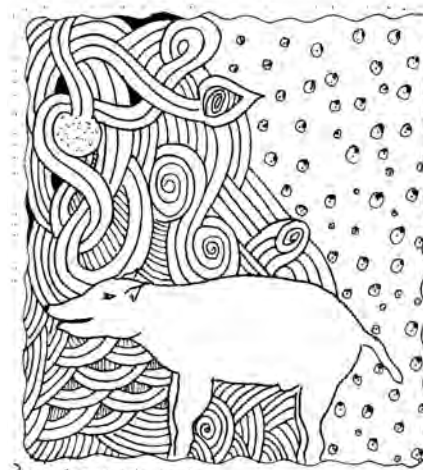
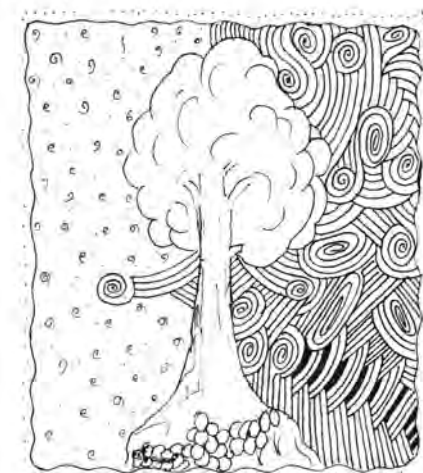
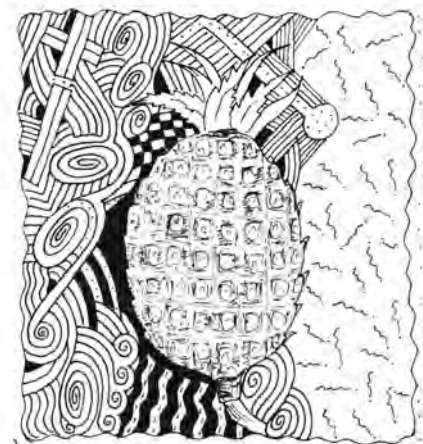
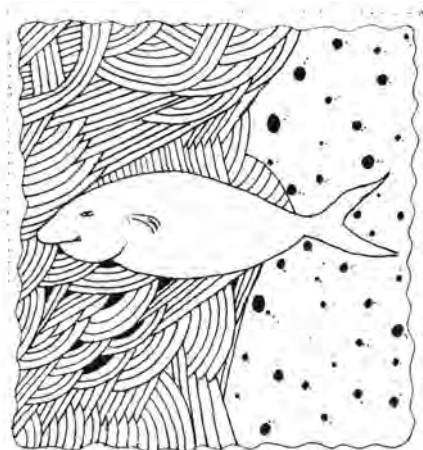
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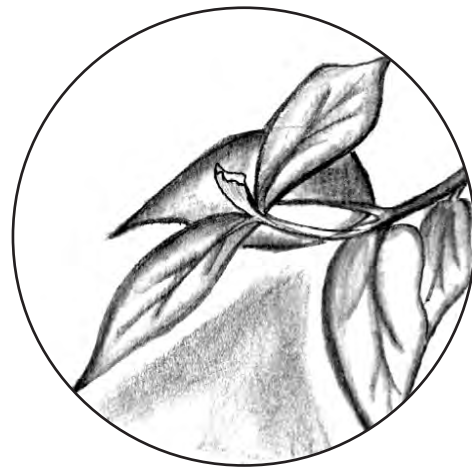
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To my family, and my friends in Australia, I haven't forgotten you, and this book will be finished soon, just a few more months!

Finally, to all the co-workers, course participants, project participants and friends, who have provided me with so much information for this book. The store of knowledge here in East Timor is huge, and hopefully this will add to the store.

May it, in it's own small way, give back a token of what I have received.

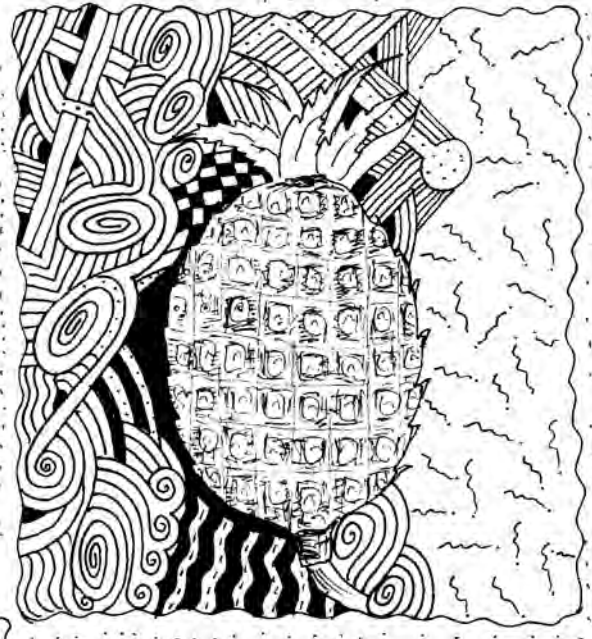
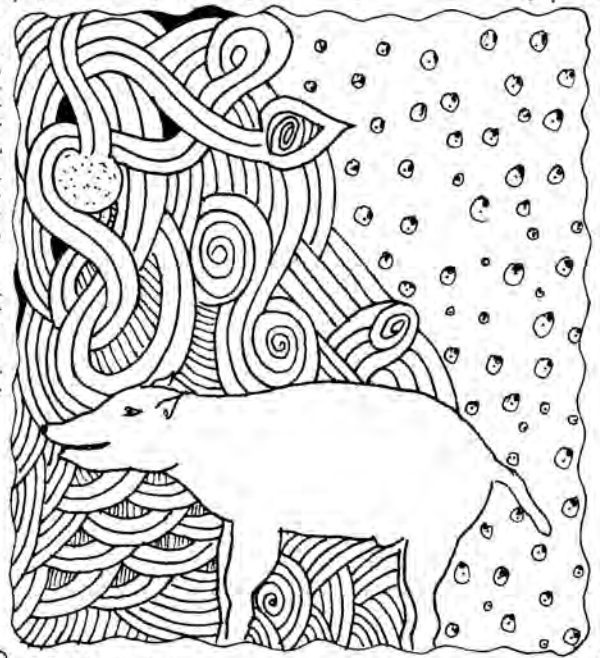
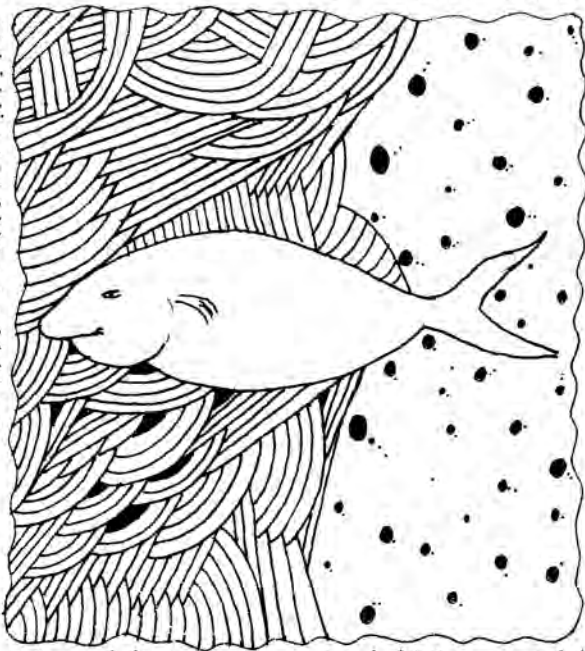
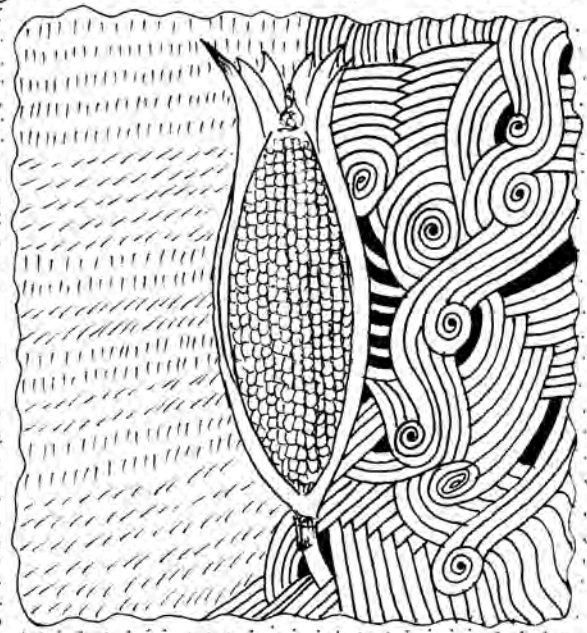
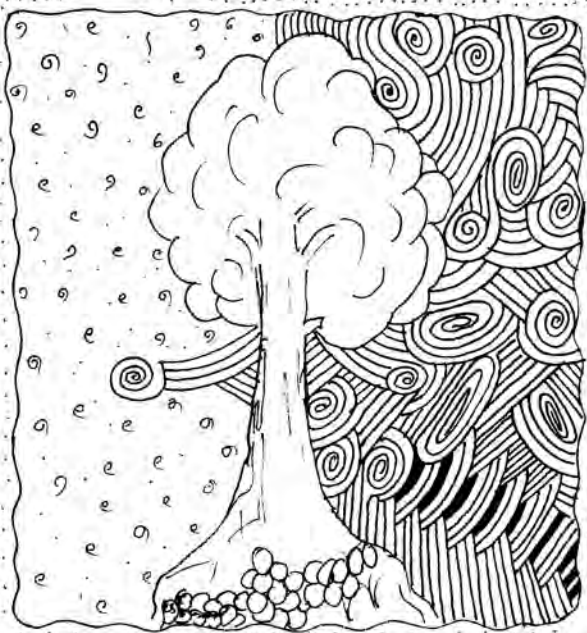
Lachlan McKenzie, July 2005

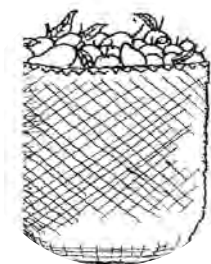
Now with the new 2008 edition coming out there are a few more important people to thank:

This book in its new form has taken shape due to the dedication and fabulous work of Herminia, Ego, Lino and Asatu! Once again to our "Oxfamily" for their continued support to republish and print this book in Tetun, and for their general support of all things Permaculture in Timor Leste

To Permaculture International & Clarence Park Food Coop in Adelaide for generous contributions to help us print more books
The Arte Moris crew - Mong, Aziby, Edson, Grinaldo and Pelle for providing ever more practical & beautiful pictures.

This book is dedicated to the future of East Timor.





Foreword

Timor Leste is the world's newest nation. It was colonized by Portugal and Indonesia for almost 500 years. During the occupation, the farming system has changed dramatically, especially since Indonesia introduced high external input farming methods.

Timor Leste gained fully independence in May 2002. By this time the country had lost approximately 70 percent of its natural resources or living environment, and much of its traditional knowledge including local knowledge about cooperative systems, protecting the land, water and natural forest, saving local seeds, using natural medicines, local foods and native animals. The result is leading to increased malnutrition and poverty. Moreover, East Timorese identity has been greatly damaged, and much of the traditional arts such as language, dancing, drumming, songs, instruments, poems, carving and more is lost or in danger of being lost.

Traditionally, shifting cultivation and slash and burn agriculture still exists in Timor Leste. It is causing increased deforestation and soil erosion, and droughts and its effects on the land and people are occurring much more frequently. These practices are often combined with mono-culture systems which use chemical fertilizers, pesticides, introduced seeds, and agricultural machinery. This is, year by year, causing increasing soil and water pollution, increased pest resistance and crop and animal losses from pests and disease, disappearance of local seeds and the disappearance of much of Timor Leste's natural habitat, including animals, birds and insects.

In November 1999, inspired by these issues, Steve Cran a Permaculture volunteer from Australia and myself, an East Timorese, started developing Permaculture in Timor Leste. What started as 2 people has now developed into a local NGO called PERMATIL (Permaculture Timor Leste). PERMATIL's work is to strengthen and promote permanent/ sustainable agriculture and culture in Timor Leste helping to provide independence, food security, sustainable incomes, cultural strength and environment protection to local communities. The name of Permaculture and its concepts of permanent/ sustainable agriculture and culture, was originally developed by Bill Mollison and David Holmgren.



After many years of working with communities, PERMATIL has now published a book called *Kuidadu Ba Rai, Kuidadu Ba Malu, ho Futuru Timor Leste*. This book is a Permaculture Guidebook from Timor Leste, for Timor Leste. The information has been collected from many years of working experience, and from work partners in Timor Leste and other countries.

The purpose of the book is to help government, civil society, communities and students to develop sustainable practices and lifestyles in Timor Leste. Nowadays, the occurrence of natural disasters is increasing in the world, including Timor Leste. This book can also be good as a reference to help solve some of the problems that cause natural disasters.

Thank you to all the people and organizations that have contributed information and practical ideas, and helped us to publish this guidebook.

Ego Lemos, Permatil Coordinator, February 2008

Welcome!

Welcome to the first Permaculture Guidebook for Timor Leste!

**Permaculture can be described as meaning
PERMANENT AGRICULTURE and PERMANENT CULTURE.**

Permanent Agriculture:

Agriculture and animal management that improves the land, provides income and produce, and is sustainable now and in the future.

Permanent Culture:

Working with, protecting and encouraging a strong East Timorese culture and environment and moving forward at the same time. Working with nature and people and learning from them, not against or in competition with.

Permaculture connects and integrates different ideas and techniques of living and agriculture together. Houses, water supply, health, waste management, agriculture, fruit trees and tree crops, aquaculture, rivers, forests, animals etc.

This Guidebook is for East Timor, about East Timor and co-written with constant help and technical assistance from many East Timorese. It is for the situation, skills and knowledge available here. It builds on the traditional knowledge, and the new techniques that are introduced augment this knowledge.

Aim of the Guidebook

To provide the information to improve better basic wealth for all East Timorese, not just in money, but in the land too. Wealth in the environment, wealth in the trees, wealth in the animals, vegetables and grains. Wealth in the people, and their knowledge, skills and connections with others.

REAL WEALTH!

This Guidebook is designed to be used by many different people

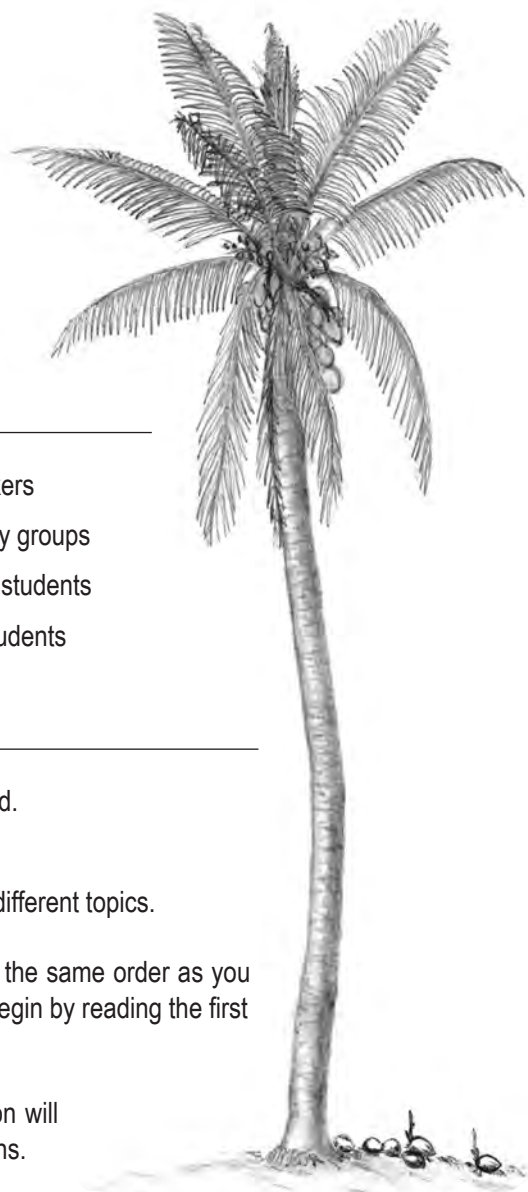
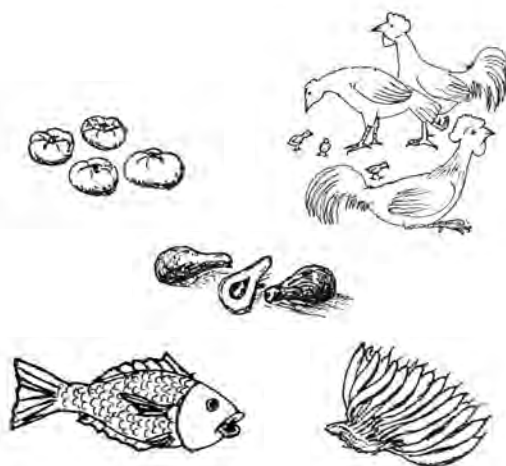
- Students learning Permaculture for the first time.
- Government workers
- Farmers
- Experienced permaculture trainers
- NGO workers
- Community groups
- University students
- School students

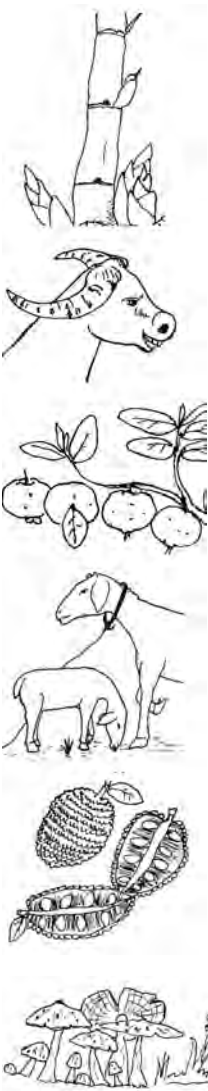
How to use the Guidebook

- Use the contents section at the front to quickly find what you want to read.
- Use the glossary to understand technical words.
- Use the reference section for where to find more information about the different topics.

The chapters of the Permaculture Guidebook are written in approximately the same order as you will need them to plan, design and implement the techniques. You should begin by reading the first chapters on Permaculture Ethics and Principles.

It is important that you understand Permaculture's basic ideas. This section will help you to see how and why Permaculture chooses certain kinds of solutions.





After Ethics and Principles, read the chapters on design methods and patterns in nature. Design and planning is the first step of all Permaculture practice.

From Chapter 4 onwards the Guidebook gives practical steps to implement techniques on many different subjects. You decide how to use the Guidebook. You can read several chapters together or one-by-one, as you need the information.

For example, if you are interested in home gardens, nurseries or farming you should read the chapter on soil before any other chapter. However, if you are interested in aquaculture or designs for the home then you can go straight to those chapters.

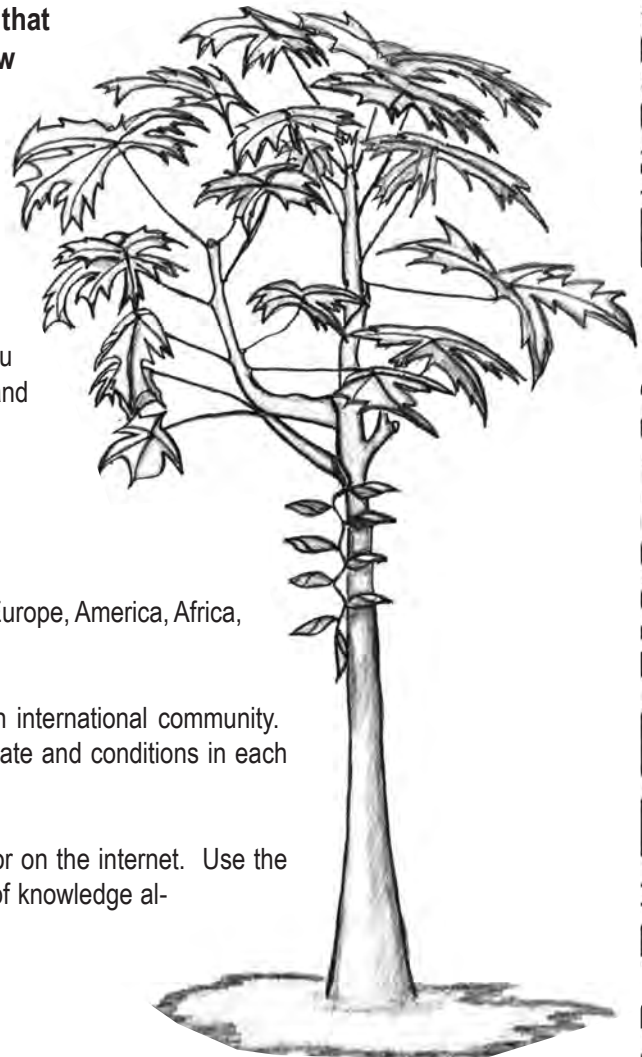
You will find that in each chapter there are many references to other sections in the Guidebook. E.g. windbreaks, compost making. This is because of the connections between the different subjects. Use the contents section to quickly find these references.

Think for yourself

Permaculture is about adaptation and creativity so use this book according to your needs.

If a technique mentions a material that you do not have, try to think of something else you can use to do the same job. Although the writers of the book have a lot of experience teaching and practicing Permaculture in Timor Leste, we have not been to every household in the country and may not know the best way to produce a solution for your situation. Follow the advice you find here and then change it to create the best result. Don't be afraid to make mistakes, and to learn from them. This is how we move forward.

One of the best techniques that Permaculture can offer is how to think creatively about problems and solutions.



Use your community

When working with the ideas in this book remember to ask advice from family, friends and elders. The people close to you will help you plan the best design. Community cooperation and the sharing of knowledge are a major part of Permaculture.

Use other people's communities

Permaculture techniques are used all over the world in Asia, Europe, America, Africa, the Pacific, Australia and New Zealand.

By choosing Permaculture solutions you become part of an international community. Although the techniques have been adapted to suit the climate and conditions in each country, the basic Permaculture principles remain the same.

Many of these techniques and ideas are written in books, or on the internet. Use the reference sections to help connect you with the huge store of knowledge already out there.

Some ideas for Implementing Techniques

* Each project, each place, each community or family that uses permaculture techniques will be different. They will come up with a different plan using different techniques and different types of plants, animals and building materials etc. Climate, soils, trees and plants, water supply, knowledge and agriculture history, the shape of the land, etc, will all be different as well, and will all affect the techniques used. A technique, plant type or animal type that works very well in one place may not work well at another place, even nearby.

Each place will be unique!

* Always use the ethics and principles to guide how to choose and apply the techniques. These remain the same but the techniques and strategies will be different each time.

* Experiment within your means, and only to the extent that you can afford to fail. This is especially the case for women who have so many different responsibilities already.

* Step by step:

- Try one thing, eg, mulching, then another, e.g animal corrals, then another, e.g. making terraces for vegetable gardens to save water. Do this as time, money and resources allow.

- Focus on simple ideas first that are the most important for improving basic production and health, and the first step to many other ideas in the future. E.g. water supply and storage, home gardens, animal housing, composts, compost toilets, small nurseries, clay stoves.

* Permaculture techniques can be an important tool for reducing disaster risks, especially food shortages, erosion and landslides, flooding, drought, fires and even disease epidemics. Solutions start on a community level, while also requiring a coordinated national plan. Many techniques on this book can be used on both levels, are easily duplicated in remote communities and can be easily integrated into short and long term disaster management plans.

Perhaps the most important part of using this Guidebook is to teach and encourage the participation of children, East Timor's future.

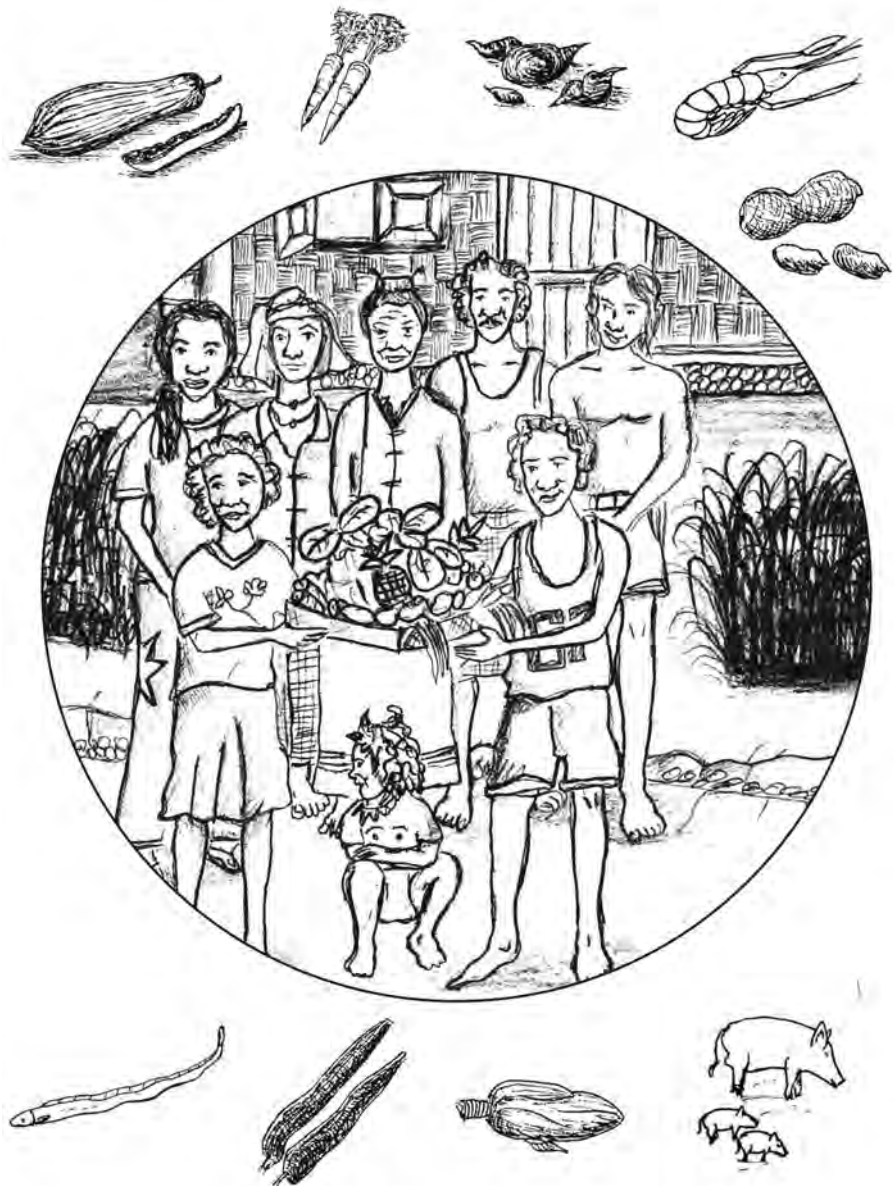
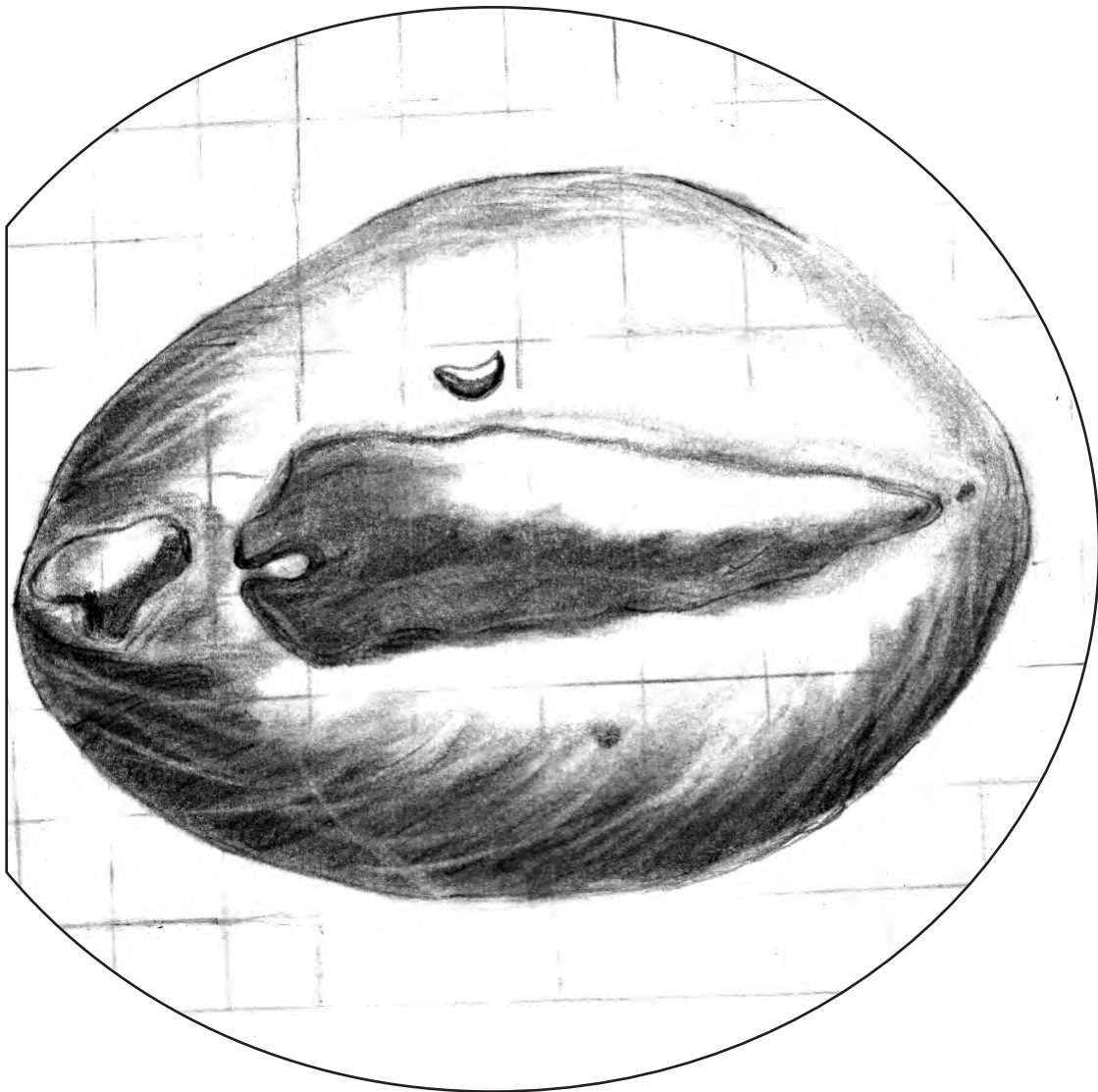
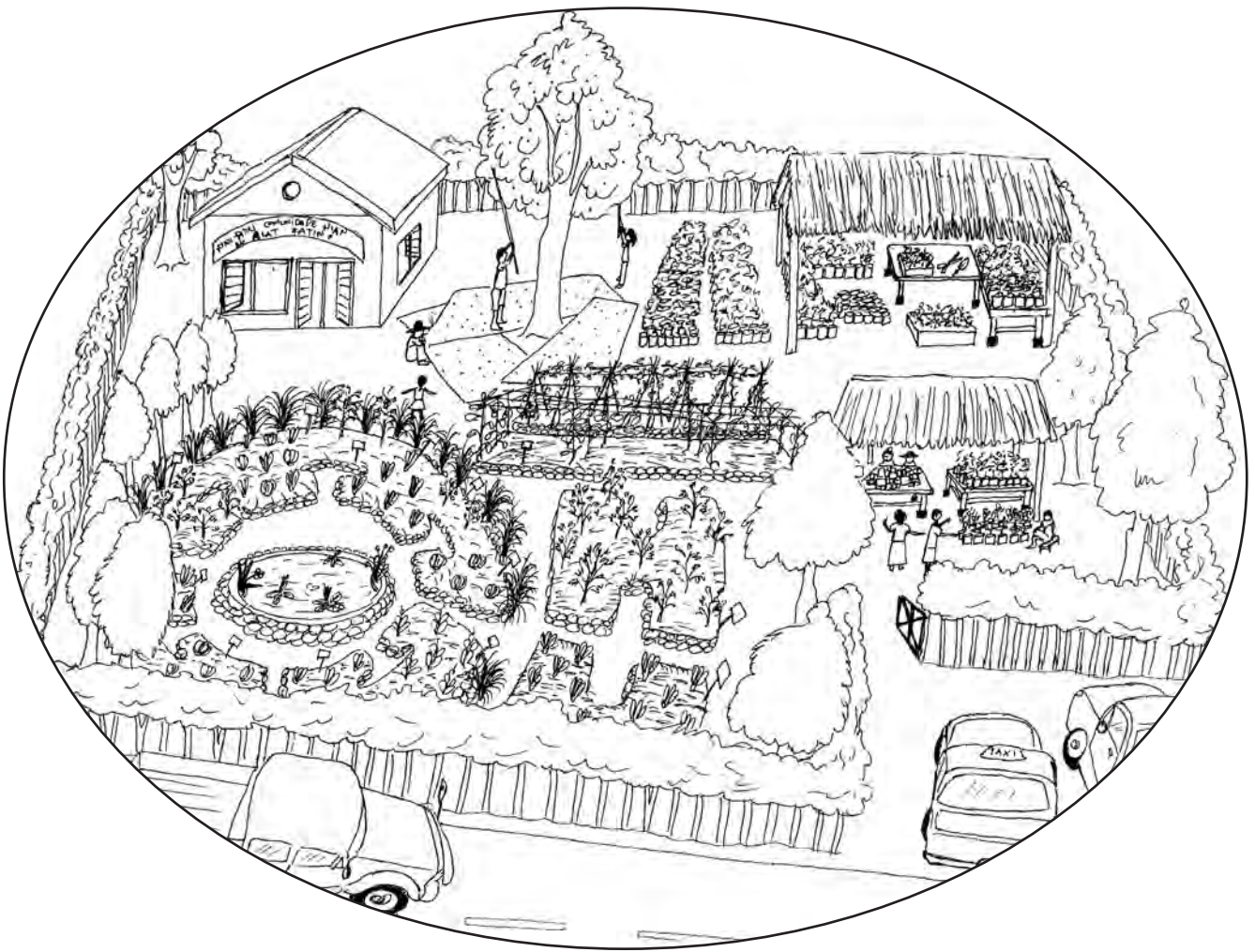


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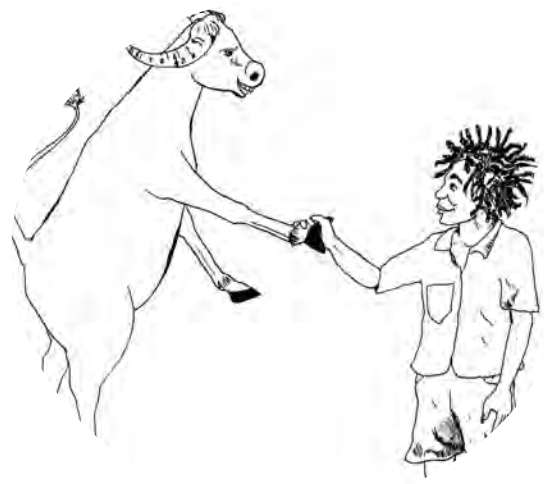
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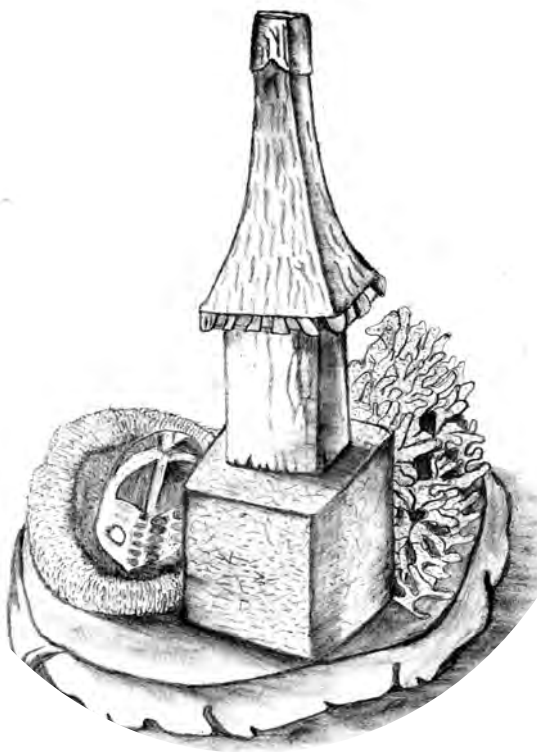
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Ethics & Principles of Permaculture



CHAPTER





Permaculture has Ethics and Principles that guide the ideas and techniques that people use. They guide people towards being more responsible for their own lives and being able to be responsible because they are more able to control their own destiny.

They guide people towards a secure future for themselves, their land and their culture.

At present there are many problems in the world...

- Natural environments are being destroyed.
- Farming land all over the world is being damaged and depleted.
- Rivers, lakes, the land, the air and the oceans are being polluted.
- People, animals, birds, fish and insects are also being polluted and many species have become extinct.
- And most of the world's population is very poor, while a small percentage of the population is very rich.

These problems are happening in East Timor as well. Now that East Timor is independent it can have much more control over it's future and it's people can take the steps towards a strong and sustainable future. Action and change must come from all levels of society – government, business, workers, farmers, communities, families, men, women and children, and from all areas of East Timor.

It is people who have created these problems.

And it is people who must change their ways for the earth to become healthy again. Future generations depend on it.

Permaculture is about techniques and ideas that move towards a healthy environment, a healthy culture and a healthy people.

Permaculture ideas and techniques also recognize and respect the value of every living being.

Every person, every animal, every insect, every tree, every plant, every fish, even the fungus and bacteria in the soil.

Every living being has its role to play and it's function. This must be considered and respected to create a truly sustainable country. If this is done then the benefits will flow back in the future.

The Ethics of Permaculture are:

1. Care for the Earth.
2. Care for the People.
3. Distribute Surplus
4. Place Limits on Population and consumption.

These Ethics cover all countries and situations. However, for East Timor at present, it is easier and more appropriate to simplify the Ethics to:

1. **Care for the Earth**
2. **Care for the People**
3. **Care for the Future**

In time as East Timor grows and develops, population and consumption issues will naturally need to be addressed, as East Timor cares for it's future.

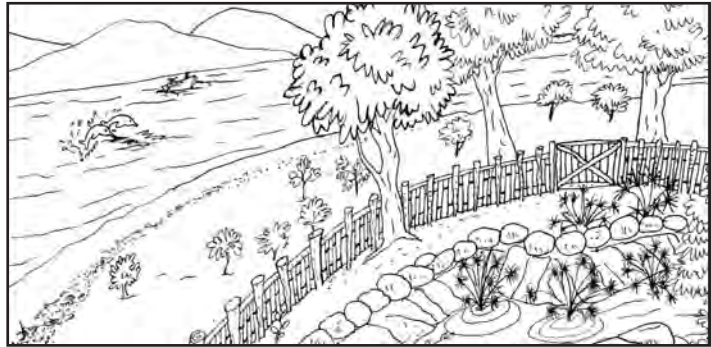


1. Care for the Land - Kuidadu Ba Rai

The land, the water, the trees and plants; the natural resources of East Timor are the key to East Timor's future. The natural environment must be protected and repaired.

This includes:

- East Timor's forests and the plants, animals and birds that live within.
- Lakes, Rivers, River catchments and estuaries.
- The Ocean, especially the coastline and the reefs.
- The Air



Any action that damages, pollutes or destroys East Timor's natural environment is doing the same to East Timor's people.

All farmland including land for forestry and animals must be thought of as the base of East Timor's wealth. If it is farmed responsibly and sustainably and the land is slowly improved, then East Timor's wealth will grow.

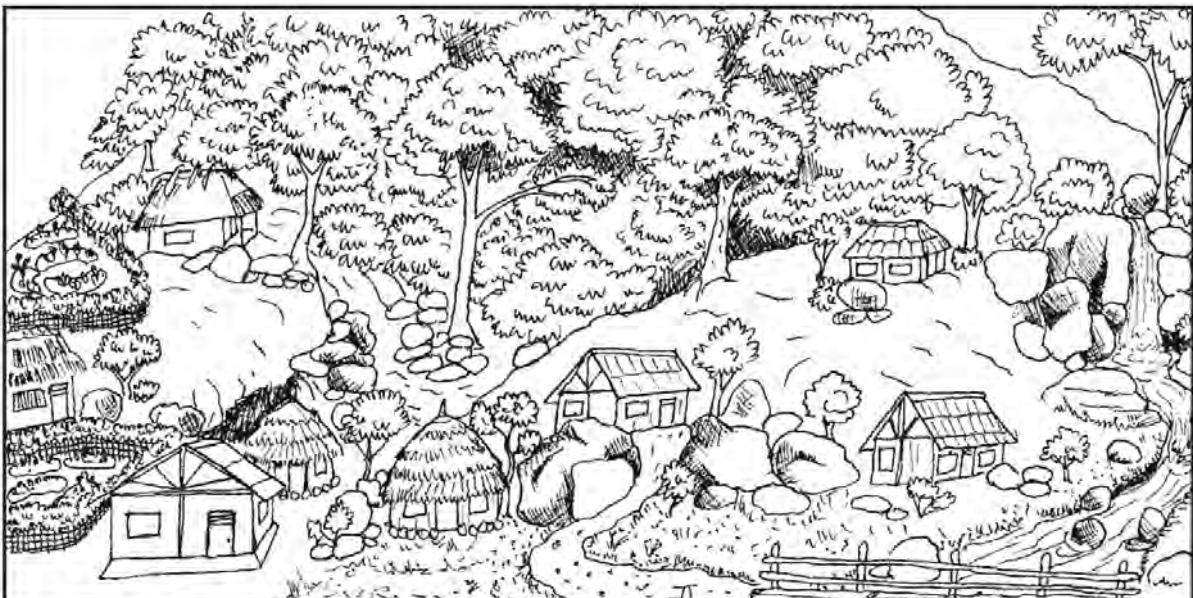
This is for:

- Long-term productivity for farmers and their children.
- Protection and health of surrounding environment.
- Protection and health of the people farming the land.



Sustainable farming includes:

- Improving soil quality
- Taking all steps possible to stop erosion and mudslides.
- Reducing and eventually stopping burning.
- Using natural fertilizers and pesticides.
- Working with nature, the land and its natural patterns.
- Using cultural practice and traditional land laws to help protect and repair land.





2. Care for the People - Kuidadu Ba Ema

People are also at the center of Permaculture strategies and techniques.

Every person has the right to a healthy future.

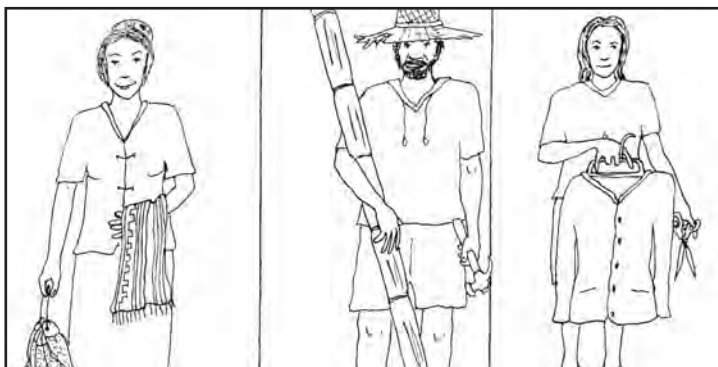
Permaculture is about improving basic food security and health for ALL East Timorese:

- Improving production, diversity and quality of produce.
- Improving food storage and preservation.
- Improving nutrition.
- Encouraging use and training about natural medicine, combined with modern medicine.
- Improving house health and hygiene, especially for kitchens, water, toilets and waste management.



Permaculture promotes better equality, security and opportunities for all East Timorese through:

- Equal opportunities and rights for men, women and children.
- Improving basic wealth, not just in money, but also in the land and people.
- Improvement of livelihoods and opportunities for people in the districts.
- Taking action to reduce the hard work like carrying water and firewood.
- Sharing and trading of knowledge and resources.



Permaculture practice is to work together with the Traditional Culture and to strengthen it. Sometimes traditional practice can be changed or improved but this is done through working with people, not forcing new ideas. This is achieved through:

- Encouraging and using traditional ceremonies, beliefs and knowledge.
- New techniques and ideas recognizing, respecting and fitting together with traditional culture.
- Education to children about traditional knowledge and ceremonies and about how the traditional knowledge and ceremonies can be part of a modern society.



3. Care for the Future - Kuidadu Ba Futuru

What we do now affects the future.

- All practices MUST consider the future.
- All plans for now MUST include plans for the future as well, on all levels – government, district, communities, families and individuals.
- Not just 10 years, but 20 years, 50 years and 100 years in the future.
- Our children, our children's children and their children will inherit this land. It is up to us to make it good place for them to live.



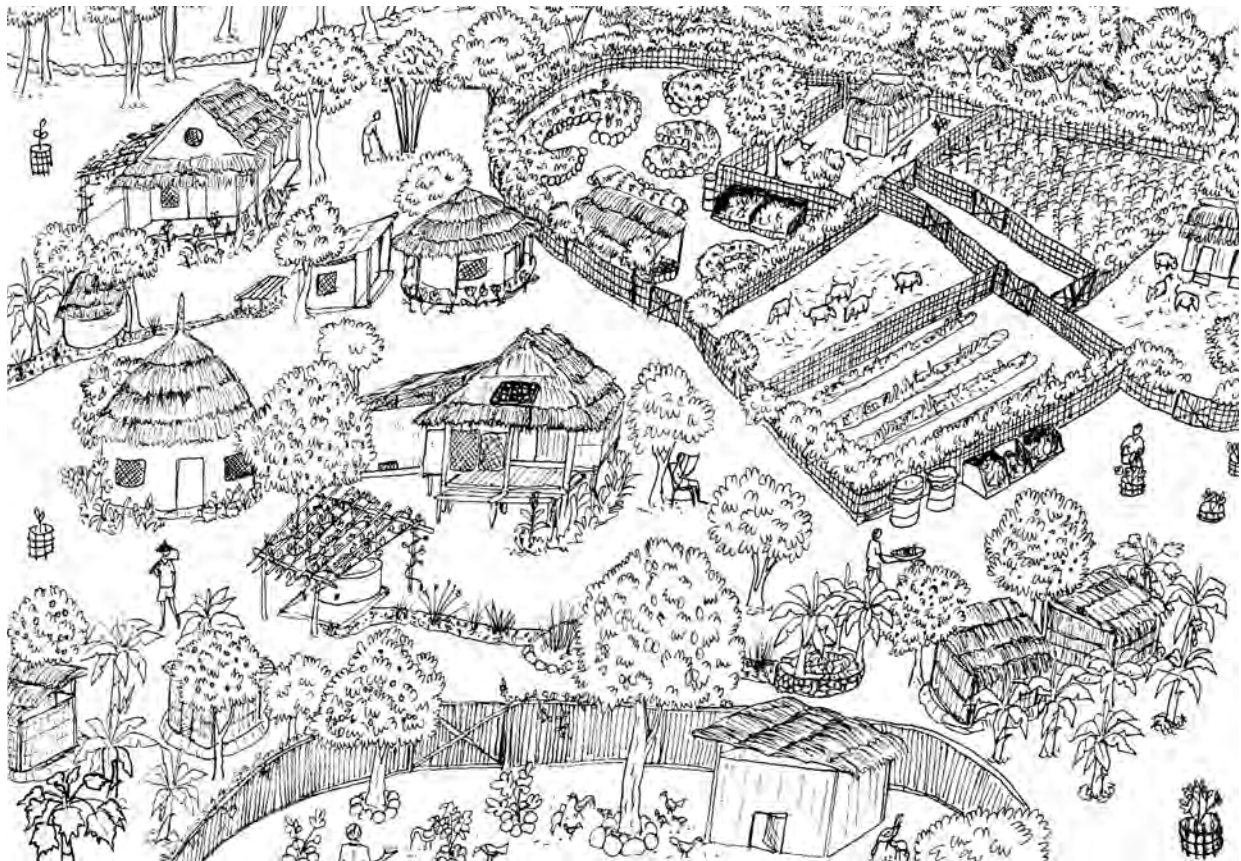
The most important part of planning for the future is EDUCATION. Knowledge and information has to be taught and shared if East Timor's future is to be strong and healthy. This will benefit everybody, including the people who share it.

This also includes sharing and trading our extra resources and skills.

Cooperation, not competition, is the key.

- Use local and natural resources whenever possible.
- Protect East Timor's natural environment.
- Reduce the amount of rubbish waste that is bought and produced.
- Recycle and reuse waste whenever possible.
- Move towards using renewable energy sources like solar power, hydroelectric, biogas and wind power.

The future is ours to decide and it begins today!



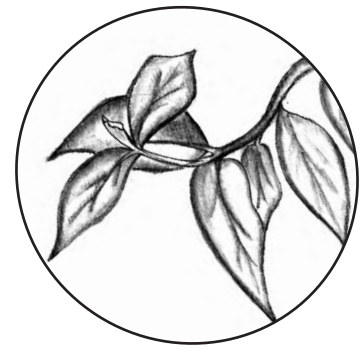
Principles

Permaculture principles are a guide for how to choose and implement permaculture and other techniques. Principles for permaculture give a structure that helps to maximize efficiency and production in a way that is:

1. Sustainable for the future.
2. Improving food security and incomes.
3. Affordable
4. Using local resources as much as possible.
5. Improving and protecting the soil, the land, the environment and the people involved.

The principles will help you to think more creatively and to apply ideas that are different each time. Each place is different, each situation is different and each family is different. Therefore plans, techniques, plants, animals and building materials will be different each time. But for every place and every project, big or small, the same principles apply.

A lot of the principles are simply common sense ideas. Don't just use them for permaculture!



Personal Responsibility

We are all responsible for our own actions! Our actions affect our own lives, our families' lives, our friends' lives and anyone else who has direct or indirect contact with us. This is true for men and for women. If Timor Leste is to prosper then we must take responsibility for now and for the future. Educating children about being responsible for the land and its people is fundamental for the future of East Timor. This is an important role for the adults and elders.

We need to use the resources available now to repair the fragile environment and plan, grow and create resources for the future, to the best of our abilities. This is what will develop a strong and resilient country.



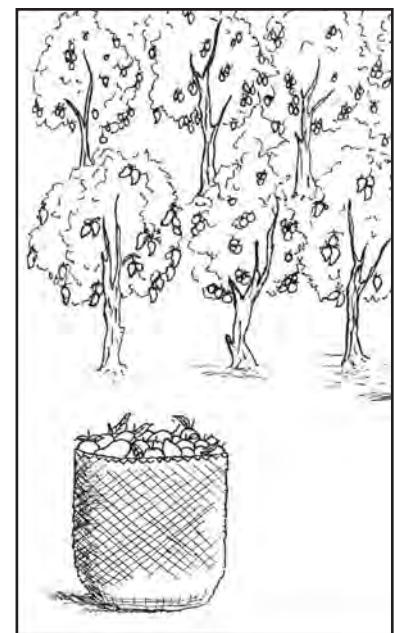
Thinking for the Future

Cooperation not competition

Cooperation between people, promotes:

- Community involvement.
- Trading between members of the community
- Shared and improved knowledge.
- Shared and improved skills.
- Many benefactors rather than a few.
- Less or no waste.
- A strong and integrated knowledge base rather than fractured, incomplete information

Cooperation is important on all levels. In the family, in the village, in the districts and as a whole nation.



Results in the Future

Competition, on the other hand, creates conflict, jealousy and anger within communities especially if a resource is scarce. A good example is water use. Usually the end result is that a few people have a lot while the rest receive little.

Competition also leads to waste.

Those few with a lot would rather see their resource wasted than share it. This helps no one. Mistrust is bred in communities because rather than sharing everyone competes for the same resource. A cooperative solution would benefit all, and could even increase the resource base.

East Timor is now an independent nation because its people worked together united in struggle. If each person tries to struggle by themselves, they have no power, no strength. It also makes their spirit weaker. If people just want competition then nothing will be solved. Cooperation leads to a strong connection together and problems can be solved easily.

For instance, if you have one "bone" from a palm frond (ai kesak), then it will take a very long time to sweep! If you put many together to make a broom, then sweeping becomes easy.

If you have one stick in a woodpile, then that stick can be easily broken, even by a child, but if you bundle many sticks together then the sticks cannot be broken! They work together and are strong.



one stick is easy to break



many sticks together are strong

See solutions, not problems

Every problem that we are faced with has a solution.

Often, the problem BECOMES the solution. We just need to look at it the right way!

Problem areas of land all have a natural solution, if we work with the land and the climate, not against it.

Good solutions will make use of the problem, like turning weeds into compost and mulch. You can also create production and benefits from the solution.

- Windbreaks to reduce strong wind problems provide shelter and increase production in the sheltered area but they can ALSO provide nuts, oils, fruit, bamboo poles, medicine, mulch and habitat for birds that will help to reduce pest problems.
- All the tree and plant waste, instead of being burnt and creating pollution can provide valuable organic matter and compost for future crops. All manures are a valuable resource too.
- Rocks can be used in dry areas to make simple terraces and catch soil and water.
- Fruit trees can then be planted and will grow well because of the rock terraces.

Think creatively and think of solutions for the long term.



"Look at my rocks!!" "The rocks can be a solution"

5 years time: "The rocks ARE a good solution!"



current example in East Timor is the drought-affected areas of Suai, Oecussi, and Atauro. Food aid is being asked for and arranged. This is necessary but only a short-term solution. It won't fix the problem.

Only when people observe the whole system and look for the reasons why the crops have failed, why there is less rain will they find sustainable answers. The people need to look at the water systems, the surrounding vegetation, the farming systems and what they are growing. Then the basic, priority problems can be solved and real solutions can be achieved.

Observation

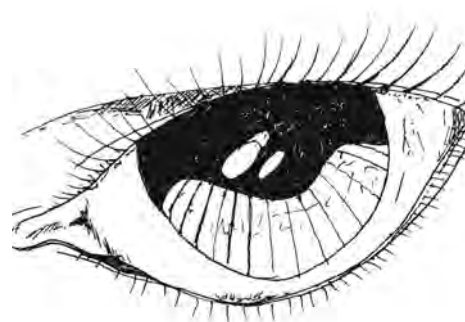


Observation of the natural patterns and cycles of nature helps us to make better plans for our farms, houses and gardens. A natural forest or ecosystem will create its own patterns, diversity and relationships between the land, water, plants, birds and animals to achieve balance and productivity. Each part of the system is connected and has its own functions as part of the whole system: a holistic design. We can imitate this approach on a house, farm, village, district and even national level!

Observation is one of the most important tools to use for continual improvement of farm design and farming practices.

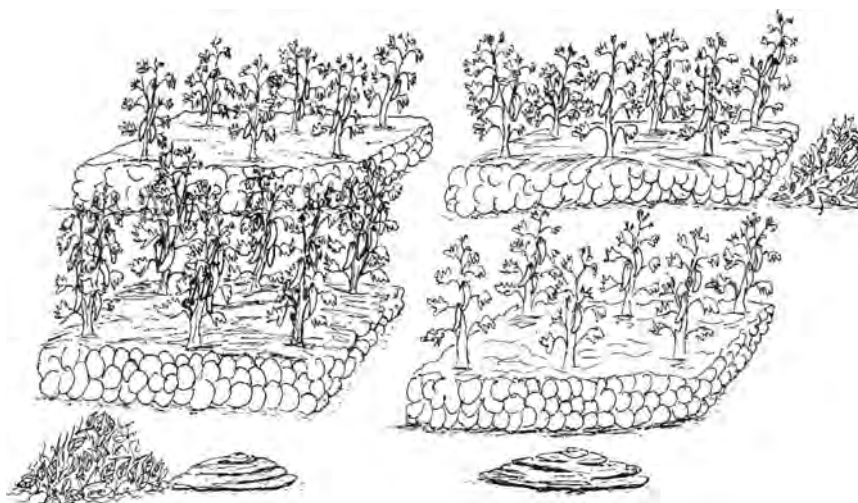
It helps us to learn by understanding things like:

- What works and what is not working and needs changing
- Why the same plant will grow better in one place than another
- The natural cycles of the environment and climate, and how to work with them, not against them
- If patterns occur when pests attack plants.
- Are some plants or groups of plants affected when others in different areas are not?
- Which plants and animals produce the best for the least effort?
- Where the water runs through the land and which areas stay wetter in the dry season.
- Where the sun shines all day, or part day and where it is shady.
- And so on.



By conducting **simple experiments** we can observe which are the best plants to grow and what is the best technique for growing them.

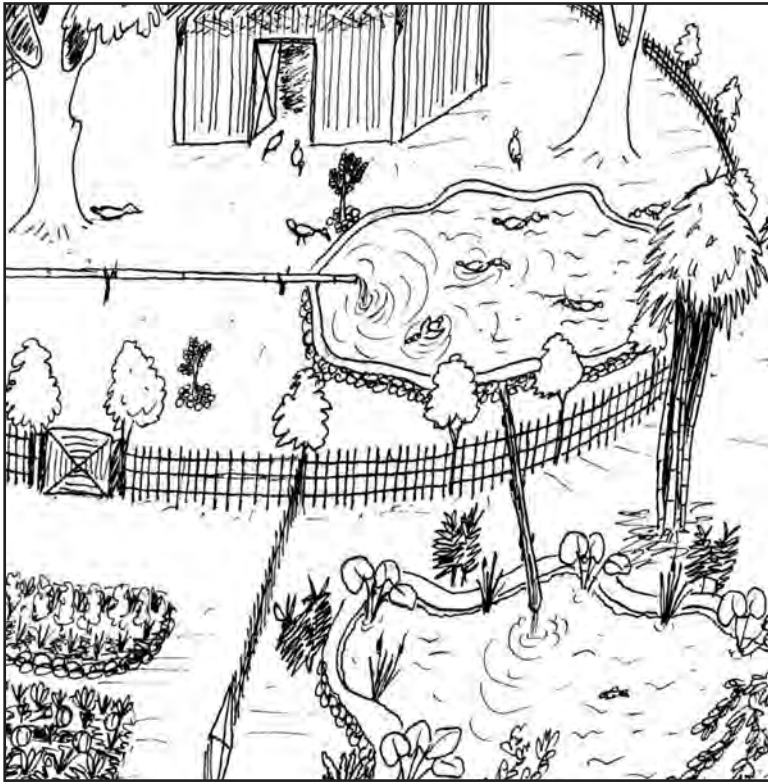
Results will be different for each area so each community should conduct their own experiments.



Experimental Garden Plots

Multifunction

Every element in a system should be multifunctional.



This means that we can:

- Choose elements that have multiple uses or products.

Example: Ducks can provide meat, eggs, manure, feathers, weed maintenance, pest control and money from sale.

- Place elements so that they provide different functions.

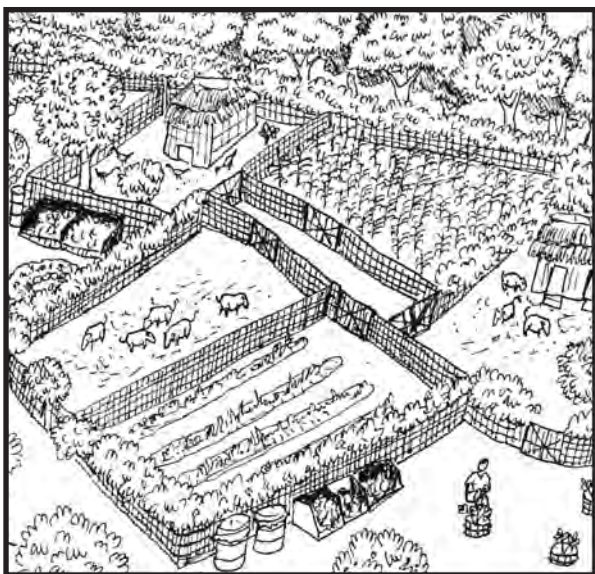
Example: Many plants and trees can be grown as a living fence & for growing vines.

- Re-use and recycle elements within the system so that they provide multiple inputs.

Example: Household water can be re-used in a pond to grow plants. The plants clean the water and can be harvested for mulch. The water can then be re-used for vegetable gardens or animals.

The more products and functions that each element provides means that you can produce more, as well as reduce the number of inputs needed.

- Bamboo provides many products; building materials, food, furniture, bags, mulch, buckets, musical instruments and so on.
- However if it is placed well in a system it can also fulfill others functions like living fences, windbreaks, erosion control, reforestation and shade.
- If bamboo is re-used within the system, different uses are fences, irrigation, trellising for vines and plant pots.



Pig, duck & vegetable rotation system



Another example is East Timorese women, possibly the most multifunctional element in East Timor! Raising children, cooking, cleaning, washing, teaching, growing crops, looking after health and giving medicine, collecting water and firewood, boiling water, raising animals and much more, every day!





Quality is Economy

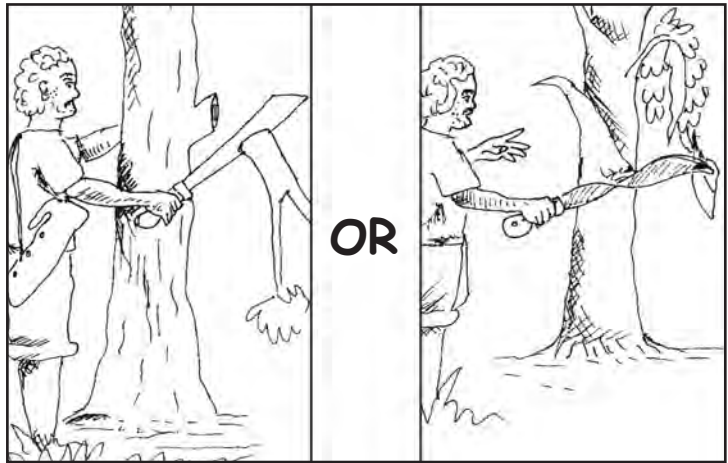
Good planning will save a lot of time and maintenance in the future.

Good implementation of the plan, taking time to do the job properly and with good materials will save having to do the job again the next year and the year after and the year after....

Something that is well made will save money and time in other ways.

Buying quality tools is cheaper in the long run than buying cheap tools.

A good quality Timorese made machete will last longer than MANY cheap imported machetes. They are also quicker & easier to use. Quality shovels, hoes, axes and other tools all last many times longer and are quicker and easier to use than cheap varieties. You don't have to re-buy them again and again and again and again and.....



Energy Efficient Systems

A basic energy-conserving rule in permaculture is that every element (plant, animal, or structure) must be placed so that it provides 2 or more functions (multi-functional).

Every function (e.g. water collection, vegetable production) is served in 2 or more ways.

People, structures, water, trees and plants, animals, fire, fuels (diesel, kerosene, petrol), machinery and fertilizers, all need energy to be produced and all can be used to create more energy.

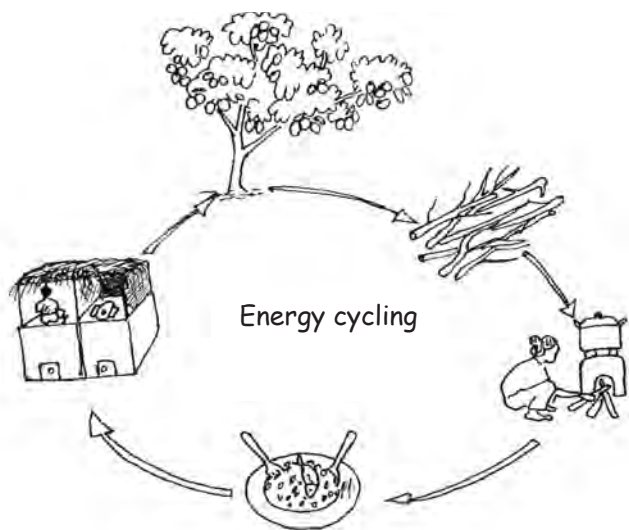
All energy that is used costs time and money.

Therefore it is good to use less energy.

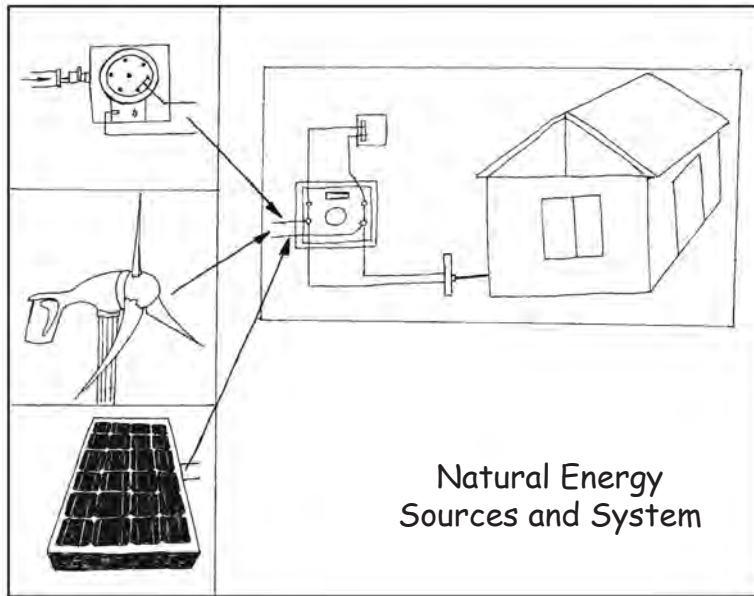
This can be done by:

- Re-using waste and manure from animals, plants, people, houses etc.
- Reduce energy needs through good design and practice. E.g. Cows grow bigger and faster if they have shade and wind protection. The trees that give shade and wind protection can also give cow food!
- Use natural energy sources. E.g. Hydro-electric, biogas, solar.
- Use technology to reduce energy needs. E.g. you need a lot less firewood if you use a clay oven

Good quality & energy efficient stove

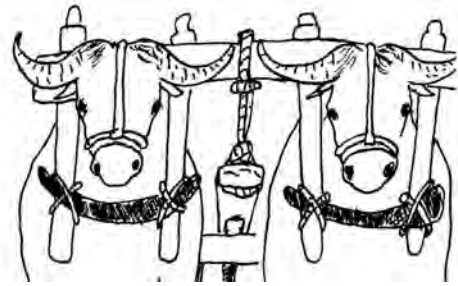


Less time and money is used and the system will help to support itself. In East Timor natural energy is precious. Energy that is used needs to be used wisely. And if trees are used for firewood, plant more trees to replace them.



Energy efficiency also relates to using solar, water or wind to create energy rather than diesel generators. There is more cost for setting up such alternative systems but the maintenance costs are small compared to having to continually buy diesel, oil and spare parts for generators. Pollution is greatly reduced as well.

Another example is using buffalo ploughs instead of tractors. Buffaloes need energy that is cheap and local, tractors need energy that is expensive and imported from overseas.



Small Scale Systems



SMART IDEA:

Only build what you can maintain and always maintain what you build.

Small systems are easier to maintain.

This means that it is easier to achieve maximum yields and to make the most of your work.

Often on large farms the yield is only moderate because there is not enough time, labour or resources to manage the farm properly. This is wasted energy.

In small-scale systems pest and disease problems are less likely to occur and are much easier to manage.

Intensive terraced vegetable garden



Work Smart Not Hard

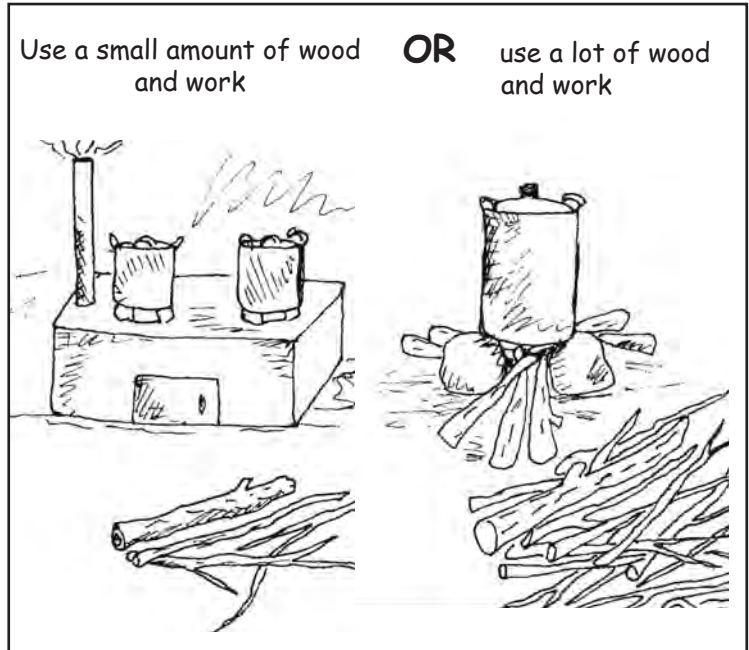
Many of us forget to use our most important muscle first when we work... **OUR BRAIN!!!**

If we use our brain first we can make a project much easier and we can plan for the long term.

Use your brain to:

- Reduce labour time
- Reduce energy expended
- Reduce outside resources needed
- Importantly, reduce costs
- Save work time in the future by doing a good job now
- Make the system do the work for you

Asking an expert about your project will provide you with a lot of great information to help you make it easier and better. But don't forget that smart ideas can come from anyone, men and women, young and old. Working smart is important in the home, raising animals, growing crops, planting trees, selling produce etc.



Some examples:

- Using stoves to reduce firewood use. This saves a lot of heavy work collecting wood, and saves money too.
- Using bamboo pipes to bring water to the house instead of collecting it each day.
- Don't just make a normal fence, make a living fence. It protects the crops or houses the animal as well as providing animal food, mulch, compost material, shade, firewood and even nitrogen in the soil!

No Waste

Waste that we don't re-use is pollution.

The pollution can be in the ground (eg: broken glass, cans, car oil, battery acid), in the water (eg: excess chemicals and washing powder, plastic and other rubbish), and in the air (eg: smoke from burning, fumes from engines). All these forms of pollution are already creating problems in Timor Leste and will cause bigger problems in the future if they are not corrected now.

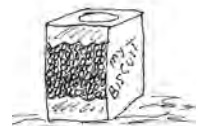
The best way to solve the problem is to NOT create the waste in the first place.

Using as many local products made from local materials as possible will reduce waste created. It will also support local business in Timor Leste.

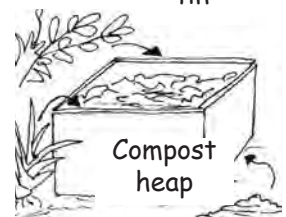
Try to make use of all available resources, especially natural resources.

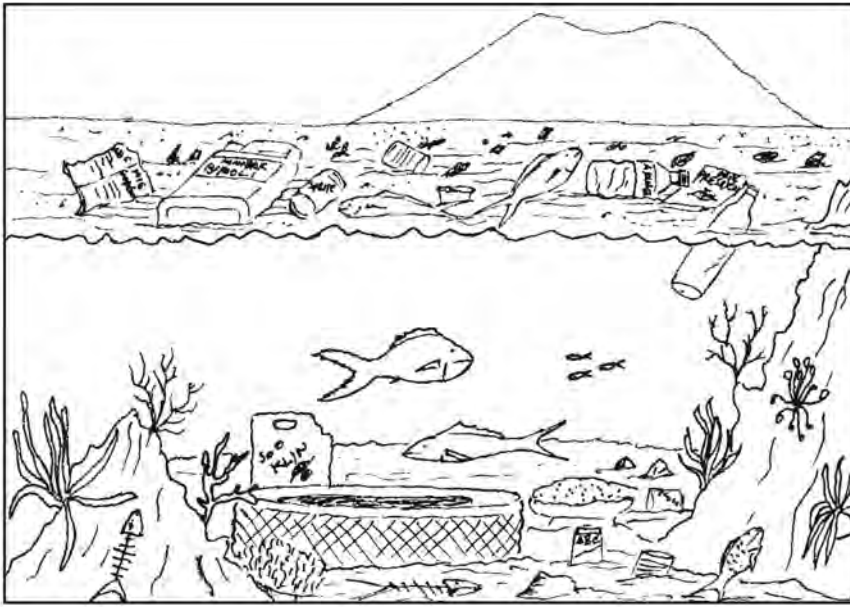
Re-use your wastes as resources.

This reduces pollution and saves on inputs that are needed. Water, garden waste, manures and a lot of household rubbish can all be re-used.



Seed storage tin





East Timor Future Oceans?

Throughout the book there will be many good ideas for re-using waste and reducing pollution.

Remember that all rubbish can create problems and doesn't just disappear if it is burnt or dumped in the river.

Ocean environments, animals and beaches all suffer because of rubbish.

The Timorese environment must be protected and well maintained if Timor Leste is to have a prosperous future.



Make the system work for you

When a system starts to look after itself then we know that we are on the right road.

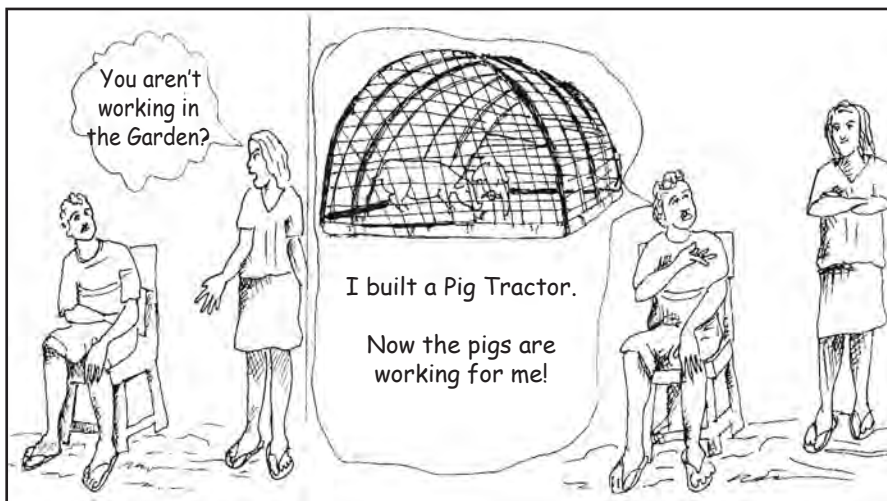
This is achieved by using one element in a system to provide a service for others element in the system. Thus, we are making our resources work for us.

Every part of the system should be producing resources. Some examples of plant resources produced are food, sale-able items, timber, fertilizer, mulch, firewood, shade, fencing, animal habitat and windbreaks.

The most important resource produced by trees is clean air! Examples of animal resources produced are food, labour, sellable items and fertilizer.

The more resources that are produced by each element, the less inputs that are needed.

We must try to obtain a yield for the energy that we put in. To grow a crop or planting trees only to see goats and pigs destroy them because they weren't protected is frustrating and costly.



Growing a successful crop but then not saving good seed for next year costs money and loses the benefit of seed improvement from crop to crop.

As resources are scarce in Timor Leste we must make the most of what we have.





Integrated Systems

Integrated systems combine different elements to work together in a single system.

If we create a system that has many different elements, such as fish, water crops and fruit trees then production will increase and the elements can help to feed each other.

Integrated systems:

- Help to increase diversity of plants and animals
- Increases the diversity of production from one system
- Help to save energy and reduce waste of precious resources
- Make it easier to re-use energy that is produced and stored in a system



The whole farm including house and living areas should be thought of as one large integrated system.

If we plan in this way then we can make use of all potential resources and maximize productivity.

Diversity

In natural environments a greater diversity of plants and animals leads to a healthier, more balanced environment.

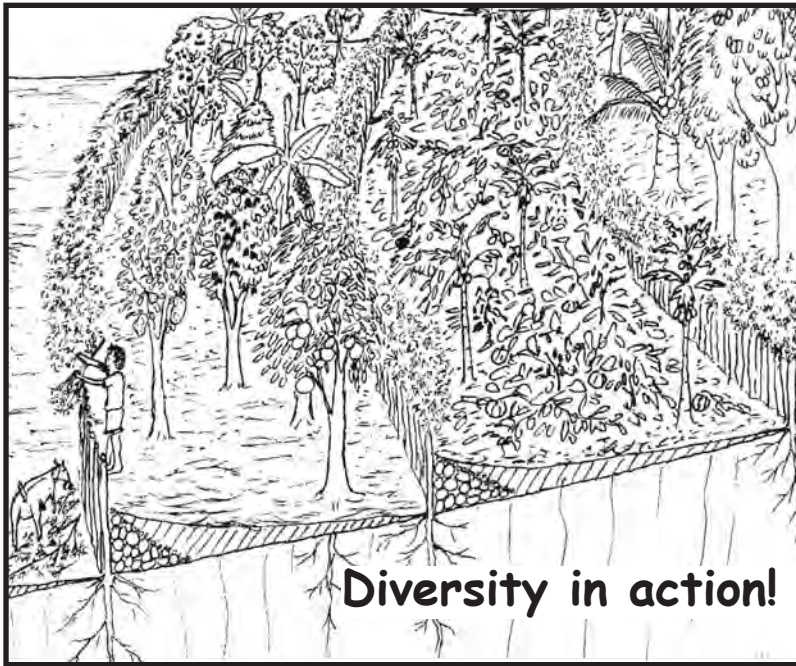
Diversity in a farm system means that we grow many different crops for food and for income, not just one or two.

Different types of vegetables, fruits, grains, tree products, animals and goods can all be produced.

Encouraging predators of pests and pollinators like birds, frogs, spiders, bats, bees, beetles and wasps is another important part of diversity.

These animals and insects help to do the work for us.





A diverse system:

- Is more resilient to extreme weather and more flexible with sudden change.
- Produces food and income more often during the year.
- Means that if one crop fails or some animals die then other crops or animals still produce or may even produce more.
- Will suffer less from large-scale pest or disease problems.
- Is more beautiful!

Moving successfully into the future also needs a diversity of ideas and skills. This must come from all members of a family and from people in a community working together.

Use of Edges

In nature Edge Effect is when 2 different ecosystems meet and a new 3rd ecosystem is created. The new ecosystem combines the other 2 ecosystems and is more complex and more productive.

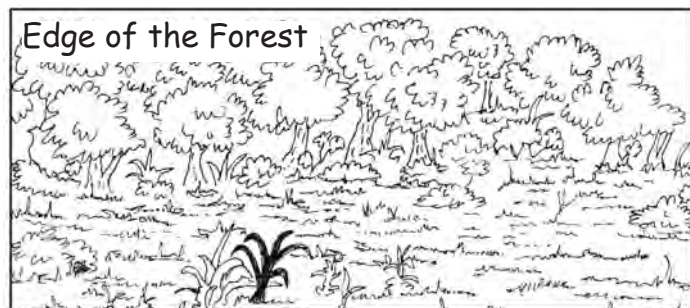
This could be:

- The edge between the land and the sea
- The outer edge of a forest
- The edge of a river (River bank)

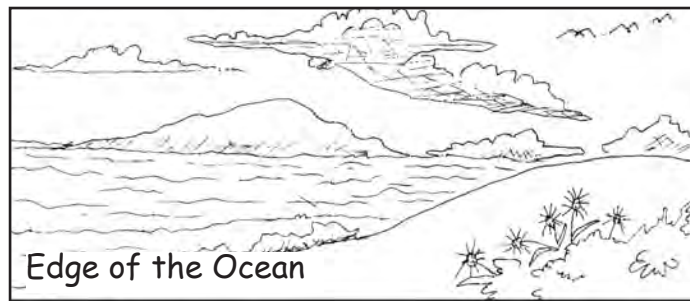
The edge is the most productive part of the environment because it contains more diversity of plants animals and insects, more fertility and more sunlight. This idea can be copied and used in agriculture and animal systems and even with houses.

For Example:

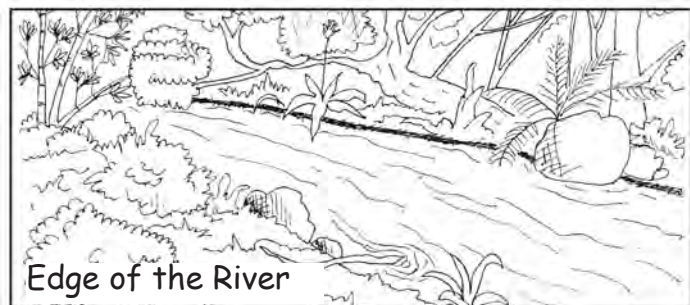
- The edge of a clay fish pond is very productive, both in the water and out of the water.
- Making terraces or swales on sloped land creates many edges, and improves production.
- The soil on the outside edge of an animal house will be full of nutrients from the manure and is excellent for growing vegetables or fruit trees.
- More edges means more production and more diversity. This idea is working with natural systems, not against them.



Edge of the Forest



Edge of the Ocean



Edge of the River



Succession and evolution

Evolution means that the strongest and most adaptable species survive and reproduce AND the strongest and most adaptable of each species survive and reproduce.

Succession means the step by step process of the natural progression of a system.

In a permaculture system we can use succession and evolution to speed up the growth and development of our system.

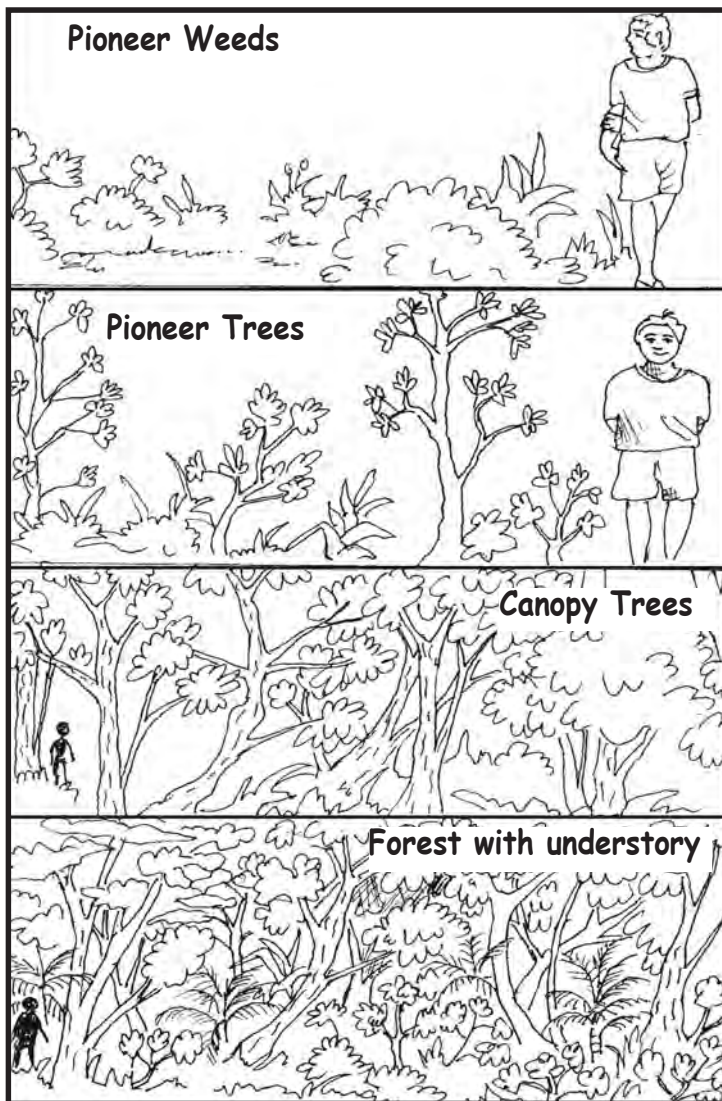
We can also use it to improve the quality of animal and plant stock from year to year.

Examples of evolution:

- Picking the seed from the BEST plants each season to improve the quality of next season's plants.
- Experimenting with many different types of fruit and vegetables to find which ones grows the best.
- Experimenting with different varieties of the same vegetable or fruit to compare growth, production and disease resistance rates. Then you can select the best variety for the land. Eg varieties of tomato.
- When planting out trees for reforestation it is wise to overplant, and then weed out the smallest and weakest trees after 1 and 2 seasons. The trees that are weeded out provide mulch and the trees that are left will be stronger and more productive.
- Learning from mistakes and consolidating knowledge from past experience. E.g. When a farmer has unexpected success with a technique or crop and then changes the future plans to include the new success.

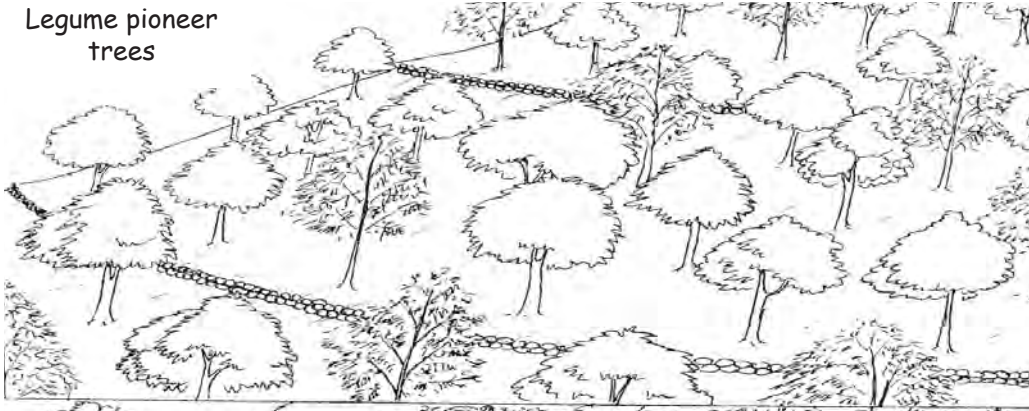
Examples of succession:

- Reforestation techniques working with the succession principal to speed up development and improve long-term success rates.
- Some large trees take many years to reach full size and production. They should be planted the correct distance apart to allow them to reach their full size. This provides space in between the large trees for 5-10 years to plant and harvest from quick growing, short-lived trees or annual crops.
- When large trees are well established, animals such as chickens, ducks or even a few goats or buffalo can be introduced to provide weed control and manure.



Natural Succession and Evolution
from Grassland to Forest

Legume pioneer trees



Remove some legumes to plant fruit and nut trees



An example of using succession and evolution with agroforestry

Beauty

Highly productive land can also be very beautiful! And if it is beautiful it will also be a much more pleasant place to be and work! It is the same for the house area as well. East Timor already has a beautiful environment and beautiful gardens and houses will add too it. Creativity, imagination and beauty should be encouraged for all members in a family: men, women and children.

A beautiful house and garden is something to be proud of!

Gardens and fishponds can be beautiful shapes.

Flowers can be grown next to and among the vegetables.

Flowering small trees and legumes can be grown with fruit trees.

And this also helps productivity and diversity!

Wooden structures can be carved with patterns and pictures, as is traditionally done.

The garden at Arte Moris art school in Comoro, Dili is a great example of combining beauty with productivity. Wood, metal and bamboo sculptures, flags, structures and shapes are amongst all the newly planted fruit trees, bamboos, flowers, vegetable gardens and shade trees. There is also a pond, compost heaps, recycling of waste water into plants, and rubbish into beautiful art.



Fish pond at Arte Moris





Natural Patterns



&

Methods for Design

CHAPTER

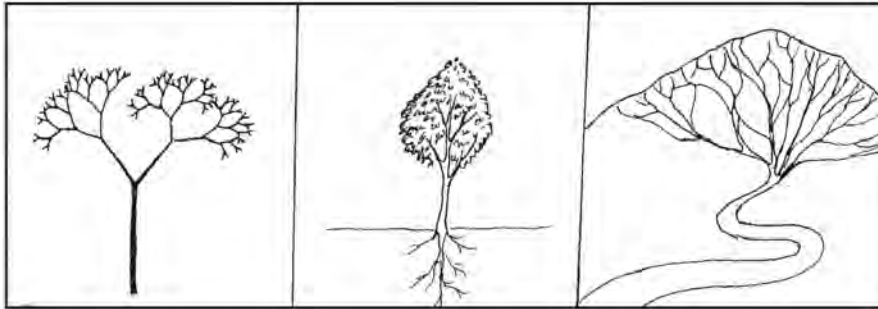


Natural Patterns

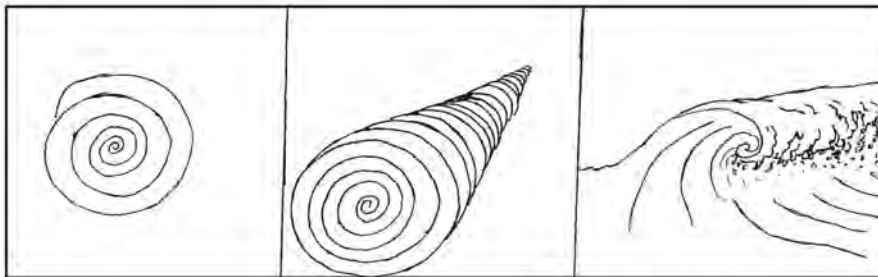
The world is made up of patterns. Every aspect of the earth from the smallest animal to the largest mountain contains patterns. Even the passage of time in seasons and years are patterns. Many patterns are repeated in different forms and in the living and non-living.

Complex shapes are made up from simple patterns. Patterns are created in response to natural energy flows. The patterns that exist in nature:

- Enable energy to flow.
- Provide solid structure.
- Are natural responses to their surroundings.
- Are what make life self-sustaining and self-perpetuating.



Remember that all energy flows. We can either assist the energy flow or inhibit it. Humans have also created many patterns such as songs, music, dance, pictures, cloth, house design and much more. Traditionally these patterns have been non-linear and flow easily.

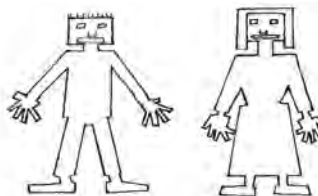


However, many human patterns, especially modern patterns, are not in harmony with patterns of nature.

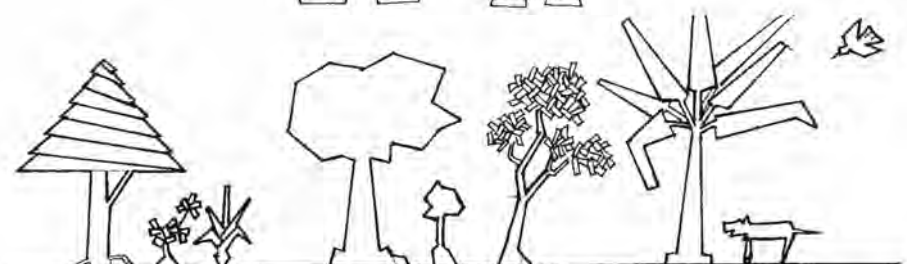
These patterns are often a response to limited time and to money and create un-natural shapes that do not allow good energy flow. The result is that these patterns require constant maintenance and can cause problems and constraints. They also provide "low quality" results that lack beauty and do not feel good or comfortable.

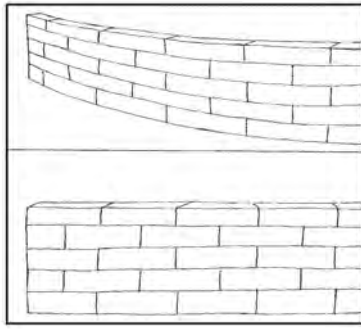
Examples of this are box-shape houses, cities designed in squares and grids, straight-line agriculture.

Are there any straight or square parts in our bodies?



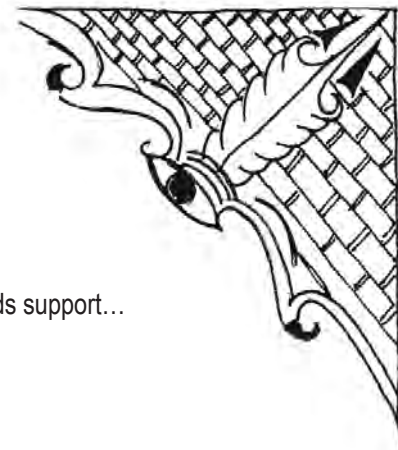
Are there any straight lines in nature?





Which is stronger?
A curved wall or a straight wall?

A curved wall can support itself while a straight wall needs support...

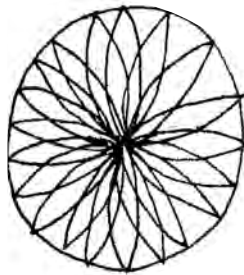


The land of Timor Leste has its own patterns, and so do its' people. These are unique! If we work with these patterns to create a farm/system/project then we will achieve better harmony, better results and less maintenance.

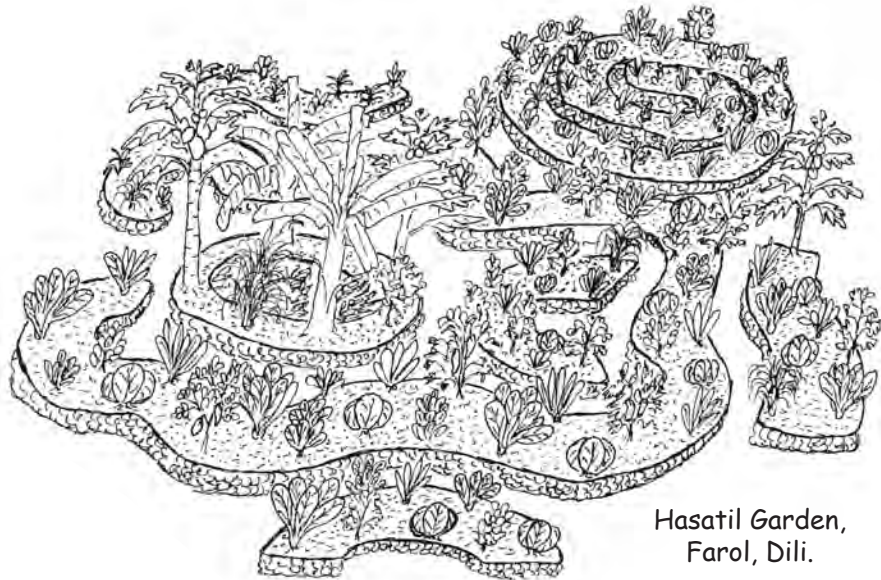
Patterns in nature are beautiful and functional.
Natural patterns in design create beauty and function.



Natural designs and shapes should be used as much as possible to improve the beauty especially around the house. In many cases it will increase the productivity but it will make the area much more pleasant to look at and work in and gives a sense of pride.

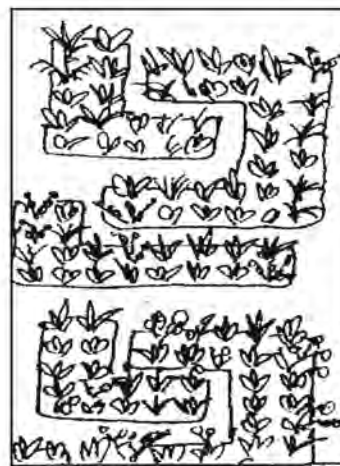
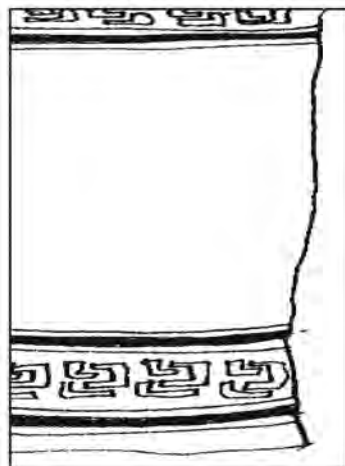


**USE
YOUR
IMAGINATION!**



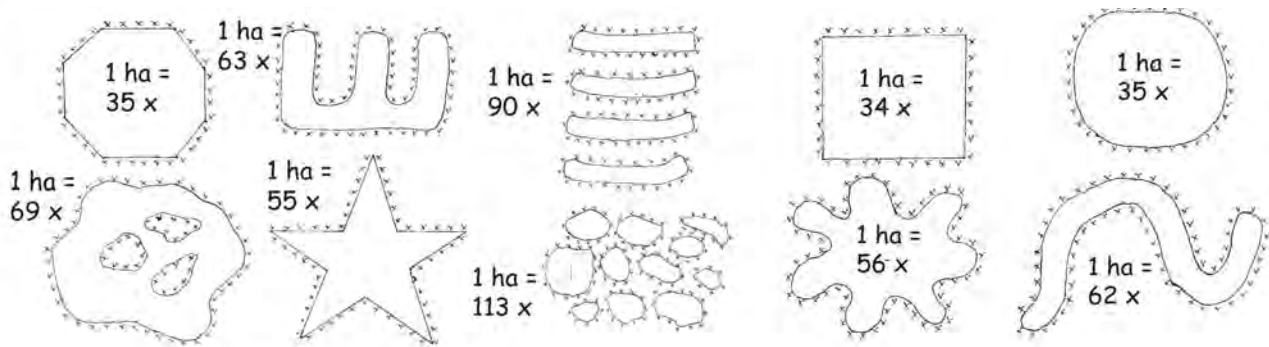
Hasatil Garden,
Farol, Dili.

Some of East Timor's best known patterns are in the Tais. Embroidery and weaved baskets also have beautiful patterns. Women can use their knowledge of these patterns in the garden and use the patterns to make the garden bed shapes.



Increased Productivity with Natural Patterns

Changing the shape of a fishpond can greatly affect and increase its productivity. Because the edge is the most productive area, if we increase the edge then we increase productivity. In reality, the shape of the pond should fit into the shape of the land. This means that the land dictates the shape, not the shape dictates the land.

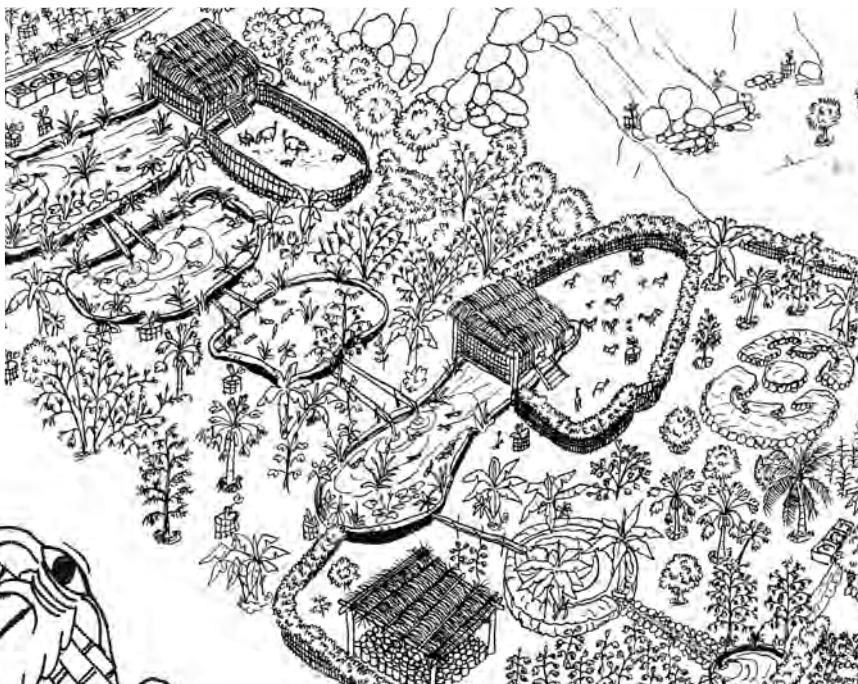


Fishpond shapes. Each fishpond is 1 ha

If you work with the natural shape then you will achieve productive results for the least amount of time and labour.

Because we have much more edge for the same amount of water: More trees, plants and water plants can be planted around the edge. These trees and plants can provide:

- FOOD for the fish from leaves and dropping fruit
- Shade for the pond to reduce evaporation and regulate water temperature
- Food for people
- Erosion control
- Fish mostly feed on the edge of ponds so more fish can be produced in the same amount of water.
- More water plants can be grown around the edge. These provide food for humans and fish and mulch for composts and gardens.
- Insect, birds and animal life will increase around the pond, which will improve pollination rates and natural pest control and provide more food for the fish.
- The water will be healthier.



Fishponds are an excellent example, but working with natural shapes and increasing edges will benefit all types of agriculture and animal production.

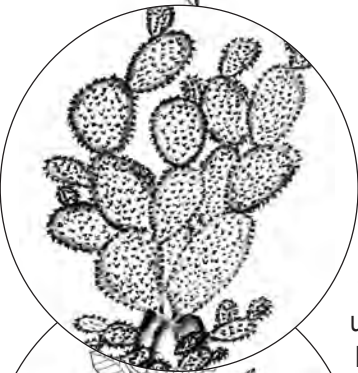
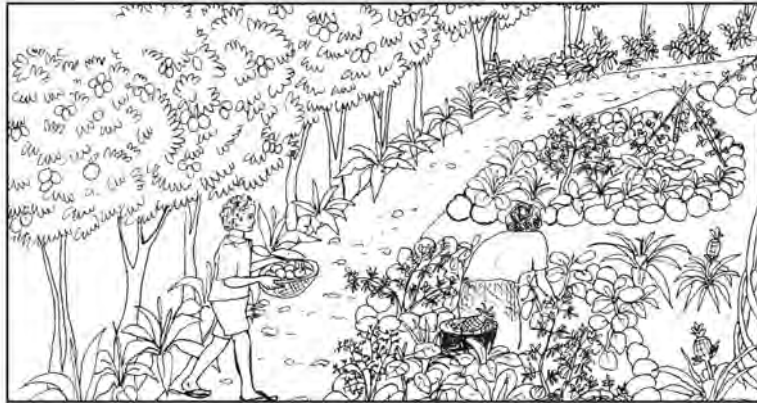


On sloped land swales and terraces are shaped with the land to catch and store water and mulch.

Rice paddies are aligned with the natural shape to be most efficient.

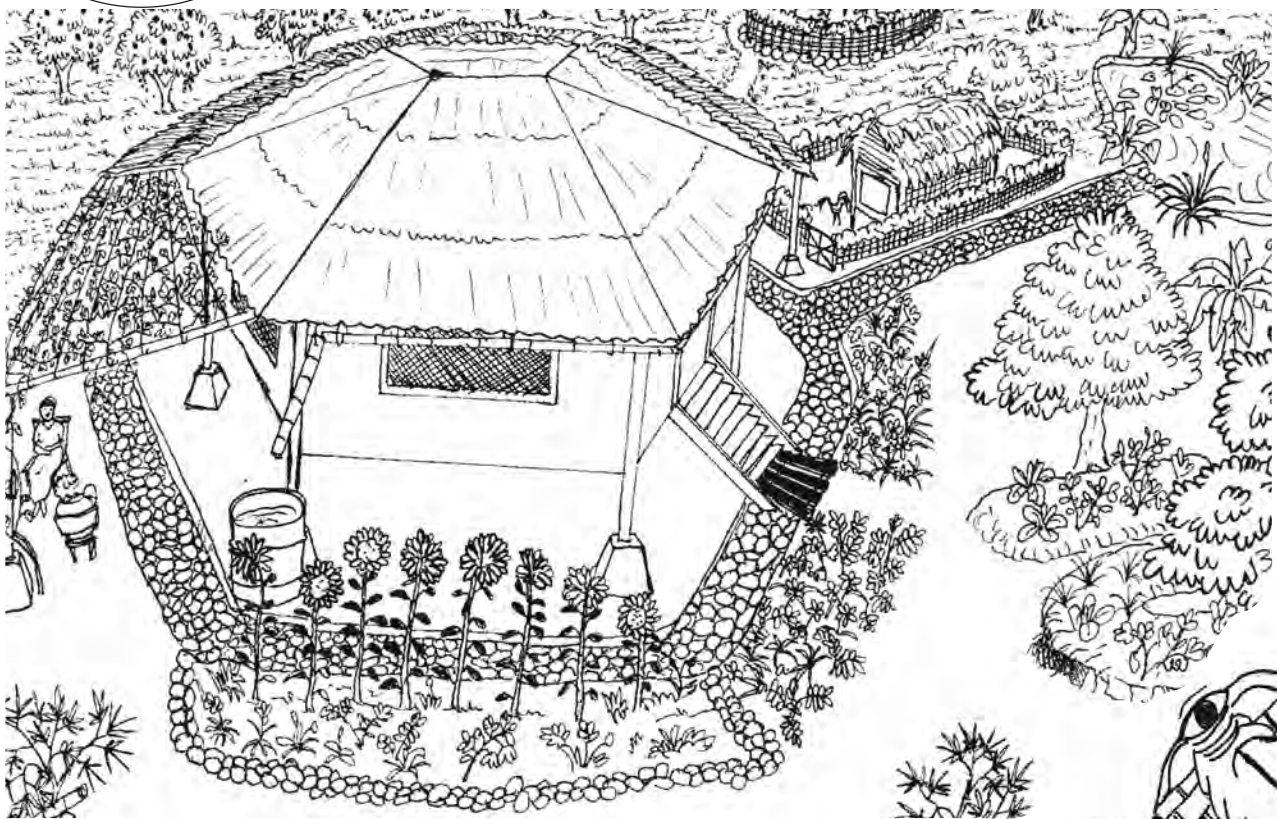
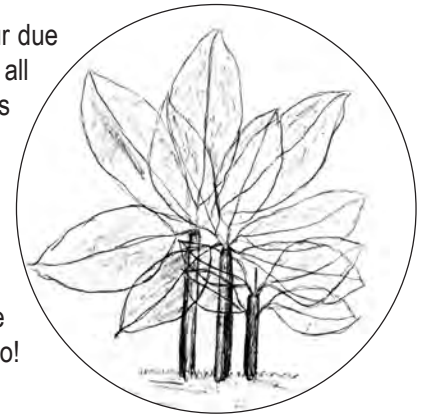
On gently sloped land, different patterns can make use of wet season rains.

Vegetables and soil can be protected AND the water run-off can be re-used.



Edges occur naturally on the land but may also occur due to human development. All edges can be used and all usage will increase production and diversity. All paths have edge on both sides that are not often used for production. Even planting path edges with fruit and flowers will benefit you and the garden.

Extra fruit and income, mulch for the soil and extra birds and insects are some of the benefits. Because the plants are on the path they are easy to harvest too!



Methods of Design

Methods of design looks at ideas and methods for planning long-term designs for agriculture land, animal systems, houses and projects.

We ask the questions:

“Where does this element go?”

“How is it placed for maximum benefit in the system?”

Permaculture combines techniques and strategies...

Techniques are HOW to do things.

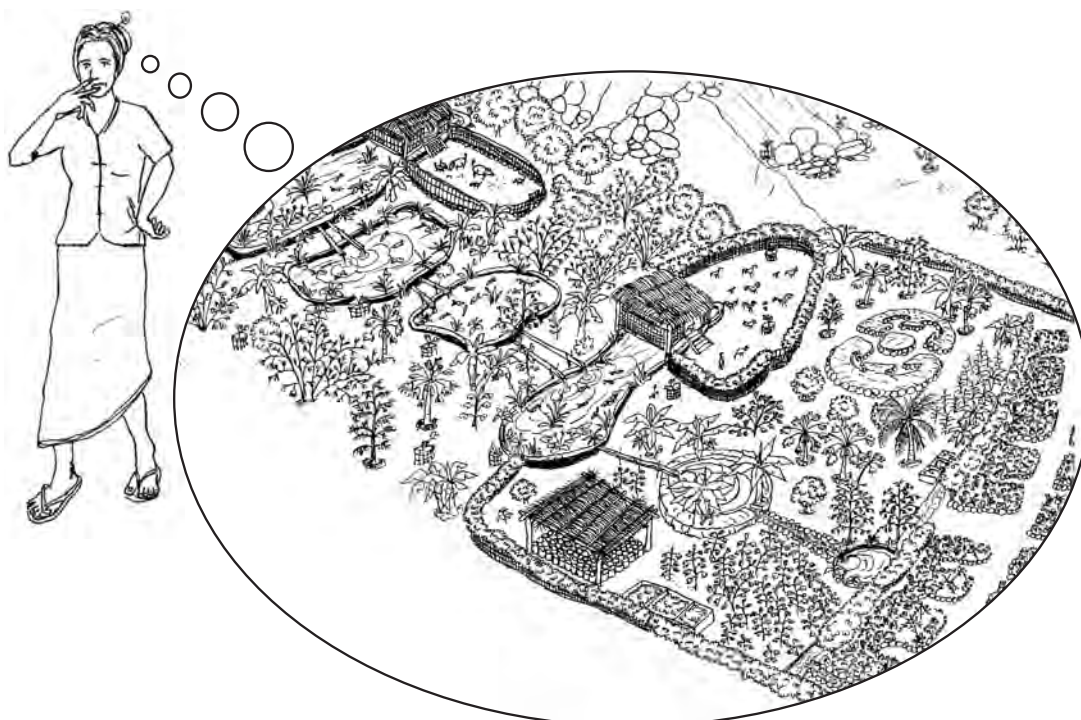
Strategies are HOW and WHEN to do things.

Design is about making a PATTERN with the elements, working with the land, to create a system.

Making a long-term design is very important because:

- It helps to plan for the future.
- It helps you to see what the PRIORITIES are for establishing a successful farm or project.
- It enables you to see how you can integrate parts of the system together to save resources and labour, and increase production.
- You can plan how to use waste from one section as a resource in another section.
- It reduces the amount of work needed in the long-term and helps you to gain maximum benefit for your work.
- The design accelerates the growth of a farm or project because the right technique is used at the right time.
- You can plan for extremes in the weather. This is very important. If your farm can cope with droughts, flooding and storms and still produce then your family and community will still have food and income. There are many techniques in the guidebook that will help cope with droughts, floods and storms.

A plan gives you a frame. Like a house, framework is necessary before you build the rest of the house, and good framework will create a strong long lasting house. It gives you more order but with flexibility. Plans can change as circumstances change. As you have successes or mistakes with your farm you can also adjust the plan accordingly.



Approaches to Design

1: Maps

“Where is everything?”

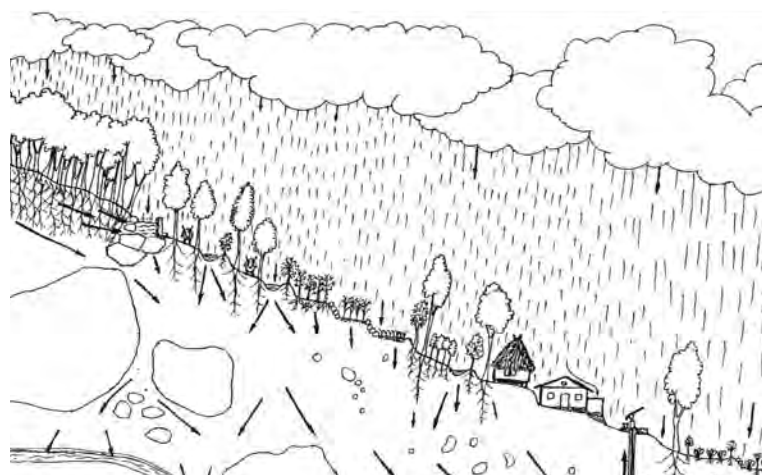
“What does the land look like?”

Drawing or making a map of the land is a very good way to see where everything is in one picture. An overview map is drawn as if you are looking down at the land from straight above, like an eagle looking down from the sky.



3D model of mountain with swales and terraces

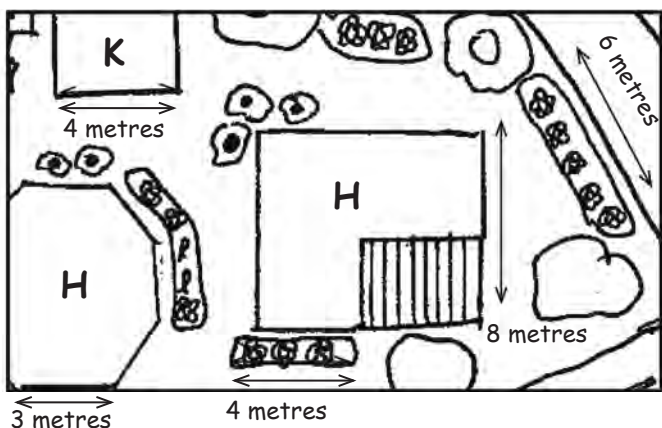
An **overview map** can also be made in sand or dirt using models to represent the features on the land. This method is often easier and more fun. You can represent mountain slopes and rivers and even experiment with real water flows using a watering can!



Profile (cross section) of good water catchment

A **profile map (cross section map)** is a different way of looking at the land and is very good for looking at sloping land or at a particular section of land. It is the same as cutting a slice of cake then looking at the slice from the side view. The land surface is the top of cake, and the buildings, trees and so on are on top with the tree roots growing into the cake.

All the different parts of the map should be drawn “to scale”. This means that they are the same size in relation to each other as they are in real life.

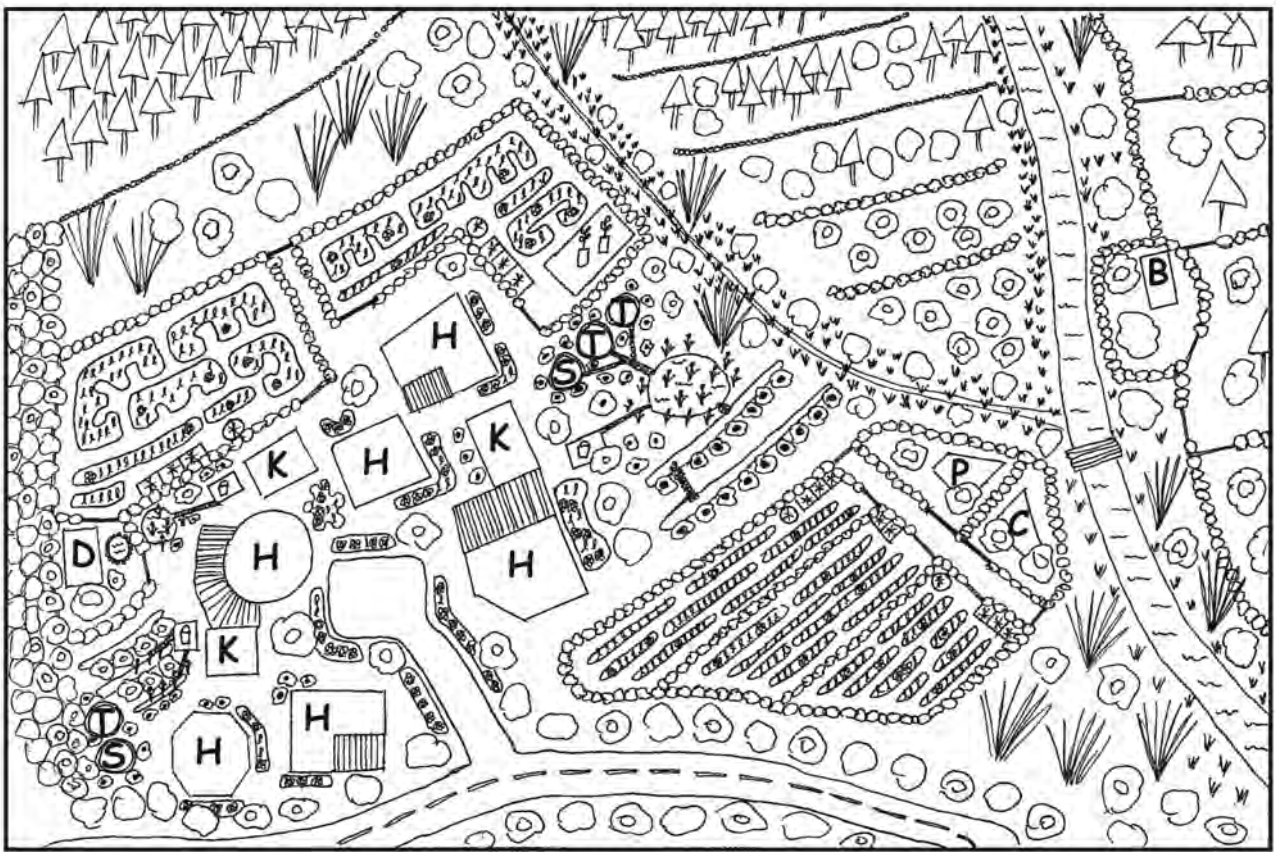


One way to achieve this is to:

1. Pace out the size of each section with equal sized steps.
2. Count the number of steps for each measurement.
3. Compare distances of different sections. A wall that is 20 paces should be drawn twice as long as one that is 10 paces. A garden plot that is 25 paces long should be drawn 5 times as long as one that is 5 paces.
4. Draw the section with distances written next to measured section.

The drawings don't need to be perfect but using this method helps to draw a more accurate map. A more accurate map will help to make a better design, meaning real life mistakes are reduced.





KEY

	- House		- Washing area		- Gate
	- Kitchen		- Shade Trellis		- Nursery
	- Toilet		- Shower		- Compost
	- Large Fruit Tree		- Living Fence		- Liquid Compost
	- Small Fruit Tree		- Grass		- Vegetables
	- Vegetable Plot		- Waste water pond		- Flowers
	- Flower Garden		- Animal House		- Bamboo
	- Windbreak	D - Duck			- Duck Pond
	- Rock Swale	C - Chicken			- Forest Trees
	- Earth Swale	P - Pig			- Tree
	- Water trench	B - Buffalo			
			- Road		
			- River		
			- Gully		

It is good to show where land is flat, gently sloped or steeply sloped. Different techniques and strategies will be used for each section so showing the differences is important. River gullies, caves and other unusual land formations should also be noted.



Maps need to include:

- * Existing buildings
- * Existing vegetation
- * Fences
- * Roads and paths
- * Boundary
- * Pipes – water, electricity
- * Any sacred land or sites
- * Future plans for gardens, grain crops and trees
- * Land that is subject to extremes and problems. Eg erosion, flood plains, rocky ground
- * Most importantly, a “Key”
- * Future planned buildings
- * Existing gardens and grain crops
- * Existing animals and animal shelters
- * Rivers, creeks, natural springs, ponds and water flows
- * Flat land, gently sloped land and steeply sloped land
- * Future animals and animal shelters
- * Any cursed land or sites

The “Key” is a section of the map where all the different features are explained. Each feature on the map is given a letter, number or symbol. These letters or numbers are then listed in the Key with a short explanation of each feature. The Key acts like a key in real life; it unlocks the door to understanding the information presented on the map.

To make the map easier to read, use different colours for the different features. For example you could use yellow for water, blue for trees, green for buildings, pink for roads...!

Different colours are important to separate between existing features and future plans. You could use black for existing features and red for future plans.



SMART IDEAS:

Use the following sections on elements, zones and sectors to help to plan the designs that go on the maps. They help to work out what are the best ideas to use and where is the best place to put them.

The map design should be done by everyone who will be a part of the work. All the family and any other workers too. The more ideas the better.



A Picture Map showing many elements



2: Analysis of Elements

“How do these things work together?”

A simple “Needs and Products” table is a very easy and very important way of understanding:

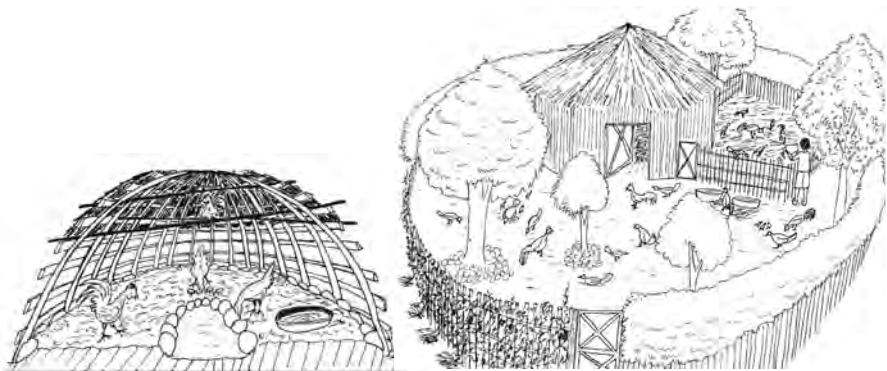
* What we need for each element?

* What products does each element give us?

For example, if you keep chickens in a chicken yard then you can collect many benefits, not just meat. To make a chicken yard and have healthy chickens then we have to look at what they need. Then we can look at what products they give back.

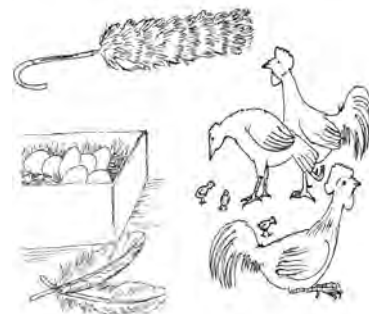
CHICKEN NEEDS

Food
House
Water
Protection from predators
Shade
Medicine
Friends – other chickens
Dry earth
Fence
Laying box
Fresh air



CHICKEN PRODUCTS

Meat
Eggs
Manure
Money
Feathers
Work - weed control
Work – pest control



And we can look at a Needs and Products chart for vegetable gardens.

VEGETABLE GARDEN NEEDS

Seeds
Compost, liquid fertilizer
Mulch
Healthy soil
Fence
Seedling area
Cultivation – tools & labour
Water
Sunlight
Weed control
Wind control

VEGETABLE GARDEN PRODUCTS

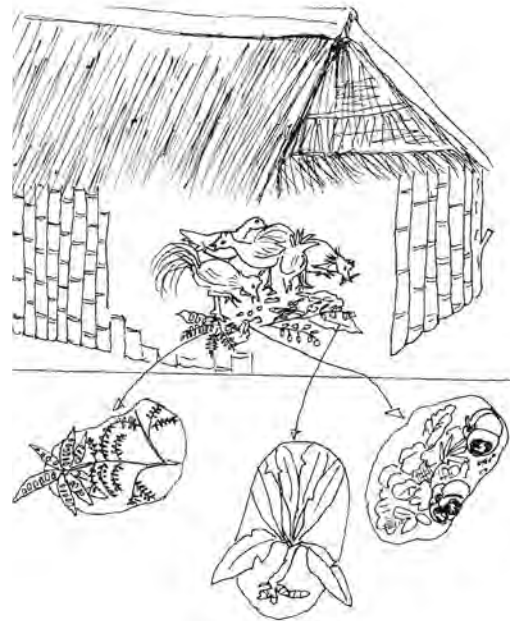
Vegetables
Fruit
Herbs and Spices
Compost material
Animal feed material
Flowers
Money
Other products through trade
Mulch material
Trellising material from fence
Products from windbreak



We can use the Needs and Products tables to connect different elements in the system and reduce the amount of imported inputs.

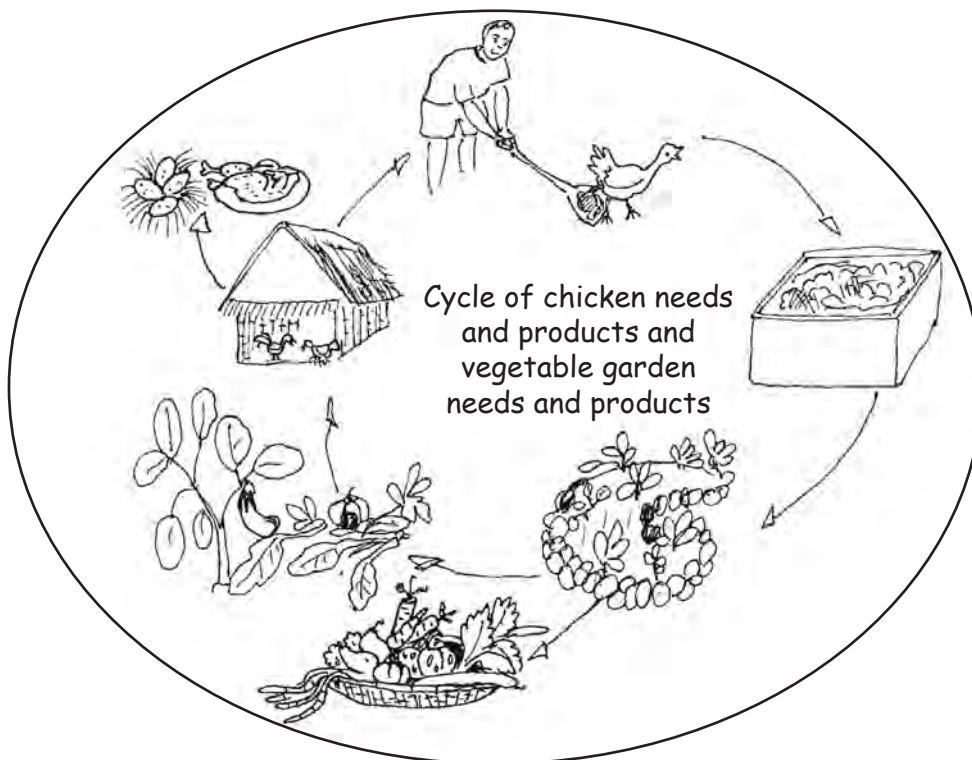
For example, chicken food can come from:

- * Food waste after cooking (product from garden via house.)
- * Weeds from garden (product from garden)
- * Pruning from trees (product of garden – living fence, shade trees windbreak)
- * Rotten food (product from house and garden)
- * Diseased plants (product from garden: giving them to chickens will stop disease spreading)
- * Chickens foraging for insects and bugs (product of building chicken yard)



Chicken products can then be used as needs in different systems:

- * Eggs, meat, money – need for people.
- * Feathers – need for cultural ceremony, making brooms, bedding material.
- * Manure – need for compost and liquid compost for vegetable gardens and fruit trees.
- * Work – need for chicken yard management.



Sometimes many needs can come from the same source.

For example trees around a chicken yard can produce:

- | | |
|--------------------------------|---|
| * Food for people | * Food for chickens from leaves, kitchen waste and rotten fruit |
| * Shade | * Windbreak |
| * Medicine | * Fence posts. |
| * Mulch for vegetable gardens. | |



We can make Needs and Products analyses for anything at all!

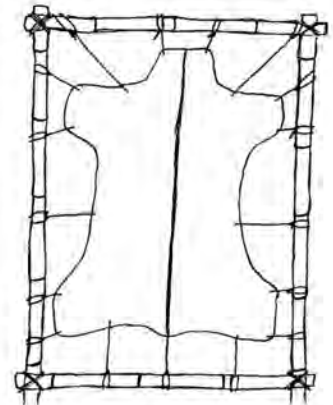
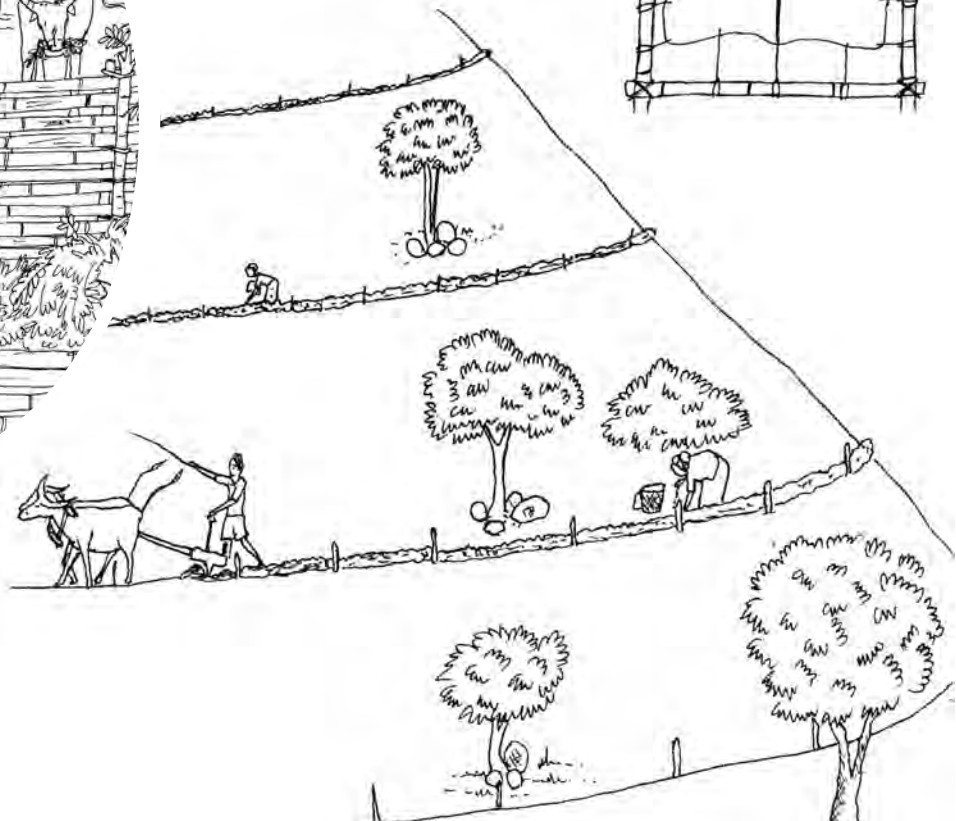
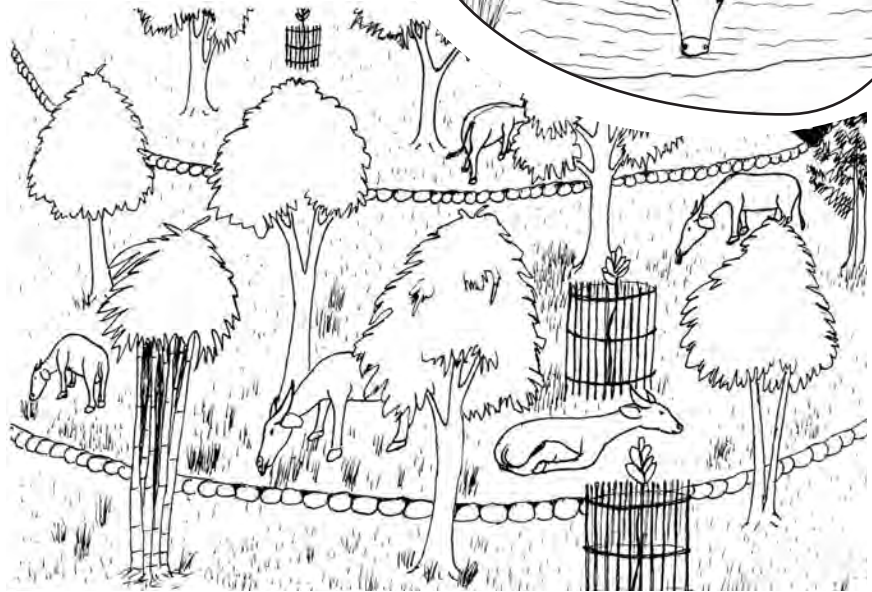
Try one on your friends or family!

BUFFALO - NEEDS

- Feed
- Water
- Shelter
- Grazing area
- Medicine
- Plough – for work
- Training – for work
- Rope
- Waterhole

BUFFALO - PRODUCTS

- Meat
- Money
- Manure
- Grass, weed control
- Horns
- Field ploughing work
- Rice paddy ploughing and fertilizing
- Leather



3: Zones

Creating a ZONE map can greatly reduce amount of time used and labour needed to create a permaculture system. It helps to show how to combine compatible elements and make the most of the land in the most efficient way.

To create a zone map you look at the farm as a series of 5 zones. The zones start at the house. Each zone represents a different area in the system. The elements are placed in each zone according to:

- How often that element is visited:** Zone 1 – most visited to Zone 5 – least visited
- How much maintenance is required:** Zone 1 – most maintenance to Zone 5 – least maintenance
- Access to water supply:** Zone 1 requires more access to water, to Zone 5 – requires less access
- The amount of land area that is needed:** Zone 1 – use less land to Zone 5 – use more land
- Their compatibility with the land.**
- Their compatibility with other elements around them.**

Examples of Zone 1 elements

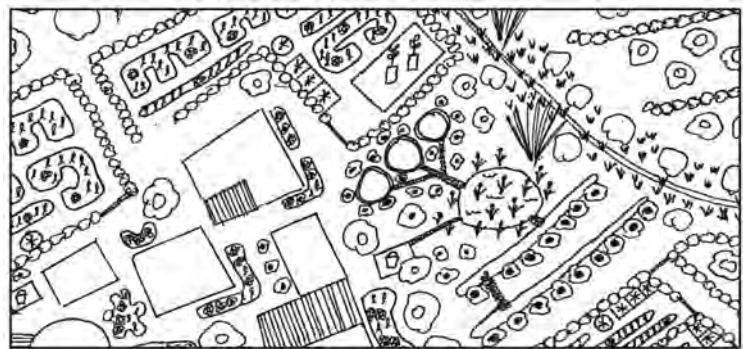


Zone 1

Zone 1 is the house and immediate surrounds. In Zone 1 we place the elements that are most attended, require most maintenance and provide household functions.

Elements that we would place in Zone 1 include:

- House, kitchen, washroom, toilet
- Nursery
- Pergolas and vines
- Small household gardens
- A few shade/fruit trees
- Water pump
- Compost
- Water tank
- Waste water pond



Zone 1 on your map

Now that you have elements in zone 1 the important task is to place them properly together.

Some shade for the house from the afternoon sun is welcome, but too much shade for vegetable plots will reduce production.

The water pump should not be placed near the toilet to stop water contamination from the toilet.

A pergola can be attached to the house. It can be used for growing vines and it will provide a shady, cool area outside. On the sun setting (western) side for hot areas, and on the sun rising (eastern) side in the colder mountain areas. Importantly it will keep the house cooler as well by reducing direct sunlight.

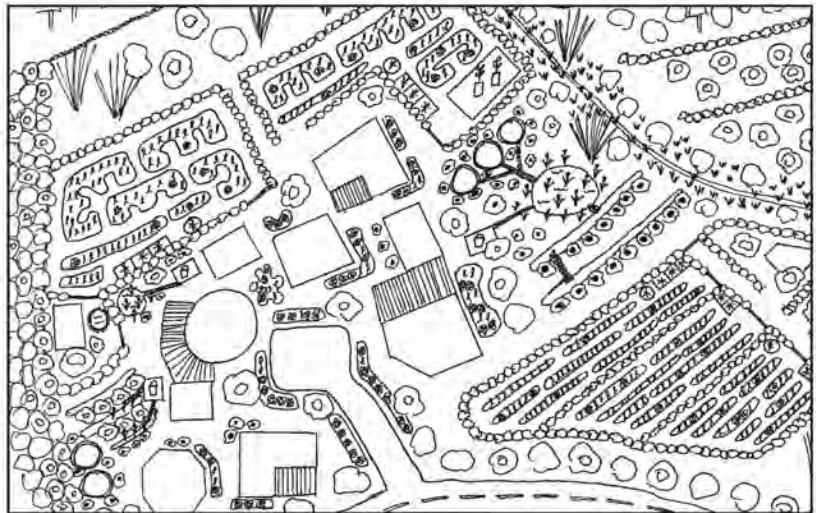
The idea is that those elements that share needs or that use what another element provides are placed together. Therefore the benefits are maximized and labour and time are minimized. The same idea is used for all the zones and from one zone to another as well.

Zone 2

Zone 2 is where we place elements that are fairly intensive, requiring frequent visits and maintenance.

Zone 2 elements include:

- Extensive vegetable gardens and crops
- Orchards and special fruit trees E.g. grafted trees
- Small animal systems E.g. chickens, ducks and even pigs
- Aquaculture (small scale)
- Compost and liquid compost
- Terracing



Zone 1 and 2 on your map

Zone 1 and Zone 2 should also have an emphasis on beauty in the design because it is close to and includes the house.

The designs also need to be based on reducing heavy work such as carrying water, transporting produce, transporting compost and manure, etc.

Zone 3

Zone 3 requires less maintenance and visits and needs more land; therefore it is further away from the house.

Zone 3 elements include:

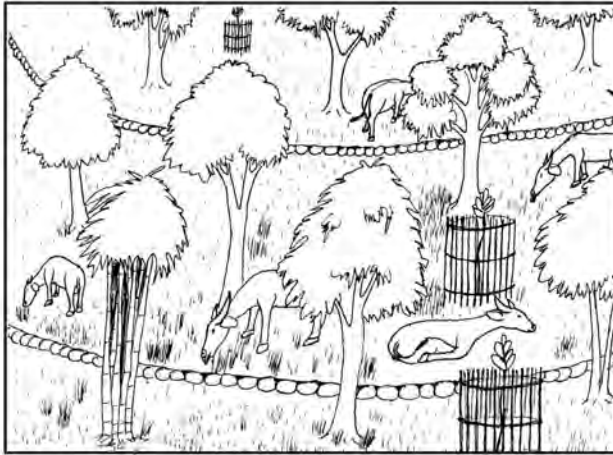
- Larger animal grazing and housing. e.g. goats, pigs, cows and buffalos.
- Large vegetable and grain crops. e.g. rice, corn, cassava and sweet potatoes.
- Fruit trees that require less work and have a shorter harvest time e.g. Avocados, coconuts and jackfruit
- Intensive reforestation with swales, growing crops, fruit and nut trees, legumes, bamboos and so on
- Windbreaks and firebreaks
- Bamboos
- Aquaculture
- Liquid compost
- Animal fodder trees

Some examples of zone 3 elements



Zone 4

Zone 4 requires a very small amount of maintenance and attention, which means minimal water and feeding. And it requires more land area. It includes tree crops, which if planted in Zone 1, 2 or 3, would decrease productivity of the other crops grown. This is because of shade and competition for water and nutrients through the roots.



Some examples of zone 4 elements

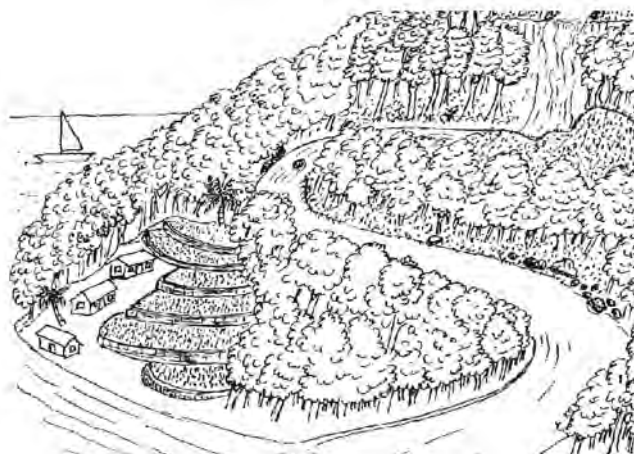
Zone 4 elements include:

- * Nut trees
- * Firewood trees.
- * Timber trees.
- * Bamboo.
- * Buffalo, cows, goats.
- * Large water bodies
- * Oil trees
- * Coffee plantations.
- * Medicine trees.
- * Animal fodder trees.
- * Rice paddies if water source.
- * Swale reforestation with trees crops



Zone 5

Zone 5 is land that will be left untouched. This zone is very important especially as Timor Leste has lost so much of its natural forest already. Natural forests provide many functions such as food and medicine for humans, food and habitat for native animals, hunting and erosion protection.



some examples of zone 4 & 5 elements

Zone 5 is usually furthest away from the house and can be on land that is difficult to use for more intensive cultivation. For example steep slopes, eroded waterways and mountains and rocky ground.

Plants that are grown in Zone 5 should be native trees, and a variety of sizes, ages and species.

Zone 4 and 5 land will often be community land. Therefore the best way to look after it is by going through community process. A Tara Bandu ceremony is an excellent community way of protecting land and its resources. Community decisions also lead to greater understanding for everyone in the community.

Different situations that can affect how land is zoned include:

- Access to water. If there is access to a spring or to irrigated water then the land holds many more possibilities for more intensive crops, fruit trees or animal systems.
- Access to roads. If the land is easily accessible by road then produce can be easily transported. Therefore larger crops will not go to waste. If not, can a shared road be built or access be made?
- Amount of erosion. If erosion already exists or the ground is very steep then the soil must be stabilized with terracing or swales or trees before intensive agriculture can be attempted.
- Soil quality and amount of rocks. Very poor soils and very rocky soils either must have a lot of work over years to create fertile soils or tree crops should be the main production focus. Usually it is better and easier to establish tree crops then slowly work on small areas for crops and vegetables. The leaves and branches, the result of pruning the tree crops will help the cropland to improve a lot quicker.



SMART IDEAS:

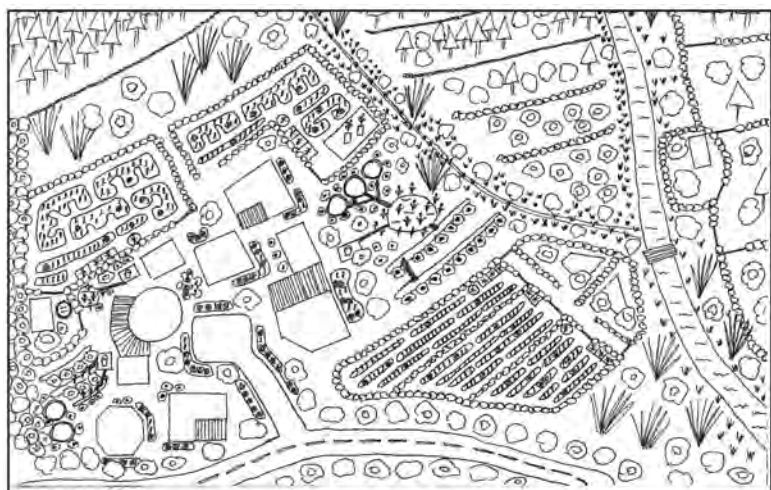
> Some elements could be in many zones. E.g. corn, pigs, citrus. This depends on:

1. Land. Soil quality, size of land.
2. Type of technique or strategy used.
3. Which elements are cash crops and which are for food, trade or family use?
4. Integration possibilities with other elements.

> Pathways are very important because they can connect zones in efficient ways. They provide location points for liquid compost, animal houses and water access. All pathways can be bordered with plants and production. The path borders can be small garden plots, flowers, herbs, vines and small fruit trees in zone 1 and 2 to low maintenance fruit and trees in the outer zones. This makes use of otherwise non-productive but easy to access land and makes the farm more beautiful!



> Zones can be implemented on a community or village level as well. This idea can help to reduce time, costs and resources for everyone. If the farms are working together then production can be more efficient, resources can be re-used and shared, and everyone benefits



Community Land Management

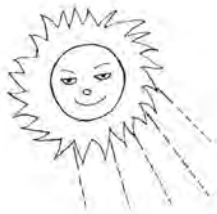
Exercise: draw a zone map with only basic zone outlines. Draw and cut out different elements (e.g.house, vegetable garden, chicken yard, pond, etc, etc) from separate paper. Take turns at placing the elements in different ways on the map to design your own farm... explain how the placed elements connect with each other.

4: Sectors

SECTORS look at the natural factors that affect the land and that affect the levels of production from the land. Natural factors are sun, wind, water flow and flooding potential, fire, slopes, soil types and sacred and cursed land. Sector planning is made to channel these natural factors into or out of the system.

The knowledge gained from understanding the effects of natural factors leads to planning that will:

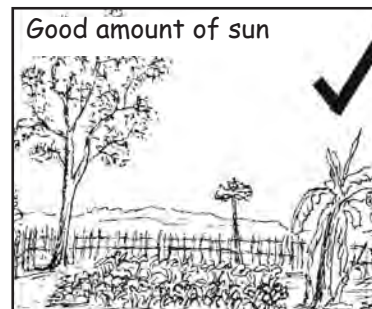
- Help to maximize yields.
- Reduce mistakes made. E.g. planting crops or trees that get washed away after heavy rains and the following flooding.
- Make the farm more resilient and able to deal with disasters and extreme conditions. E.g. fire, flooding, erosion.



A: Sun

Question: direction of the sun is important. By observing its path during the day you will find where the maximum and minimum sun exposure areas are. Remember that this changes from wet season (higher arc in the sky) to dry season (lower arc in the sky).

Answer: use the areas of maximum sun exposure first and for the most important crops. For reforestation work it is also important to establish the best areas first. Areas of semi shade are better suited for animals. Some crops, like coffee and vanilla grow better in semi shade.

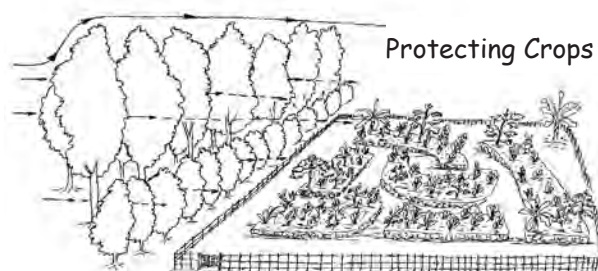
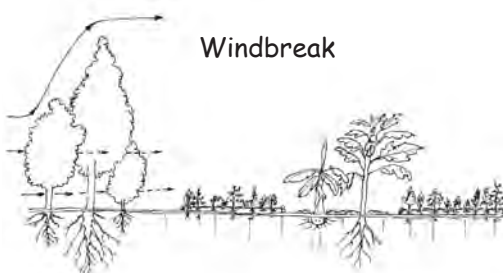


B: Wind



Question: Where does the wind usually come from and how strong is it? How often is it strong? Wind can greatly reduce growth of plants and increase water use.

Answer: plant wind breaks in appropriate areas to protect crops, animals, aquaculture and house area. Only plant tough trees in very exposed areas because the wind and sun will dry out and damage or kill many trees.



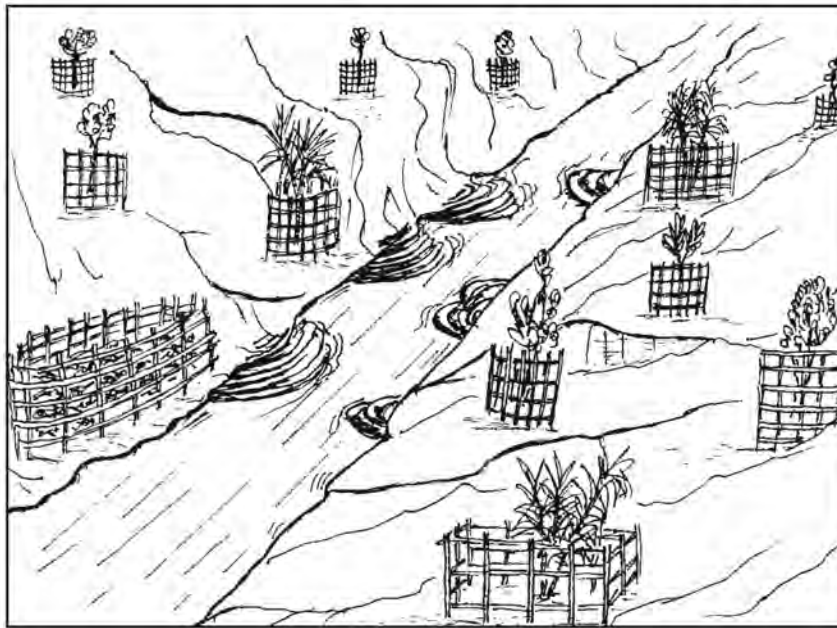
C: Water Flow

Question: Where does the water flow through the land? Are there any springs? Are there areas of erosion?

Answer: Natural water courses and springs are important to protect by planting trees and vegetation to prevent erosion. Water usage and collection points can be established and irrigation (metal/bamboo pipes, rocked trench) can be established to channel water.

Erosion and potential erosion can be repaired using swaling and tree planting. (Look in the Reforestation chapter (CH 7) for detailed explanation of swales). This also prevents potential mudslides and large-scale erosion which if unchecked will be a huge problem in Timor Leste in years to come.

Remember that every time erosion happens, valuable soil for crops is lost and the chance of mudslides increases. Erosion will also cause problems down the river and in the ocean.



Repairing eroded waterway

D: Flooding

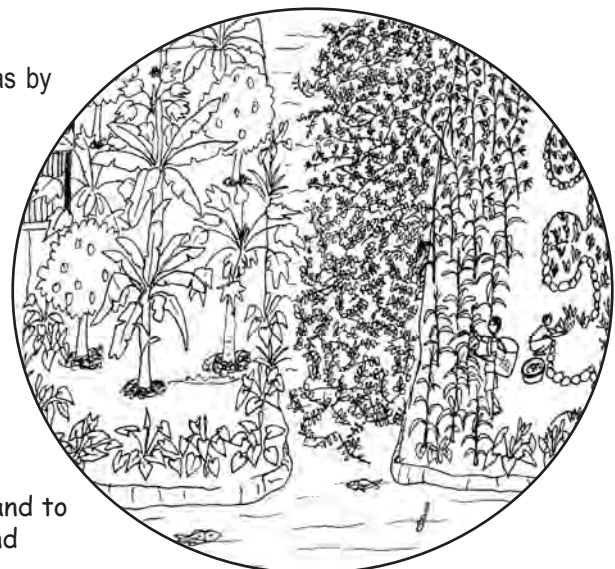
Question: Are there any areas of the land that flood with high rainfall? Also look for naturally swampy areas and places along water courses that show evidence of overflow.

Answer: Observe where the water comes from and protect these areas from erosion and landslides. The best way to reduce flooding and to reduce the amount of water run off is to use swales, terraces and reforestation to STORE as much water in the land as possible.

Take advantage of naturally swampy and flood prone areas by growing compatible crops.

For example rice paddies, kangkung, cress and taro can all be grown. Ducks, fish and freshwater prawns systems could be introduced. This way water can be stored and used and the overflow can be regulated.

Water channels can be used to reduce extreme flooding. Look at the Aquaculture chapter for many more ideas.



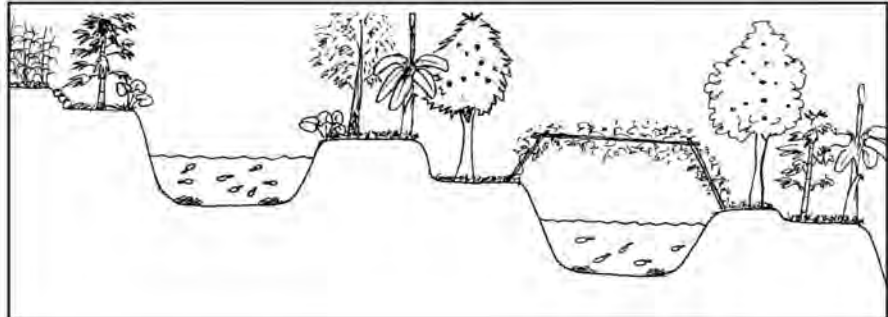
Changing swamp land to productive land

E: Slopes

Question: How steep are the slopes on the land? How can the soil be protected and how can the slopes be used to benefit production?

Answer: As with flooding, catching and storing water in the ground will improve sloped agriculture production and protect the soil. Different techniques such as swales and terracing can be used. Gravity can be used to irrigate both naturally using swales or with piping, bamboo or hoses. Gravity can also be used to run water into aquaculture systems or water catchments.

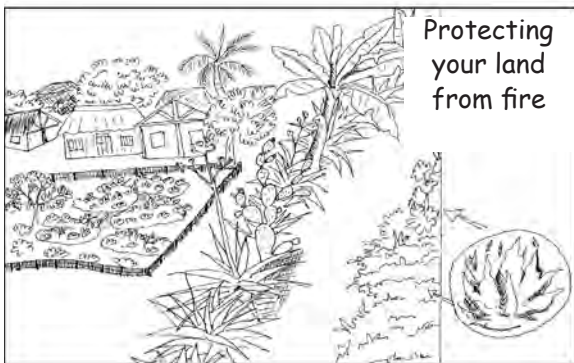
Using slopes to increase yield



F: Fire

Question: What direction is fire most likely to come from? Usually fire will move fastest going up the slope and from the direction that the wind comes from most often.

Answer: Planting a firebreak, 2 or 3 rows of fire resistant trees in long lines with a cleared gap on either side (like a wall or fence), will help to reduce or stop a fire from spreading. Bananas, Papayas, Fig, Cactus, etc. This should be planted in the area that the fire comes from. A firebreak can also be multifunctional in that it also provides food, wood and other resources.



Firebreaks are very important to help protect buildings and animal housing, orchards, vegetable plots and other intensive agriculture areas.

A very important part of fire management is talking to neighbors about fire and cooperating with them. Having community meetings about stopping burning, encouraging alternatives to burning and compensation for fires spreading from one property to another should be considered.

G: Soil Types

Question: Are there different types in soil on the land? Are there differences in the depth of topsoil? Areas that are rocky, swampy or salty should be noted and treated differently.

Answer: look at the soil types section in the Soils Chapter (**CH 4**) and test your soil types to find out what soils you have. You can also test the PH of the soil (acidity or alkalinity) using a PH tester. (**see CH 4**) Try to use the best soil areas for your most important crops but remember not to plant high maintenance crops too far away as this will cost time and labour. All soils can be improved and turned into productive, healthy soils if good management is used. Use tough trees for rocky and salty areas, and water loving plants for swampy areas and think of long-term ideas that can make these areas productive.

H: Sacred or Cursed Land

Question: Are there any sacred or cursed areas on your land, and will this affect what can be done to the land?

Answer: Talk to the Liurai and Chefe about the best way to use the land, heal the land, or if the land should be left untouched.



5. Observation and data collection

When you are making a plan for your land, observation is very important and should be the first step when considering what the land can be used for. Using observation we can see how the natural elements affect the land. For example the same variety of tree will grow differently in one area to another. Is this because of the amount of water available, different soil depths, different soil types, wind exposure, amount of sun or another factor? Investigation will tell us and help us to make a better plan.

Nature gives signs that we can look out for such as:

- Fleshy leaf plants and reeds will grow better where water is present.
- If there is a prevailing wind, then the tall trees will all grow leaning in the opposite direction.
- If the wind is often strong the trees will be smaller and stunted.
- Yellowing of all leaves and new growth, and early maturing and small size of fruit or flower are all signs that nitrogen is deficient in the soil. (See soil chapter (CH 4) for more)



When you observe and work with nature you will waste less time and resources.

Local Knowledge

Local knowledge is always an important source of information. Here in Timor so much information is passed on verbally and not written down. Finding out as much as possible about climate, natural factors, what grows well and what used to grow will help to reduce mistakes made. The elders in the community are the best sources of information. This kind of information can also be very important when planning for extremes of weather.

Local Government

The government agricultural workers can help to provide information and support. Information about government projects, weather patterns, seeds and plants, techniques and about what support is available can all help. Setting up a farmers' group will help to make the most of any information and support.



Other sources of information are NGO's (Non Government Organizations), agriculture schools, radio, books, universities and computer internet.

Set up farmer and community groups and seed saving groups as resource bases. Other support groups, such as women's groups, are also very important.

Representatives can work with wider representative groups, such as Hasatil, and with the Government. This will help to maximize benefits of information and support. Sustainability will be improved and the whole community will benefit.

Intuition

Using your intuition should be a part of every decision making process.

Intuition is about sensing or instinctively knowing what to do and when to do it. It comes from trusting in yourself and from past experiences and knowledge of your own, your family, and community. It also comes from your spirit.

It is very important to look at all the facts and details, especially with technical work, but it is also important to follow your intuition.

Intuition allows for more new ideas, more creativity and more flexibility, and will make any project more beautiful.



SMART IDEAS:

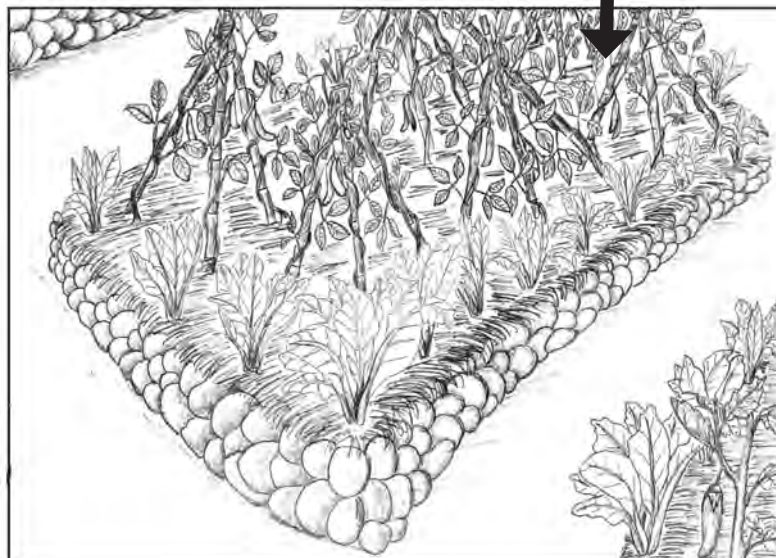
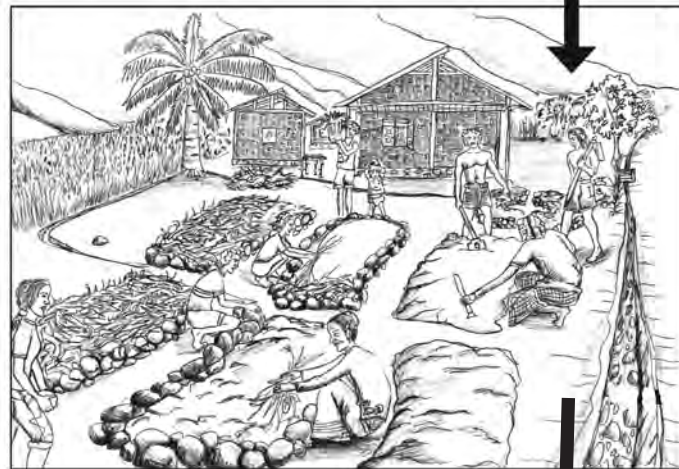
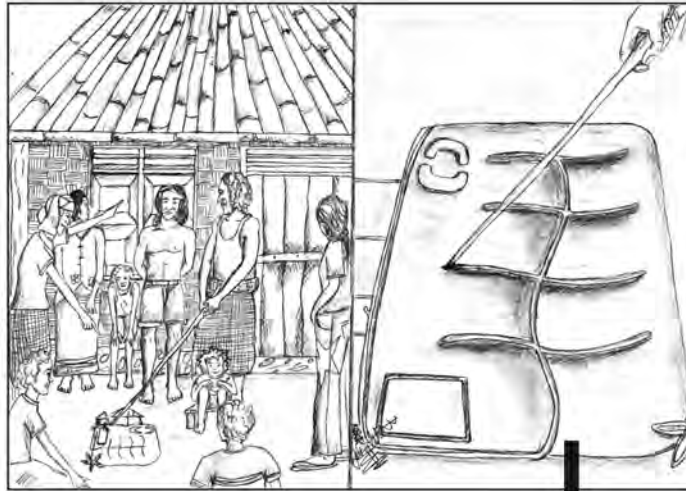
- All plans and designs must be designed particularly for the people who do the work. And all planning and designing must be done by or including the people who do the work.

This means that women and children must be part of the planning process, especially in Zone 1 and 2 where women do much of the work and children help a lot too. This will greatly reduce the chance of mistakes being made and inappropriate designs that may increase work and time needed rather than reduce it.

- Bringing together all available information and making plans and maps have many benefits, both for now and the future. Remember that plans and maps will change after 1, 2 and even 10 years.

This happens as you learn more, use better techniques, have successes and make mistakes. This is GOOD! Everyone makes mistakes, and can learn from them and make better plans.

- **Planning ahead will help us look to the future, for the children and for an abundant Timor.**





Houses & Water Supply

CHAPTER





Everything is connected to everything else. This is a principle that is very important to remember for creating sustainable agriculture systems. You can work with it, to your future benefit or ignore it, to your future detriment. This principle is also true for the house and living area. This area includes the kitchen, washroom and toilet. It is part of the land around it.

Every house is affected by the land and environment around it.

Examples:

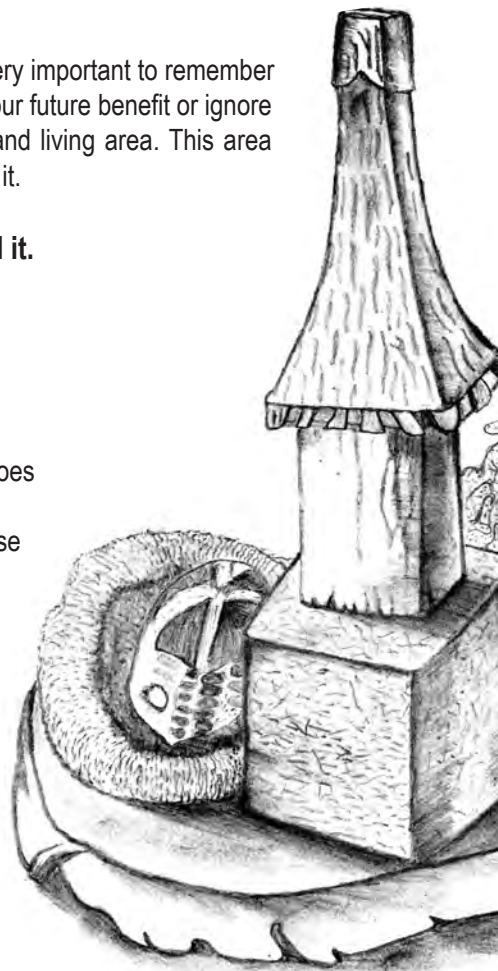
- Rainfall, erosion, floods, mudslides
- Wind
- Temperature
- Soil type, rocks, trees
- Water supply
- Diseases from mosquitoes

All these factors can be addressed to reduce work, improve the house and living environment and reduce or prevent problems in the future.

Every house also affects the environment around it.

Examples:

- **Using resources** – food, water, firewood or cooking fuel, building materials, medicines, electricity, transport, cleaning materials etc
- **Creating smoke, rubbish, dirty water, human waste, disease problems**
- **Agricultural practices** – vegetable gardens, animals, large crops



It is essential for the future of East Timor to reduce the negative impact on the environment as much as possible.

- Reduce how many polluting materials are used. E.g. plastic bags, firewood.
- Reduce much pollution is produced. E.g. burning.
- Re-use waste that is produced. E.g. human waste, leaves.
- Clean dirty water of pollutants before it returns to the rivers.

Community ideas

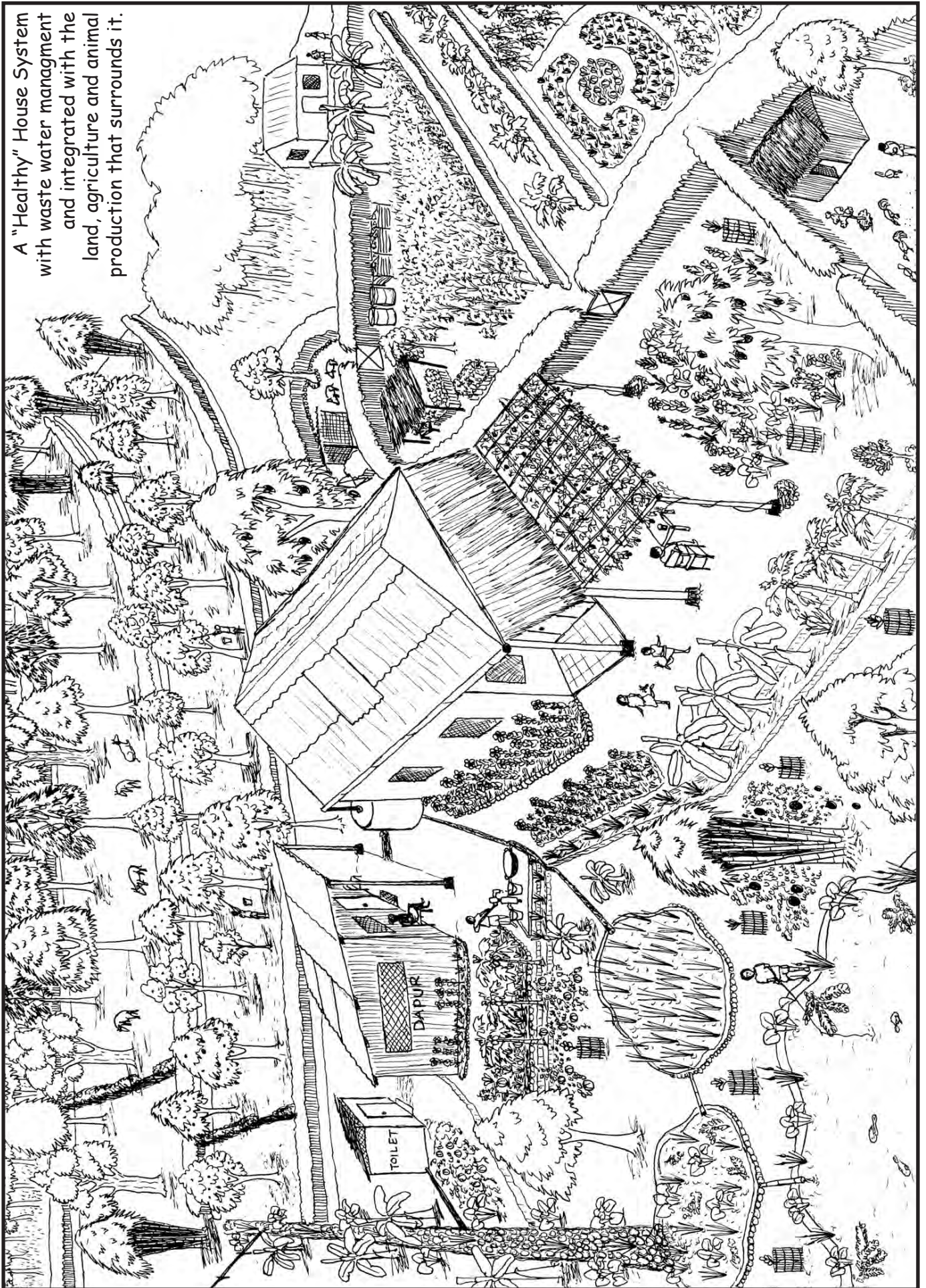
Each individual family can improve the house and living areas. But there are many ideas for improving the house and living area that can be organized, applied and managed on a community level. Many improvements will be better, cheaper and easier to maintain if the community works together.

This can be achieved through the process of community meetings and agreement. It is important that everyone can have input and that everyone in the village understands and has ownership of community improving projects. It is also important to work with the government to improve the situation at a community, district and national level.

This chapter will explain

- 1. How to create a house area that is comfortable, healthy, functional, and that minimizes resource use and costs. E.g. improving water supply, using windbreaks, improving natural light and ventilation.**
- 2. How to clean and dispose of waste and if possible turn house waste into useful products. E.g. cleaning and re-using water, compost toilets and showers.**
- 3. How to make more use of natural resources and how to make them last longer. E.g. building with rocks, clay or earth, treating bamboo to kill borers.**
- 4. Family, community and national ideas for improving the house and living areas.**

A "Healthy" House System with waste water management and integrated with the land, agriculture and animal production that surrounds it.



How do you create a healthy house?

A healthy house is practical, long lasting house that uses minimal energy makes living easier and better and reduces costs. It is also important to have a house to be proud of. A house that looks beautiful inside and outside. These can be combined.

Making your house better doesn't have to cost more money. In fact many ways to improve house and living quality will save money and also provide extra resources for your garden and animals. E.g. fertilizer for fruit trees, water for vegetables, food for animals, less firewood to buy.

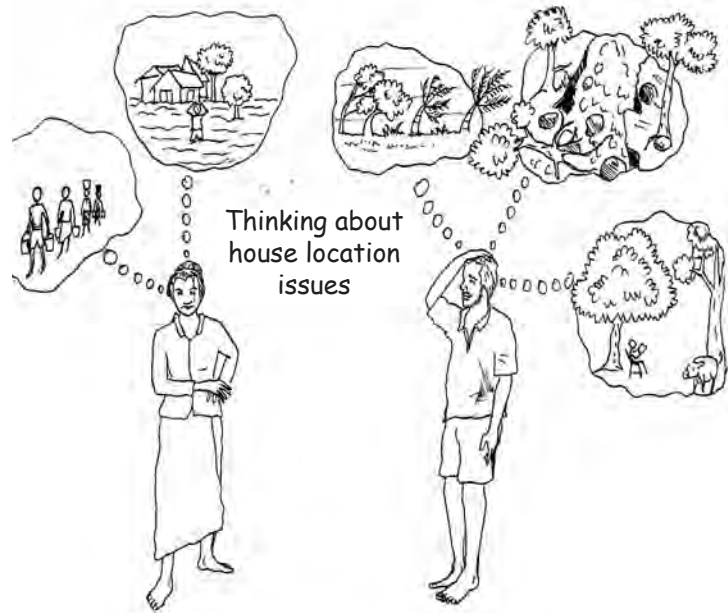
When you build a house or improve an existing house, there are some important factors to apply.

1. House Location

Build the house in a good location. This can also be considered as a community.

Think about:

- Possibility of mudslides coming from above
- Possibility of floods. It only needs to flood once in 5 or 10 years to destroy the house, animals, crops and even people
- Where do strong winds come from?
- Where is the closest water source?
- How much sunlight is there? Are there any shade trees?



Often it is not possible to have a lot of choice on where to build the house. But there are many ways to reduce the chance of problems and make the house area better and more comfortable. E.g. windbreak to reduce strong winds, pipes or bamboo to bring water.

2. Reduce risks

- **Stop erosion and reduce chance of mudslides.** Above the house, swales can be made to catch the water and soil. It is best in this situation to make the water slowly run to one side, away from the house. This water can then be caught and re-used below the house in ponds, banana pits or vegetable gardens. It is most important to plant trees straight away and to protect them. Grasses and bamboo will also help to hold the soil.



- **Reduce chance of flooding.** Reafforestation of East Timor's mountains and along the riverbanks is the best long-term solution to reduce flooding risk. But sometimes flooding will still naturally occur.
- **Reduce the chance of fire.** Close to the house can be kept clear. Fires go much faster up hill and with the wind. Use firebreaks (in CH 2) if fires are a risk.
- **Reduce Damage to houses from very strong winds.** Don't build on top of hills if possible and plant trees to create windbreaks.

Community Idea: Preventing Disasters

Preventing disasters is a family, community and national issue. As a community rivers and river banks must be protected to reduce flooding risks. Trees, bamboos and grasses along the river banks will reduce erosion and flooding risks. Reafforestation of community land will reduce landslide risks. Productive trees and bamboos can be used. Tara Bandu ceremonies will protect community land trees.



3. Suitable for climate

There are many different climates in East Timor. A house should be designed to be suitable to the area where it is built. Mountain areas like Maubissi and Ossu get very cold at night. Bricks, rock or mud brick is best to stay warm at night. A house that can be closed up to keep heat inside is important.

Coastal areas, especially the north coast stays hot, so materials like bamboo, bebek panels and a grass roof will stay much cooler than cement blocks. An open house with an outdoor living area and airflow will be much more comfortable. Opening windows are important too. However, security is an issue, especially in Dili, so any plans need to include lockable rooms.





Areas like Aileu, Baucau, Los Palos, Maliana and many others are in the middle so a house can combine rooms that stay warm with open areas as well. All areas get hot so outdoor shade structures will improve the house area a lot. Trees around the house can improve the climate a lot by providing shade, reducing winds and cooling the air.



Rendering clay bricks

4. Good health and disease prevention

A lot of sickness and disease that happens in East Timor can be reduced or prevented by a well-designed and well-built house area. This is especially true in the kitchen.

Problem	Solution
 <p>Smoke causes chest and breathing problems and can cause tuberculosis</p>	<ul style="list-style-type: none"> • Good ventilation in kitchen • Smoke chimney (pipe) • Minimal smoke producing stoves & ovens • Use gas
 <p>Mosquitoes cause Malaria, Dengue fever and many other sicknesses. They breed in still water</p>	<ul style="list-style-type: none"> • Don't let water lay in pools • Cover any tanks or washroom water • Screens on windows • Mosquito nets for sleeping
 <p>Diseases can be spread because of dirty washing area</p>	<ul style="list-style-type: none"> • A well-built washing area that is easy to keep clean • Fast drainage of washing water • A simple filter system to clean washing water
 <p>Diseases can be spread because of open, dirty toilets</p>	<ul style="list-style-type: none"> • Composting toilets and toilet rooms prevent animals and insects from eating/touching human manure • Using toilets instead of rivers • Good toilet hygiene
<p>Mice, rats, dogs, cats, cockroaches, flies etc can spread diseases, especially if they eat food or manure</p>	<ul style="list-style-type: none"> • Keep all food in containers or bags that prevent pests from entering • Prevent animals entering kitchen • Build easy to clean house • Wash hands before meals
<p>Mould and damp walls can cause chest infections and breathing problems</p>	<ul style="list-style-type: none"> • Dry floors and living area • A roof that doesn't leak • Keep rain away from walls • Good ventilation
<p>Burning rubbish produces smoke that can cause many health problems.</p>	<ul style="list-style-type: none"> • Recycle as much rubbish as possible • Burn the rest in special area away from the house and children

All of the solutions are explained, with diagrams, later in the chapter.

5. A House that is easy to clean

A house that is easy to clean will reduce work and improve health. Easier cleaning will benefit the whole family. A cement or stone and cement floor will make the floor easier to clean and better for health. Walkways made from small or large stones between kitchen, house, washroom and toilet will reduce dirt and mud and reduce disease risks.

6. Waste management

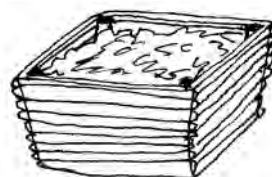
Waste includes food scraps, used water, human manure and urine, plastic, paper, tins, cans, bottles, smoke, ash, leaves, batteries, old car and motorbike parts, old oil, old metal, etc.

But waste is also the rubbish and pollution that is created when products are made and transported (e.g. food from Indonesia, plastic toys etc) and when energy is created. (e.g. smoke from diesel generators) We contribute to this when we buy products and use energy.

A well-designed house will reduce the amount of waste that is produced. Being responsible with what you buy and use will benefit East Timor's future generations and help protect the environment.

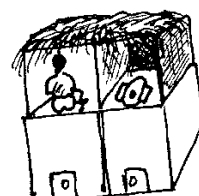
Use this idea:

- 1st - reduce the waste that is created
- 2nd - re-use or recycle what you can
- 3rd - responsible disposal



Good waste management is separating the waste and turning most of it into products

- Leaves are valuable mulch and fertilizer for vegetables
- Food scraps can be fed to animals.
- * Used water is run to the garden via water trenches
- Compost washrooms turn water into bananas
- Compost toilets turn human manure into fertilizer
- Wood ash is excellent for composts and liquid composts
- Plastic containers can store seeds
- * Aqua bottles have many uses
- Tins make good seedling containers and watering cans
- Paper can be added into compost pits
- Glass bottles can be cleaned and used to store honey, oils, palm spirit, etc
- Old tyres, cans, broken buckets etc can be used in a nursery for seedling containers or for flower containers
- Old plastic bags can be re-used. When they have holes they can even be woven together to make strong carry bags!!



Bad waste management is burning everything, letting animals eat human manure and letting used water lay on the ground.

Even worse waste management is to dump rubbish in rivers! It makes pollution in the rivers and oceans and creates big problems for the future. It also looks ugly and spoils East Timor's beautiful environment.



Burning waste



Some waste will still be burned. If rubbish, especially plastic, is burned quickly at a high heat it creates a lot less smoke and is much better for people and the environment. A circle of rocks made into a burning area will provide a place where rubbish can be burned. Put the rubbish into plastic bags and store it in the burning area until it can all be burned at once. This creates the heat and reduces smoke and pollution.

- * Cover the top until it is burned to stop dogs from entering
- * Leave holes in the rocks to let air through to help it burn quickly at a high temperature
- * Make the rock circle away from the house



Rock burning circle
- view from above

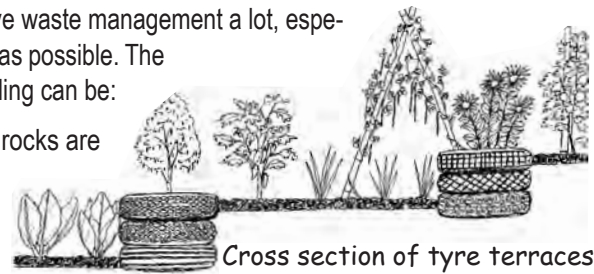
DON'T let children stand near the smoke and breathe it in. It is poisonous!

Community and Government Ideas

Waste dumps

There will soon be waste dumps in every district. They will improve waste management a lot, especially from towns. But first, separate and recycle as much rubbish as possible. The rest can then go to the waste dump. On a community level, recycling can be:

- Using old tyres to make terraces. Use in the same way that rocks are used to make a rock swale. Trees can be planted below or even inside the tyres.
- Making compost from all the leaves, manure, etc.



Cross section of tyre terraces

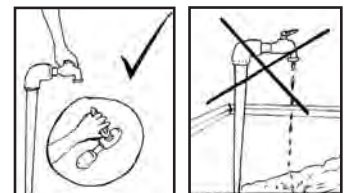
In small villages and communities for the rubbish that is burned, a community burning area can be made to reduce smoke and environment problems. This is made from large rocks or coral, the same as for families but larger. Make a circle about 2 metres wide and 1 metre high. It is important for government and communities to think about the future and start working towards proper storage and recycling of waste:

- Toxic waste such as used car oil, batteries, tyres, medical waste, etc
- Glass bottles, tins
- Scrap metal
- Plastic

This will slowly replace burning. But remember that the best way to deal with waste is to not create it in the first place! Use natural, local materials instead whenever possible.

7. Reduce water and energy use

Water is a precious resource that is often hard work to collect. This chapter explains many ideas for collecting and storing water, but it is better to use less water in the first place. Even in towns and villages with pipe water it is very important to use only what is needed to make sure that there is enough for the future.



Water saving ideas for households

- Always turn off taps after use. You can use spring taps that turn themselves off
- Make a composting toilet because it uses much less water
- Re-use all the kitchen and washing water in the vegetable garden
- Use buckets and sinks for washing, don't leave the water on continually while washing



Energy is the fuel needed for the house. Wood, kerosene, electricity, generators, gas petrol, oil and even candles all provide energy for cooking, lights, music, cars and more. Oil and petrol is expensive and will get more and more expensive, and the supply will not last forever.

It is very important that people all over the world reduce energy use and change to using renewable energy. Some types of renewable energy that can be used in East Timor are solar panels, micro-hydro generators, bio-gas generators and wind generators. These are explained in the Alternative Technology Chapter (CH 14).

This chapter looks at how to reduce the amount of energy you need to use with good house design. Good ventilation, natural light, insulation, good house design and smart use of building materials all help to reduce the amount of electricity used.

Most important is using stoves and ovens that use less or no wood, or using gas. East Timor's trees are being used very quickly and are being cut down much, much faster than they are being planted. It is already a big problem for the environment, and it will get much worse unless changes are made.

There are places in the world now where people have to walk all day just to collect firewood. Is this the future of East Timor?



Cooking stoves that use little or no wood

8. A long lasting House

Wood, bamboo, beak panels, grass and other natural materials are cheap and cool but often will only last 4 or 5 years, and sometimes less. They then need to be replaced. However, by curing the materials and by choosing the right types of materials, especially for bamboos, they will last years longer. Reducing rotting by keeping the ground dry also helps to increase the long life of the materials. Stone or clay will last much longer than cement blocks. By covering stone, cement blocks, clay and other building materials with a render they will last much longer. A render is a mix of different materials, which covers the wall with a thin layer to protect the wall. Clay, sand, cement, cow manure, rotten milk, lime and water are examples of materials used in different countries. It is common in East Timor on cement block walls. Read further on in this chapter for techniques.

Building a house

Start with a plan

Use the factors above as guidelines to help make the plan. Include all the family in the planning process to be able to address all the needs. Women spend much more time around the house and therefore will have a much better idea of how the house needs can be met, and how to deal with health issues and cleanliness. This also includes materials used and how to make the house more beautiful. If these needs are met it will save time and effort and improve lives for all the family.

The plan for the house area should include trees, gardens, outdoor living areas, shade structures etc. E.g. a shade structure for growing vines will cool the house, provide a outdoor sitting area and can provide food like grapes or passionfruit.

House designs

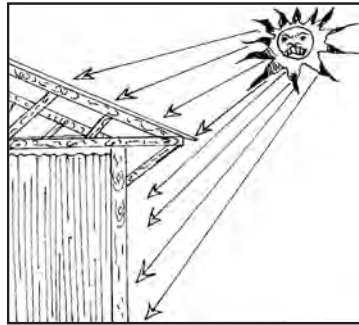
Each district and even sub-district has their own designs for their traditional houses. These houses reflect the climate and the materials available to build with. The cement brick houses are generally based on the Portuguese style or more recently, Indonesian style. They are sometimes not suited to the climate, especially on the coast. It is important to choose the materials that will suit the climate the most. But the design of the house shape and size will also make a big difference to the temperature, comfort, strength, durability and for disaster prevention. A change from the usual box shape house will also make it much more beautiful!



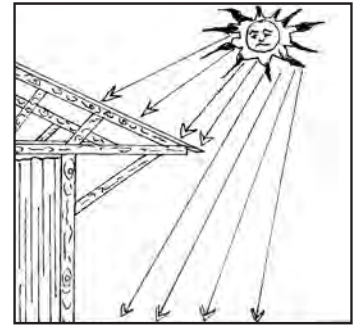


SMART IDEAS FOR HOUSE DESIGNS:

- A curved wall is stronger than a straight one! And it looks better too.
- A house can have indoor and outdoor living areas.
- Traditional houses can be combined with modern houses.
- Room placement is important. The rooms that face the afternoon sun will be the hottest in the house at night. E.g. a bedroom that gets the afternoon sun: In cold areas this is good, but not in the hot coastal areas.
- A verandah or shade structure built on the west side of the house (where the sun sets) will keep the house much cooler for night.
- A house can have an open ground area and raised house area above it on poles. This improves ventilation a lot and reduces flood risk. This is common in the Covalima district.
- A roof that is wider will reduce direct sun on the walls. This will cool the house a lot in hot areas.
- In strong wind areas, a 4-sided roof rather than 2-sided roof to help prevent wind damage. This is because the wind blows over the top instead of underneath, which can even lift the roof off!



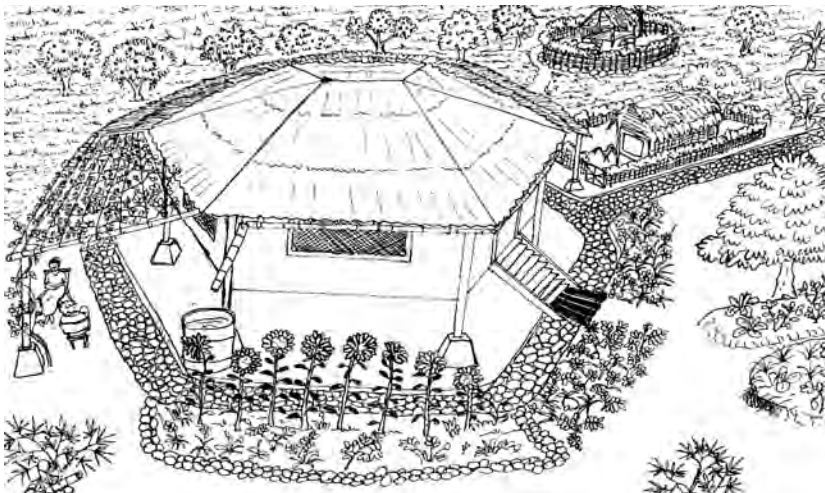
OR



OR



**Be creative
and
decorative
with the design.**



Future additions and changes can also be planned for. E.g. if you can only build a small house now because of materials available or money, you can include in the plans to build more rooms in the future.



House building materials

The most common house building materials in East Timor are wood, beak panels, bamboo, grass and palm leaves for traditional houses, and cement blocks, wood and tin metal for modern houses. These are very familiar and need no explanation of how to use them. Bamboo, clay and stone are also used traditionally and are excellent building materials if used properly. Some ideas and techniques for using them are explained simply but long and proper explanations are far too large to put in this book. Reference books, internet sites and NGOs that have experience and information on building materials and building designs are in the reference section.



Clay

If it is built properly a clay brick or clay wall house will last for many, many years. There are clay and mud brick houses in different countries that are 100 – 200 years old or more! In East Timor there are many areas that have excellent clay for building clay bricks and mud walls, and there are some clay built houses. Clay houses stay much cooler in the hot weather than cement block houses. But good ventilation is important during the day. The clay walls store some heat during the day. At night the clay walls will slowly release the heat that has been stored and naturally keep the house warmer. Clay houses are best for the areas in East Timor that are cold at night.

The clay can be used to make walls by using clay, water and some dry grass. The materials are mixed together and the wall is built by starting at the base and slowly adding more clay mixture. Or the clay can be used to make bricks. The bricks are made from a clay and water (A small amount of dry grass can also be used.) They are put into a mold and pressed, then the mold is removed and they are dried. It is a similar process to making cement blocks. Two other types of blocks are stabilized earth blocks and adobe blocks. Stabilized earth blocks are made from clay and earth and have 10% cement. Adobe blocks are made from garden soil and cut grass. Experiment, but don't try building with clay until you have a lot more information about how to make the bricks, walls or blocks. Look in the reference section.



SMART IDEAS:

- A render is essential for clay bricks and very important for a long lasting house and to improve insulation. Use some cow manure in the render to help protect the wall from insects and the weather. (and it doesn't smell when it is dry!)

- The roof of a clay house needs to hang over the walls to protect them from heavy rains.

Stone

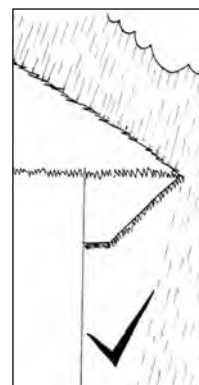
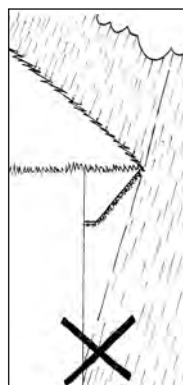
A stone house takes time to build but if built well will last a long, long, long time. Stone walls take a long time to heat up so will they stay cooler during the day. But they store heat very well, therefore the house will stay warmer at night. Another benefit is that stone can be easily combined with other building materials. There are plenty of good rocks to use in East Timor. The main problem is transport for the rocks.

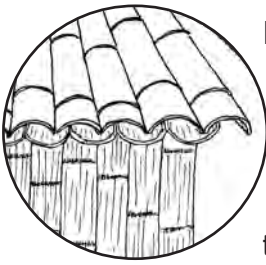


SMART IDEAS:

- DO NOT use the mortar to support the rocks and hold them in place. If you do then the wall will fall down in a few years or earlier. Only use it to fill in the gaps in the rocks.

- To use the benefits of the stone but reduce the costs and time for building the house only build the west wall (sun setting side) with rocks. This will help to keep the house cool in the afternoon and warmer at night.





Bamboo

Bamboo is already well known and used. It can be used for the roof, walls, outside pergolas, decorations, furniture and more.

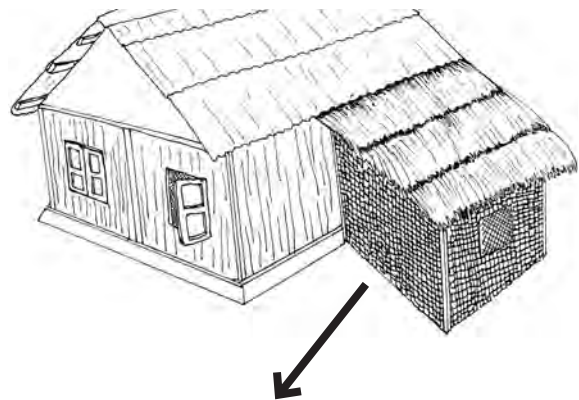
Bamboo is excellent for hot coastal areas because it gives good ventilation. It is also light but strong and easy to work with. Selecting the right type of bamboo, cutting at the right age, and curing it will make the bamboo last for many more years.

Look in the Bamboo Chapter (CH 8) for the information.

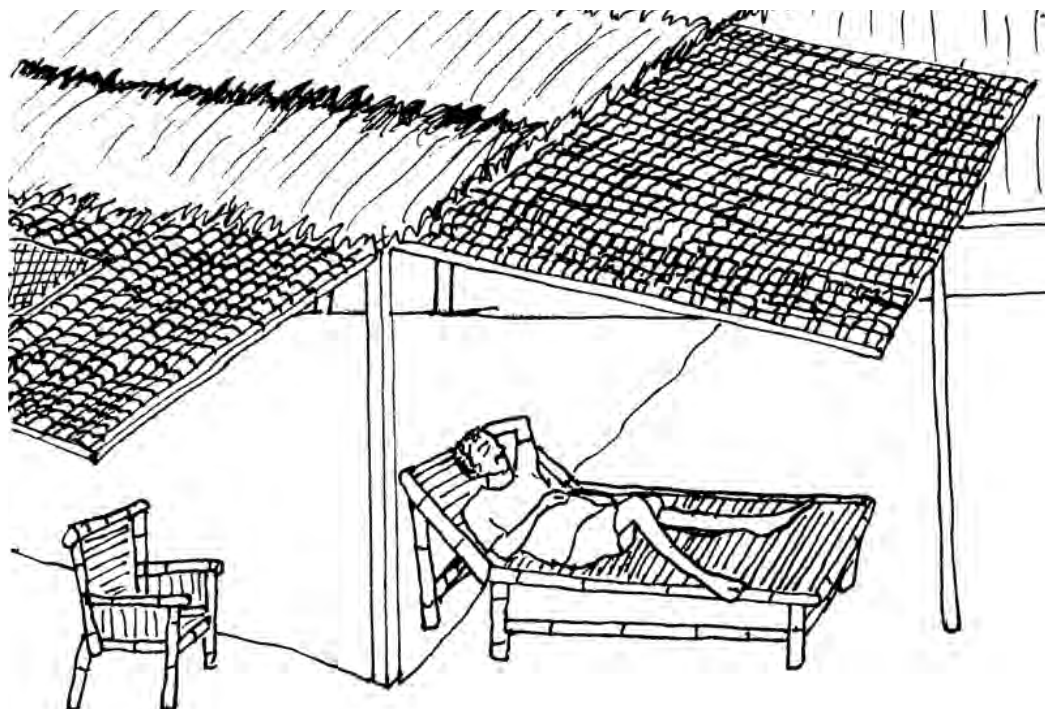
Mixed material design

This means building a house using different building materials. E.g. stone, wood and bambak panels, or clay and bamboo, etc. It can be whatever combination you want. Houses that are made from different materials can maximize the benefits of the different materials and therefore maximise comfort and health.

- Clay and rock are the best materials for staying cool during the day and warming at night. Cement block walls don't work so well but are OK if they are covered with render.
- Bamboo and bambak give good ventilation and are cheap.
- Long lasting wood like Eucalypt can form the structure.
- A tin roof lasts longer and can be used to catch water. A grass roof is cheaper and is much better for insulation. A bamboo roof is also good and could be used for water collection.



Raisable walls for ventilation during the day and security at night



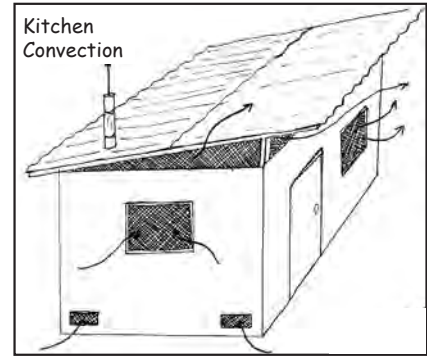
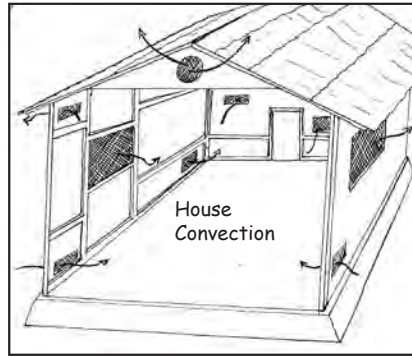
Improvement Ideas for Houses

These ideas can be used for new houses or to improve houses already built. Simple, cheap improvements can make a big difference to the living area.

Ventilation

Good ventilation will keep a house much cooler. Hot air naturally rises. Air vents can be used to help hot air rise and escape. An air vent is a small hole approximately 30cm x 15cm covered with wire screen to stop mosquitoes, mice, rats. If there are air vents near the roof then hot air can escape. If there are air vents near the ground then cool air can enter. As the hot air leaves through the air vents near the roof cool air is pulled through the vents at the ground. **This is called convection.** You need air vents at low down and at roof level for convection to work. Opening windows also helps to cool the house.

Trees and plants around the house will make the air entering the house even cooler.



Insulation

Insulation will keep the house cooler during the day and warmer at night. **Render** - A render will cover and protect the walls. They help to keep the walls cooler during the day and warmer at night. Render can be used on cement blocks, clay, rock and even bamboo and babak walls.

For cement, clay and rock - The thicker the render, the better the insulation, and the longer the life of the wall.

Two recipes for a cheap render are:

- 8 parts sand
- 1 part cement
- 3 parts fermented cow manure (cow manure is fermented when fresh cow manure is put in a bucket with water then sits for 5 – 7 days.)

Or

- 1 part clay
- 4 parts sand
- 5 parts fresh cow manure
- + hydrated lime

The cow manure helps to seal the render and protect it from insects. And it doesn't smell when dry! The lime helps to protect the wall from rain and acts as an insect repellent.

Render for bamboo and babak panels



This idea is best used in colder areas in East Timor.

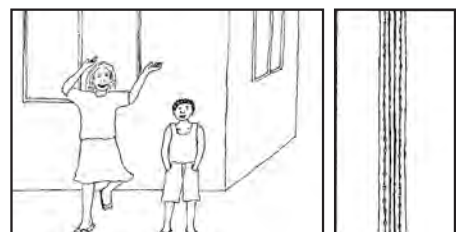
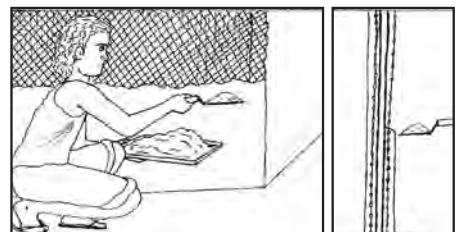
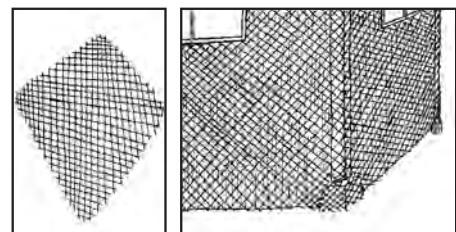
1. Cover the split bamboo or babak panels with chicken wire outside and inside. This will hold the render in place. Rendering both sides will help protect the bamboo or babak panels from insects and help it to last much longer. It will also improve the insulation.

2. Apply the render until it is covered and you cannot see ANY of the chicken wire, bamboo or babak panels. Again, the thicker the better.



SMART IDEA:

A layer of bricks 2 or 3 bricks high at the bottom of the wall will help a lot to protect the wood, bamboo or babak panels from insects and mould.

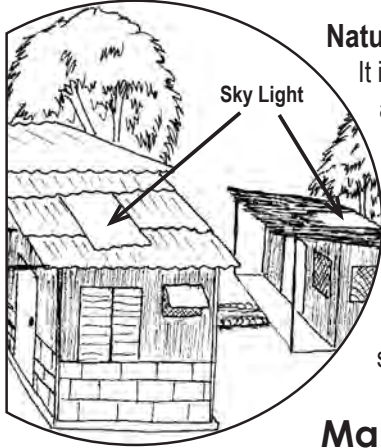


Curtains

In cold areas, curtains or material (e.g. tiis) that covers the window on the inside will stop some heat escaping through the windows at night.

Roof insulation

Traditional roof materials are very good insulation. Insulation material for houses and other buildings is available in Dili. It is manufactured and is designed to be placed under roofs. The insulation keeps the buildings cooler. In cold areas it also keeps buildings warmer at night. It is expensive but for houses and businesses it will make a big difference to comfort and it will also save money because less electricity is used for airconditioners and fans.



Natural light

It is important to provide natural light in houses. If a house is too dark inside it can damage the eyes of adults and especially children. More candles and electricity will be used as well. This is a problem for some types of traditional houses. Large windows in the house provides natural light. If glass is too expensive or not available then cover the windows with wire screen to stop mosquitoes and animals from entering.

Sky Light

A sky light can also be used to increase light. This a piece of clear plastic sheet, the same size and shape as tin roof sheets, that is fitted in the roof.

Making your house last longer

If you protect the wood and bamboo from borers, termites and other insects they will last for years longer.

Bamboo

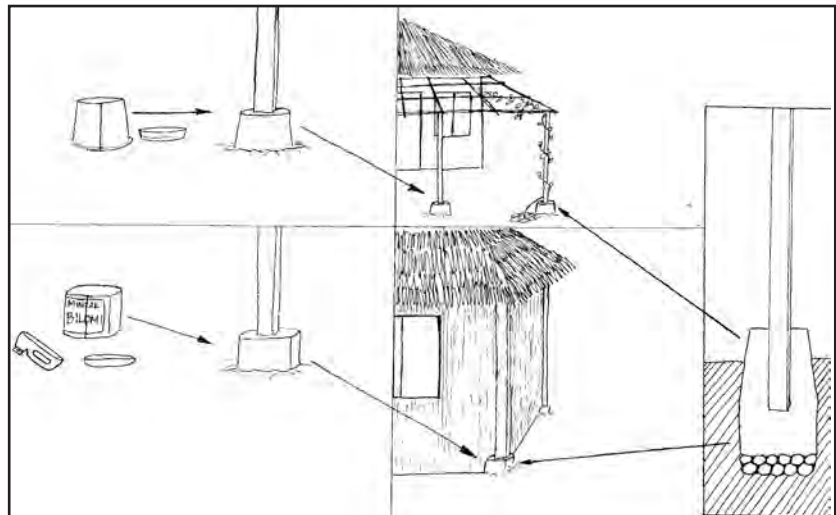
Read in the Bamboo Chapter (CH 8) for how to choose, cure and store the bamboo correctly.

Wood

- Paint sump oil (old car or truck oil), especially around the base of the pole. It will help protect it from termites and borers for much longer. Repaint the poles every 2 years to continue the protection. However it does increase the fire risk for the house.
- Paint will also help to protect the poles. It looks better but it doesn't work as well.
- Use Eucalypt poles if possible or other trees that have very hard wood. White ants and borers won't eat it as quickly and sometimes not at all.
- Traditional ceremonial houses are built using woods that naturally last for many, many years. This knowledge can be transferred to houses and the types of trees used need to be planted for the future.

Cement post holders will help stop termites and white ants from eating in at the base of wood or bamboo poles, because the wood is no longer in the ground.

- **STEP 1:** Dig hole in the ground, the normal depth for a house pole.
- **STEP 2:** Prepare old bucket or oil container for use as a cement mold.
- **STEP 3:** Fill 50% with cement, place the pole in the hole and then fill until cement is 10cm from the top.
- **STEP 4:** Place bucket or oil container mold in the hole, around the pole. Fill with cement to the top.
- **STEP 5:** Remove mold when dry

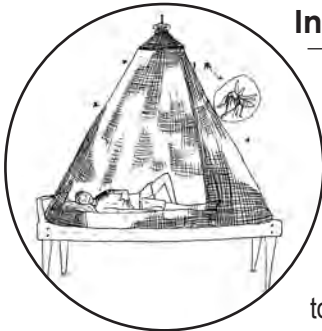


Keep the area and ground around the house as dry as possible

Wet ground around the posts and house brings white ants. They cannot live in dry ground. Wet ground also encourages mould and fungus on walls, which is not good for the walls or for peoples' health.

Render on walls will make them last much longer. Smoke from a wood fire will help a grass roof last longer because it will deter insects and help make it waterproof. But if you are using fire inside all the time, more and more smoke will stay inside over time as the roof becomes more sealed. Therefore you will need to provide a chimney or place for the smoke to escape to prevent health problems caused by too much smoke.

Roofing nails are much better to use for roofs than normal nails. They help to hold the roof down in very strong winds and make it last longer.



Insect screens

Mosquitoes cause many diseases. Disease problems can be reduced if all windows, vents and openings are covered with insect screens to stop the mosquitoes. Mosquito nets can be used over beds to stop the mosquitoes biting while people are asleep.

Outside improvements

Pergola / Shade Structure

A pergola or shade structure can be large or small. They are simple to make and provide a shaded outside living area. They also keep the house cooler. Many different vines can be grown on the pergola, including passionfruit and grapes. Palm leaves can be used to cover the structure and provide shade until the vines grow over it. Pergolas can also be used to shade a small nursery.

Trees and windbreaks

Trees provide shade for the house, keeping it cooler. And they can be grown as a windbreak to protect the house from strong winds. The trees will also help to keep the air cooler because of the moisture in their leaves.



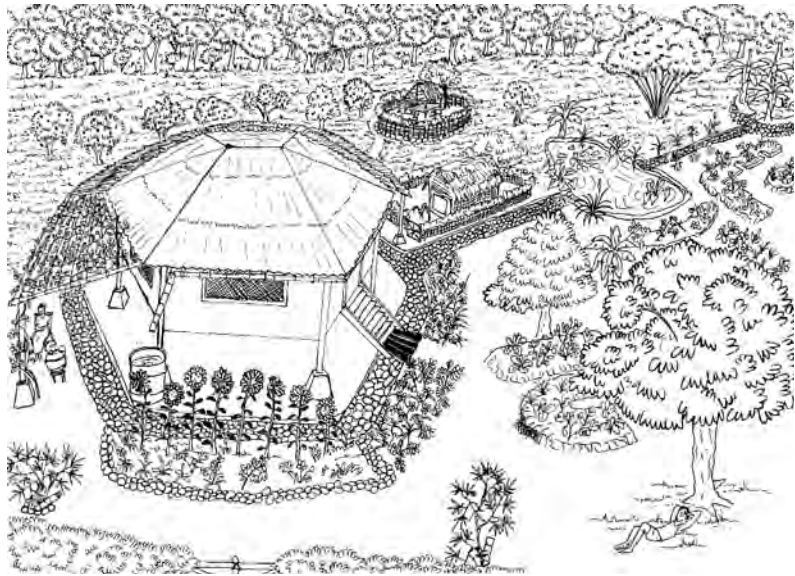
SMART IDEAS:

- In hot coastal areas a pergola/shade structure can be built, or trees or vines can be planted on the western side of the house (where the sun sets). This will help to keep the house much cooler at nights.
- Some trees, like ai hali, grow far too big to be planted next to a house. Too much shade can cause moisture and ventilation problems in the house. Also, the roots can destroy walls when the tree gets older.
- Be careful not to make too much shade for the vegetable gardens.



Gardens

Gardens around the house make the house area much more beautiful. Flowers, vegetables and herbs can all be grown together. Also, because the leaves have moisture in them, the trees and plants help to keep the air cooler. Be careful not to put gardens directly against wood posts or walls or you will encourage rotting and insect problems.



Ponds

A pond adds beauty to the house area. It can also provide you with fish and vegetables. A large pond will also keep temperatures cooler during the day and warmer at night. This is because the water is slower to increase temperatures than the ground, and then slower to cool down at night. Add neem leaves regularly to prevent mosquitoes from breeding. Tilapia, Ikan Gourami and Ikan Mujair also eat mosquito larvae in the ponds.

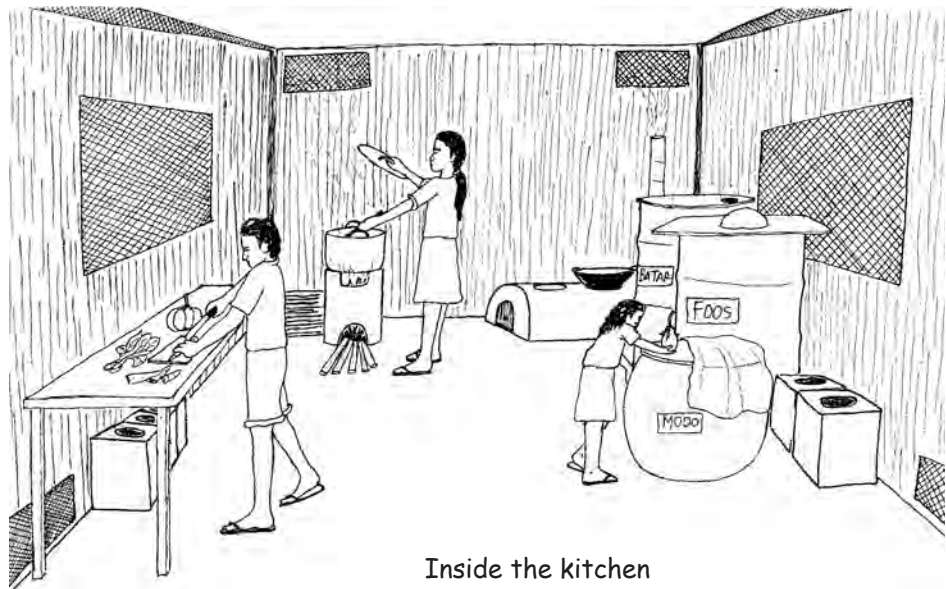
Kitchens

People spend more waking time in the kitchen than any other room in the house, especially women and small children. Therefore it is very important that it is a healthy, clean and comfortable environment.

The kitchen includes the washing area.

A well designed and built kitchen will have:

- Excellent ventilation – especially important in smoky kitchens
- Lots of light – needed for cutting and preparing food
- Water run-off trenches that clean and re-use all the water
- A stove and/or oven that reduces the amount of wood used and smoke produced
- A food preparation area that makes cooking as easy as possible
- Good sanitation and be easy to clean
- Good food storage
- Firewood storage place – wet or green wood produces A LOT more smoke
- No animals



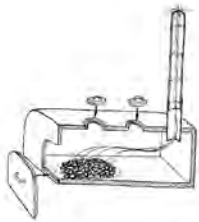
Inside the kitchen



An unhealthy kitchen is dark, smoky, hard to keep clean with water lying in puddles outside and animals inside. This causes serious health problems for the family and can spread diseases. Women must be included in the designing process because they understand and use the kitchen a lot more than men.

Stoves and ovens

Stoves and ovens are essential for reducing the amount of smoke in the kitchen. There are many different types of stoves and ovens including traditional East Timorese types. They also use much less or no wood. Read in the Alternative Technologies Chapter (CH 14) for how to make and use stoves and ovens as well as other cooking technologies.



Outside the kitchen

Ventilation

Good ventilation is essential in kitchens because of the smoke. Smoke in kitchens is one of the major causes of Tuberculosis in East Timor, and many other health problems as well. Using plastic for starting fires is also a problem in poorly ventilated kitchens because the plastic smoke is poisonous. Even when kerosene or gas is used for cooking, good ventilation is very important.

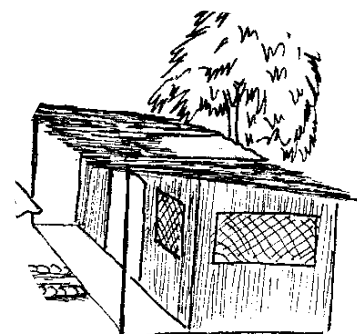
- Air vents low down and high up on the walls will allow air to flow. Air vents are small holes (approximately 30cm x 15cm) covered with wire screen to stop animals and insects.
- Opening windows will help as well
- A gap between the walls and ceiling will allow smoke to escape. Cover the gap with wire screen to reduce mosquitoes.
- A chimney can also be used to let the smoke quickly leave the room



Lots of Light

Often the kitchens in East Timor are very dark. This makes preparing food difficult and can cause eye problems. Windows can be used to let in more light. The air vents for ventilation will also help. An outdoor area or separate food preparation room is another solution and is common here. This can also make food storage and pest control easier. Windows need:

- Screens to stop animals, especially rats and mice
- Screens to reduce mosquitoes
- Other gaps that let light enter should be screened as well



Sanitation

The kitchen and washing area is where many diseases are caught and spread. If it is hygienic and easy to clean then many diseases can be prevented. This doesn't mean that it should be cleaned much more often, but that good kitchen design will make sanitation much easier to achieve and maintain. Vinegar and lemon juice are both good natural cleaners. Add some to the water that is used to clean the food preparation area and floor to help kill some of the bacteria that can cause sickness.

Food Preparation area

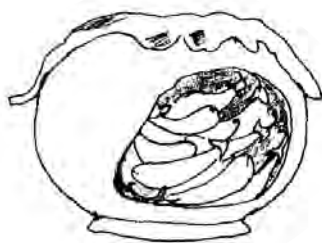
It is best if the food preparation area is off the ground, about waist high, and easy to clean.

- This helps keep animals away from the food
- It is easier to keep clean
- There is much less bending over, which causes back problems and makes food preparation much harder

Food Storage

Store food in bags or containers that animals and insects can't enter. E.g. drum for rice and corn, old biscuit tins, plastic containers etc.

Also, food bags can be hung from the ceiling. Use a drum lid to stop rodents climbing down from the roof.



Clay pot



Floor

The floor of the kitchen is easier to clean and wash if it is slightly raised from the level of the ground outside.

A floor made from rocks with mortar or cement is much better for health and easy to wash and sweep.

Animals

No animals should enter the kitchen.

Put all the food scraps in a bucket or container and feed it to the animals away from the kitchen area.

Chickens, dogs, cats and pigs all carry bacteria that can make people sick. There is more chance that this will happen if animals are in the kitchen. Also, chickens especially will defecate in the kitchen which is not healthy, or nice to smell!

Many kitchens do not have doors, allowing access to animals. A door can be just a simple frame of wood with a wire screen. **It costs a little money but is worth the cost because it will improve people's health.**



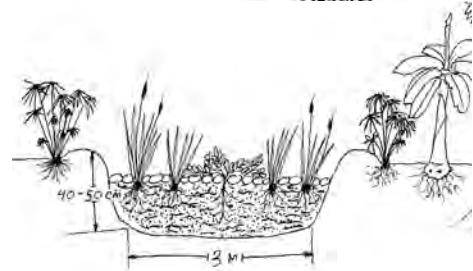
Even just a low door to stop dogs, pigs and chickens is good, but a proper door will also prevent rats, mice and mosquitoes from entering.

Washing area

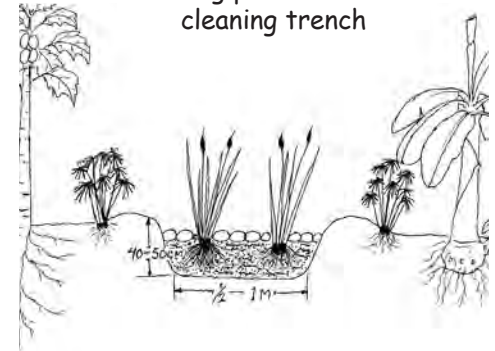
It is healthier and easier to have the washing area off the ground. Bending over all the time is hard on the body and bad for long term health. A small table for the dishes to dry in the air is good. Split bamboo works well. Dish towels get dirty easily and spread bacteria from dish to dish. Most important is what to do with the used water. Reusing the water provides many benefits.

The following ideas can also be used for clothes washing water and washroom water. If possible, combine them together to make less work and maintenance.

- It can be run into a pond. Because soaps and detergents enter the pond it is NOT for vegetables or fish. The water can be cleaned by using reeds, bulrushes and other water plants. The plants absorb the chemicals and nutrients from the soaps and detergents and store them in the stems and leaves. To clean the water properly the pond needs to be 3m x 3m or more for the use of 1 large family. (approximately 1m² per person) The pond is filled with sand then 1/2 filled with small rocks. Plant the water plants into the sand. Cut the water plants back regularly and use as mulch around fruit trees. A place where the water can overflow must be made, especially for the wet season. The overflow water can be easily run in a trench to a banana pit or between vegetable plots.
- It can be run into an absorption trench then into a banana pit. First, the trench dug 40 - 50cm deep if possible. It should be about 5 - 10 metres long and approximately 50cm wide. Then it is half filled with sand then filled with a layer of small rocks. To improve the water cleaning ability it can be planted with reeds or bulrushes. Any extra water that flows out from the trench can be run into a banana pit or swales. Bananas and papayas can also be planted along the side of the trench.
- On sloping land the water can be run via a pipe or small absorption trench, down into a swale. Fill the bottom (trench) of the swale with sand and gravel. Reeds and bullrushes should be planted to improve the water cleaning ability. On top and below the swale you can plant bananas, papayas, citrus, chillies, pineapple and more. Don't plant vegetables, especially not root crops like cassava, sweet potato or yam. But pumpkins and watermelons are good.



Cross sections of water cleaning pond and water cleaning trench



Adding neem leaves

For many districts in East Timor where water is scarce, the trench or swale methods will be much more practical and easy to maintain.



SMART IDEAS:

- Any ponds, trenches or swales that are used to clean water from kitchens, washrooms or toilets need to have a small fence around them to stop animals like ducks, pigs, goats, cows and buffalo from drinking the water or eating the plants. It could make the animals sick and will damage the water cleaning system.
- Phragmites australis is the best water cleaner that grows in East Timor. It is a type of water reed that grows up to 2 metres high. It is easy to grow; dig up some root stock, carefully divide it and replant it. Water Hyacinth is also excellent. It lives on top of the water and multiplies very quickly. Water Lilies and bulrushes also work well.
- Many people wash clothes in the rivers because there is no water supply. When water does become available in villages it is important to stop washing water in the rivers to reduce the pollution from the washing powders. It also saves time and hard work. Create a washing area that combines with the dish washing and washroom so that the dirty water can be easily cleaned and reused to grow fruit and vegetables.
- Add neem leaves (1 - 2 large handfuls) or neem oil (about 20mls) a few times a year to prevent mosquitoes from breeding.

Washrooms

There are many different ways to make a washroom from very simple compost showers to rock, clay or cement block washrooms. Use whatever building materials are most appropriate for you.



The most important idea is to make use of the waste water.

Compost showers

A compost shower is a dug pit circle, approximately 2 metres wide and 1 metre deep. This is a cheap and simple way to directly re-use the water. There are 2 methods for making the shower.

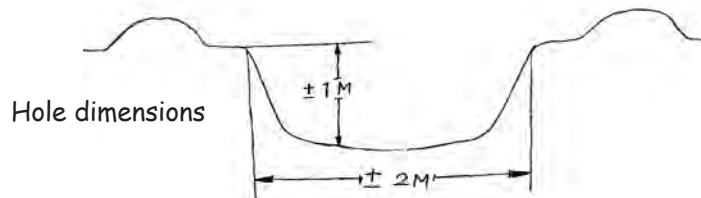
1. Fill the hole with:

- 10cm layer of palm hair, covering the sides as well
- Fill with Rocks or coral until near the top
- Add gravel to fill the gaps and then a top layer of gravel 5 to 10cm thick

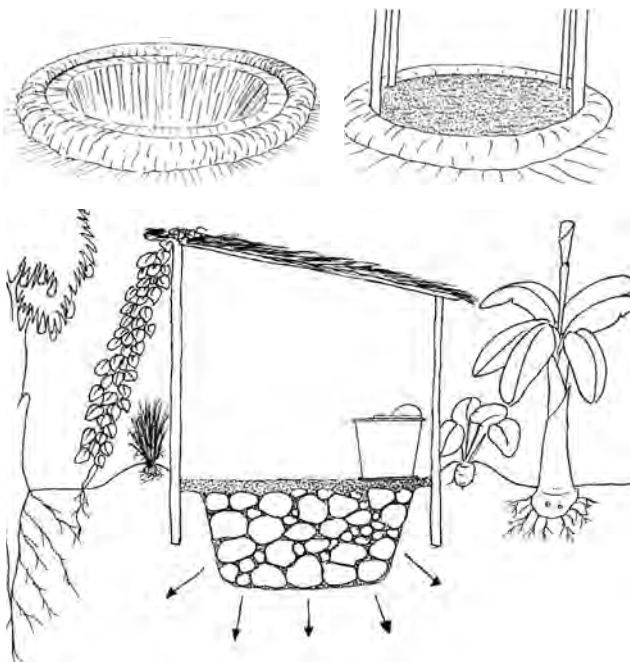
This allows the water to filter through easily into the ground.

2. Half fill the hole with coffee or rice husks. This will soak up the water. Then make a floor with eucalypt poles covered with bebak. This method has been found to rot in 1 to 2 years, so a new floor will need to be made.

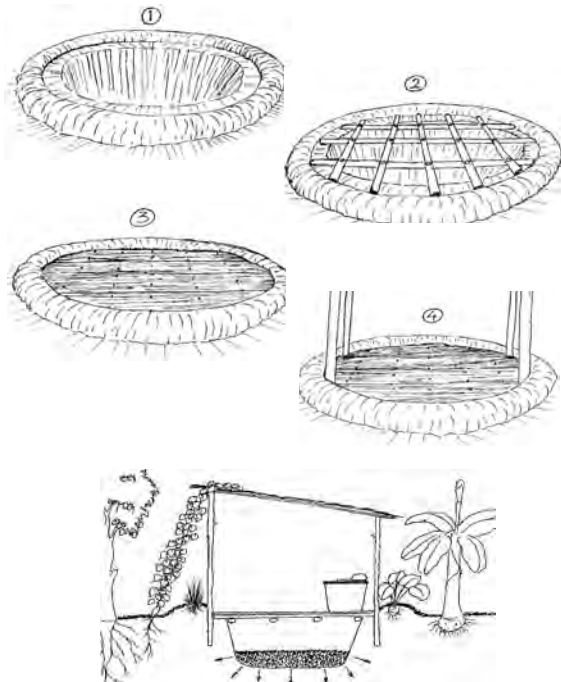
Build a simple structure around the shower to give privacy and provide trellising for vines. All the water will be stored in the ground for trees and plants to use. Bananas, pumpkins, gourds, luffas, watermelons, papayas, pineapples, chillies, tomatoes, passionfruit and other plants can all be grown around the edge and will use all the water.



Method 1 - rocks and sand



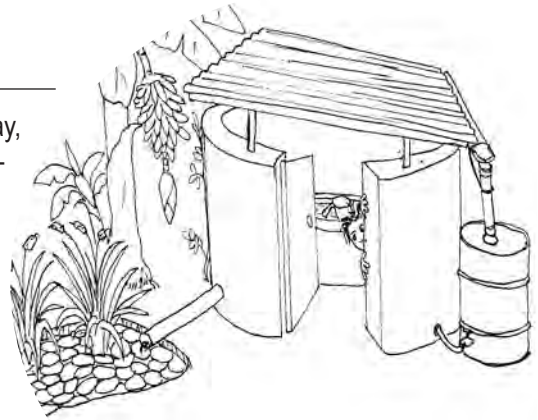
Method 2 - Bebak floor with coffee or rice husks in pit



Washroom design

A washroom can be made from whatever materials are available. Clay, rocks or cement block will last a long time. Use a cement based render or tiles to protect the walls. A rock, cement or tile floor is easy to keep clean and hygienic. And it doesn't have to be square! Bamboo, wood or beak can also be used but will become mouldy from the moisture and will need to be replaced much more often. The mould can promote sickness as well. If you use a tin roof, water can be easily collected in a drum or tank to use in the washroom. The used water can be run outside through a pipe or trench to be re-used. If possible use a pipe because it is easier to maintain. Look

at the kitchen section for ideas on how to clean and re-use the water. You can put the kitchen washing area and the washroom water into the same water cleaning system. The clothes washing water can be added as well.



Compost toilets

Human manure is a valuable resource and can be turned into quality fertilizer. But it must be treated and composted properly so that diseases are not spread. It is common for pigs to eat human manure. This is not healthy for the pigs and can give diseases back to the people who eat the pigs.

Compost toilets provide many benefits:

- Makes great fertilizer.
- Use much less water, sometimes none at all.
- Reduce and prevent disease problems.

This is turning a problem into a solution.

Compost toilet pit

A compost pit toilet is very simple to make and use.

Simply dig a large pit, approximately 1 – 1.5 metres deep and 2 metres across. Use the soil that is dug out to make a mound around the edge of the hole.

Make a floor with eucalyptus poles and beak to cover the hole. Make a small hole in the middle of the floor to be the toilet hole and make a cover for the hole for when the toilet is not used.

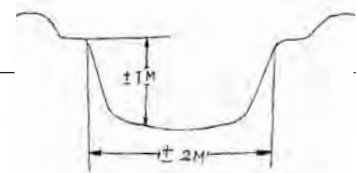
Build a simple toilet house around the toilet to give privacy. This can be made from wooden or bamboo poles and palm leaves or grass. Whatever material is cheapest and available. Face the door towards where the wind comes from most often. This will help to prevent bad smells.

A Ventilation pipe is not essential but it can be added to increase the speed of composting and reduce any bad smells. It can be made from a bamboo pipe with the insides cleaned out, and inserted into a hole in the beak floor. Seal any gaps between the pipe and the floor to stop flies or insects.

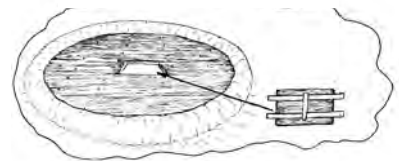
The time that it takes to become full depends on how big the pit is. Usually about 1 to 2 years.

When the toilet is full, dig another pit. Add more leaves, rice husks etc to the first pit then leave to rot for at least 6 months.

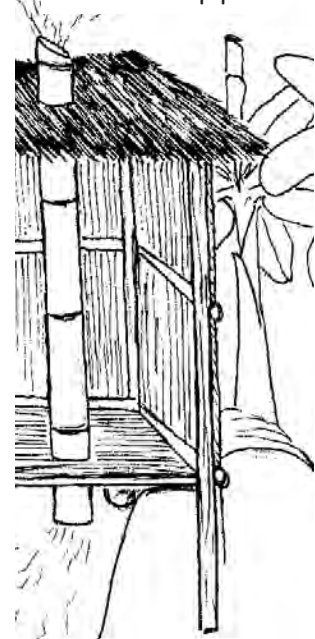
The manure can then be removed and used around fruit trees and the pit can be used again. By this time, the floor and walls will need to be rebuilt.



Floor with lid

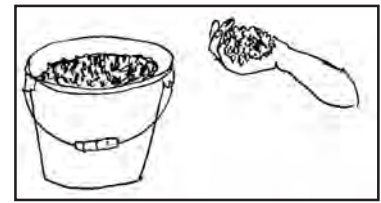


Ventilation pipe



How to use a compost toilet pit

- Add one large handful of rice husks, coffee husks or sawdust every time the toilet is used. This will turn the manure into fertilizer and stop it from smelling! Very important! 1 bottle EM every month will also help the composting process.
- Add about 5 handfuls of wood ash or lime once a week. This will help the manure to rot faster and make better fertilizer.
- Keep a lid on the hole in the floor when not being used to stop flies from entering to pit. Flies can spread diseases from the manure.
- No extra water is needed. The manure works better with little or no water added. Men should not use the pit for urination to reduce liquid content. Feed a large fruit tree instead.
- Dig the pit as far away from rivers as possible. This is because in the wet season bacteria from the toilet might enter the water via underground water. This can cause sickness when people use the water from the river.



Plants: Bananas, pumpkins, luffas and passionfruit are the best plants to grow around the edge. Citrus trees can also be grown nearby. The bad bacteria (and taste) doesn't transfer into the plant or fruit. But the manure is too strong for most vegetables. Also, don't plant root vegetables that might directly touch the rotting manure. This can spread disease.



SMART IDEA:

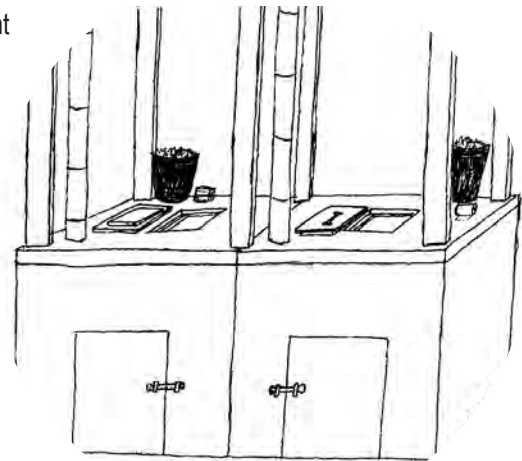
DO NOT use the toilet as a place to put rubbish!!!

Compost Toilet systems

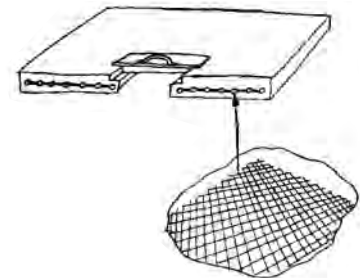
There are many different types of compost toilets with many different designs. If you are interested there are lots of internet sites and books that can show you the different types of toilets in detail. We will describe one type in this book that is a cheap and simple design that is fairly easy to maintain and is used in many countries.

2-Box Compost Toilet

This compost toilet is simply 2 cement boxes joined together. The boxes are made from cement blocks. Each box is about 1m x 1m x 1m (1m²) on the inside. The cement blocks must be rendered inside and outside to make them waterproof. On top of the boxes make a cement slab about 10cm thick. It is very important to use steel reinforcing rods in the cement. This is so that the toilets can support the weight of the people on top.



Cross section of cement toilet top



On top there is a toilet hole in the middle of each box about 20cm wide. Each hole needs a lid that fits very well when the toilet is not in use. Each box has a small door at the bottom on 1 side. This is to remove the compost when it is ready. The door has to be big enough to fit a shovel. A simple house is built around the toilet to give privacy. The easiest method is to add wooden or bamboo poles at each corner when the cement slab is being made. Attach palm leaves, split bamboo or grass to make the walls. Design and make the house so that the door faces where the wind comes from most. This will help a lot to reduce any smells.

Ventilation pipe

A ventilation pipe improves composting and reduces smell. They are used with most types of composting toilets. They can even be added to simple pit toilets. With this type it is not essential but it is recommended. A piece of bamboo about 1.5 - 2 metres long and as wide as possible is good. Remove the inner core so that air can flow through. The ventilation pipe must be added during construction of the top of the boxes so that the bottom of the pipe is just inside the box. Air is then drawn out from the container through the pipe. Paint it black at the top to improve ventilation.

Water Use

With this toilet no water is used at all. It will not work if water is used. Toilet paper is used instead. The water floods the containers and stops the manure from composting. Men and women should also urinate in a separate bucket in the toilet room, because too much urine also causes problems. The urine can be mixed with water and used to fertilize fruit trees.

Overflow pipe

An overflow pipe can be added at the bottom of each box. This will allow any excess liquid to escape. Wire mesh must be put on the inside of the box at the start of the pipe to stop any solids from escaping.

- It may get blocked and need cleaning.
- The liquid **MUST** be run into a water cleaning pond or trench as described in the kitchen section.
- It does improve the management and reduce problems but it requires more work.

Even with an overflow pipe, **NO** water should be used, and a separate urination bucket is preferable.

How to use: Use in the similar way as compost toilet pits:

- Add 1 handful of rice husks, coffee husks or sawdust after every use.
- Add about 5 handfuls of ash once a week, a week, and 1 bottle of EM every month if possible.
- Keep the lid closed when toilet is not used.
- The manure needs to be stirred with a long sick occasionally, about once a week.
- No rubbish at all. It will cause big problems.

For one family it will take about 6 months to fill up one box. Then the other side can be used. Leave the first side for 6 months to rot into compost. No stirring is needed. Then when the 2nd container is full, the compost can be removed from the 1st container and it can be reused. The compost is high quality and it is good to use around vegetables and fruit trees.



SMART IDEA:

If there are too many people for 2 containers it is better to build more containers than bigger containers. It is important to have enough containers that the compost in each one can stay and rot into compost for 6 months.

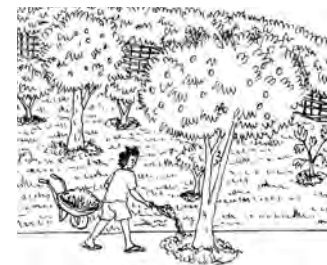
This system takes more time and money to make, but it works very well if it is maintained properly. Many different types of compost toilets can have urine and small amounts water go through them. However these toilets have pipes that remove the liquid from the toilet and direct it into water cleaning systems. Toilets like these are excellent for large houses, and especially for eco tourism, offices and towns. A good working example is the toilets at the eco-village on Atauro. Look in the reference section for more information.

More research must be done before any attempt to make a composting toilet. If it is not built properly then it will require a lot of maintenance and will not produce compost properly. Most houses in towns have septic tanks. Maintenance of these tanks will help to reduce bacteria problems in the water supply and therefore reduce illness from bacteria. 3 important ideas are:

- Build any septic tanks as far away from water pumps and rivers as possible. Overflow from septic tanks can pollute the water supply and make people sick.
- Add a small amount of lime twice a year to help balance the PH level. (PH is the measure of acidity or alkalinity – look in Ch 4 – Soils for explanation)
- Don't use bleach for cleaning the toilet. It will kill the good bacteria that is needed for treating the manure properly.



Cleaning out and using the compost



Water Supply and Storage

Collecting Water



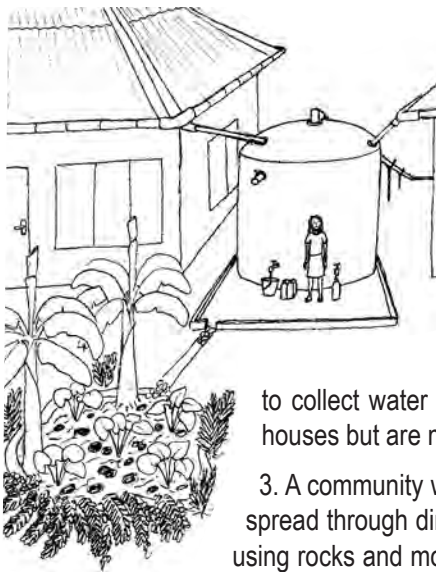
Collecting water is very hard work that can take many hours each day. Women and children do most of the water collection. If water can be collected from close to the house, a lot of time and energy will be saved and can be used for other activities. This will improve the life of the whole family.

There are water collecting techniques that can be used by families and also by communities.

Family / House Ideas

1. The roof of the house, kitchen and even washroom can be used to collect water. A tin metal roof catches a lot of water when it rains. Use a piece of bamboo cut in half as a gutter to collect the water and run it into a tank or drum. Bamboo roofs could also be used. Community idea: A bigger tank can collect water from many roofs. But don't forget to turn the tap off after using it!
2. Water can be brought to the house using irrigation pipes. Metal pipes or simple bamboo pipes can be used.
3. Water for gardens and ponds can be collected using swales. Make the trenches of the swales so that the water runs very slowly in one direction. At the end where the water runs to make an overflow point with rocks. This water can then be directed into a pond or water storage hole, to be used for animals, vegetables and fish.

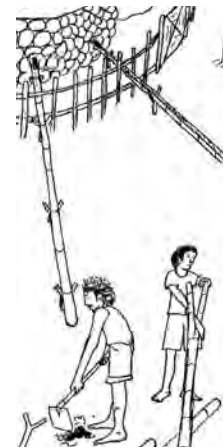
Community Water Collection



1. Water springs are a traditional source of water. The springs need to be protected from animals and from damage. A separate animal drinking hole can be made. Bamboo or metal pipes can be used to run water to communities and stored in large cement storage tanks. The overflow from the storage tanks can be used for watering fruit trees and vegetables using pits or swales. Using the overflow water in this way also reduces mosquito problems.

2. Water pumps and bores are another good way to collect water from close to the house. They can be for individual houses but are much cheaper for groups of houses or communities.

3. A community well. Community well water must be kept clean because sickness can quickly spread through dirty water. The well should be built up in a circle around the edge 1 metre high using rocks and mortar or cement. Steps can be made for children. This will stop dirty water returning into the well and stop animals making the well dirty. A separate animal drinking place can be made. Don't use dirty buckets or containers to collect water.



A cover for the well will reduce mosquitoes breeding.

4. Pumping water up hill to storage tanks – petrol pumps or ram pumps. Ram pumps use NO petrol and require much less maintenance. There are ram pumps successfully working in East Timor already. Read in the Alternative Technology Chapter (CH 14) for more information.

5. Working with the government to bring in town or village water.

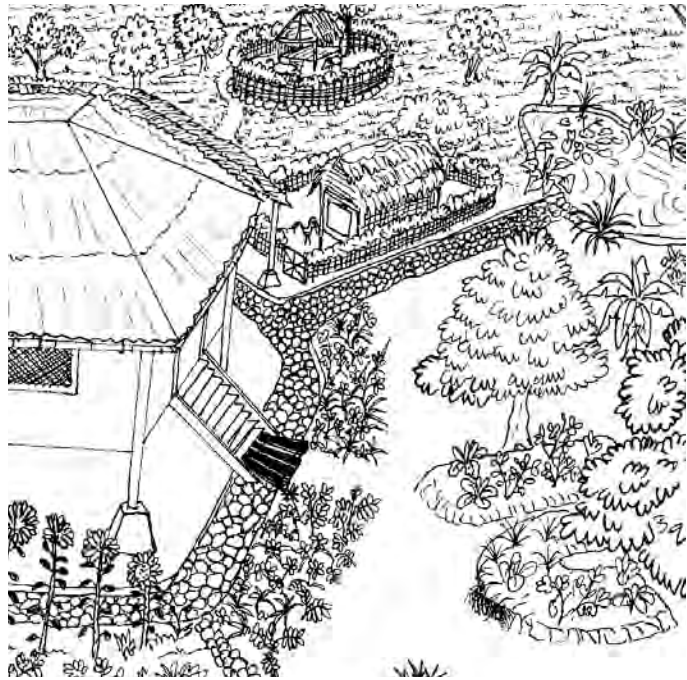




SMART IDEAS:

- In the mountain areas in East Timor where it gets very cold at night, drops of moisture collect on the tin metal roofs. This is because the air temperature becomes very cold. The water can be stored in drums or storage tanks from the tin metal roofs, especially in the dry season. On most cold nights water can be collected. Even a small amount of water will reduce the hard work of carrying water.

- Storing wet season rain. Some wet season rains that fall on roofs can be stored in tanks but most will not fit. The extra water can be stored in the ground, in ponds and by planting trees. (Trees store water in their roots, trunks branches and leaves.) A shallow trench can be dug around the house where the rain falls and filled with rocks. Use the soil from the trench to make the ground higher on the side closer to the house. This will help keep the house dry in the wet season. The trench is dug so that the water runs slowly along the trench away from the house. It can be directed into vegetable gardens, banana pits, swales, etc.



Storing Water



Storage tanks with taps can be used to store the water. This makes using the water easier. A storage tank can catch water from piped water, from pumped water or from water caught from a roof. It can be made from concrete or can be a plastic or tin metal tank. Petrol drums can also be used, especially to catch water from roofs. They must be cleaned very well to remove all the petrol:

1. Wash very well with detergent
2. Wash out with water
3. Leave in the sun for a week before use

Reafforestation around village

Reafforestation around villages and towns will help A LOT to store water because:

- Much more rain soaks into the ground and erosion is reduced.
- Keeping the store of underground water more constant. This is very important for future water supply.
- They provide leaves for mulch, which also helps to store more water in the ground.
- Reducing strong winds that dry out the ground.

This idea is especially important in places where communities collect water from under the ground. Without trees the water level below the ground can drop, making it harder to collect water and reducing the quality of the water. This has happened in many countries already.



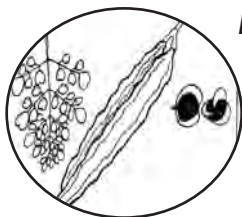
Forest Above a Village to Protect the Water Supply

Keeping Water Clean

House water that is stored needs to be kept clean. This will reduce the chances of sickness.

- Cover storage tanks and drums at all times. Stop mosquitoes from breeding.
- Don't use dirty buckets or containers to remove water, especially if not using taps.
- Use crushed Moringa seeds. Read below
- Check the water source regularly to make sure it is clean and maintain it if necessary. E.g. spring, bamboo pipes, roof and gutter.

Cleaning Water for Drinking

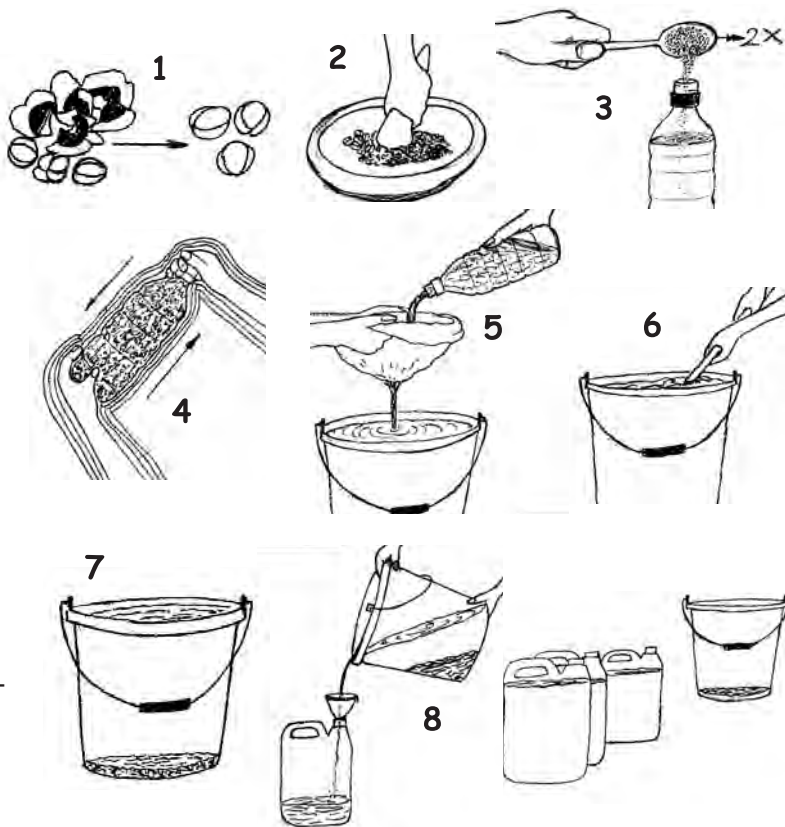


Moringa seeds

The seeds of the Moringa tree can be used to clean water of dirt and most bacteria. It is used in Africa, India and other countries. It is a simple, effective way to make dirty water drinkable and will prevent A LOT of sickness and even deaths, especially for children. It also saves A LOT of firewood, hard work and time because water doesn't have to be boiled.

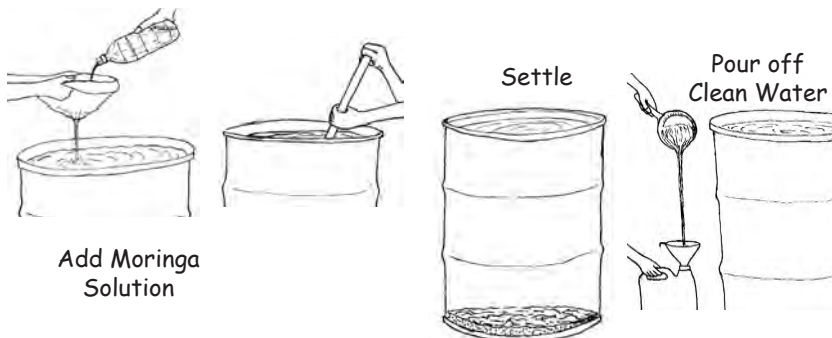
How to use the Moringa seeds

1. Remove some seeds from the shell of the seed.
2. Crush the seeds into a fine pow- (brown) seeds.
3. Add 2 small spoons of powder and water into an aqua bottle.
4. Shake for 5 minutes.
5. Pour this solution through a clean cloth to the bucket of water to be treated.
6. Stir fast for 2 minutes, then slowly for 10 minutes.
7. Then leave for 1 hour undisturbed. The dirt and bacteria (usually between 90 to 99%) will stick to the Moringa seed powder and sink to the bottom of the water.
8. Carefully pour off the clean drinking water into bottles or containers, leaving the powder in the bucket.



SMART IDEA:

You can also use a drum to clean the water and scoop the clean water from the top.



Community idea

You can use Moringa Seeds to clean large amounts of water as well. Use at a rate of 1kg of seed powder for 10,000 litres of water. (approximately 1 gram for 10 litres)

Water Filters

Water filters are used to clean water of bacteria that can make people sick. This means that all drinking water can be clean and that water doesn't have to be boiled before drinking. Benefits:

- This saves A LOT of work!
- And it saves A LOT of wood!!
- Which means that it saves money.
- People's health is improved, especially children.

They can be made from clay

The clay is made into bowls that are used to hold and filter the water, and then fired (cooked at extremely high temperatures) in a kiln. A kiln is a large oven for cooking clay products.

Some are already being made by an East Timorese business in Manatutu.

The bowl for filtering the water has a special base made of different clay than the rest of the bowl. The water can slowly pass through the base.

How clay water filters work

Clay is made up of millions of very, very small particles joined together. The clay particles, when joined together, form even smaller holes between them. Water can very slowly pass through these holes. The size of the holes depends on the type of clay because different types of clay have different size particles and therefore different size holes between them. Unclean water carries lots of bacteria. For the clay used in a water filter, the size of the bacteria is larger than the size of the holes in the clay. Therefore, when water flows through the clay holes, any bacteria in the water is stopped and removed from the water.

This makes the water safe to drink.

Clay water filters MUST be fired in a proper kiln to work. The temperature of the firing also affects the size of the holes because the clay shrinks as it is fired so the holes become even smaller.

- If the holes in the clay are too small, the water will take too long to flow through.
- If the holes are too large the bacteria will not be stopped and the water is not cleaned.

This is why careful testing and proper firing must happen so that the clay water filters work properly.

How to use a water filter

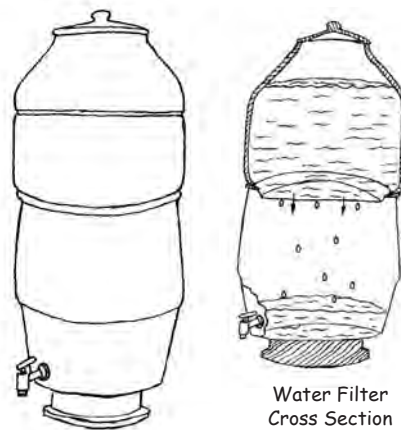
Water filters are very easy to use. Simply pour the water into the top bowl. The water will slowly filter through the bottom into the bowl below it. As it does the bacteria and dirt is caught and stays in the top. Drink the water from the bottom container. The base of the top container might become blocked because of the bacteria and other materials that are caught, so it should be cleaned occasionally for it to continue to work well. Use a brush, boiling water, lemon and vinegar to clean it, not washing powder.



SMART IDEA:

- Large amounts of water can be cleaned with Moringa seeds and then put through a water filter as needed. This will make the water very safe to drink and will help the water filter to last much longer.

There are many other types of water filters as well. One type is very similar but uses silver nitrate (a natural antibacterial material) in the top clay bowl to help clean the water. Look in the reference section for where to find more information.

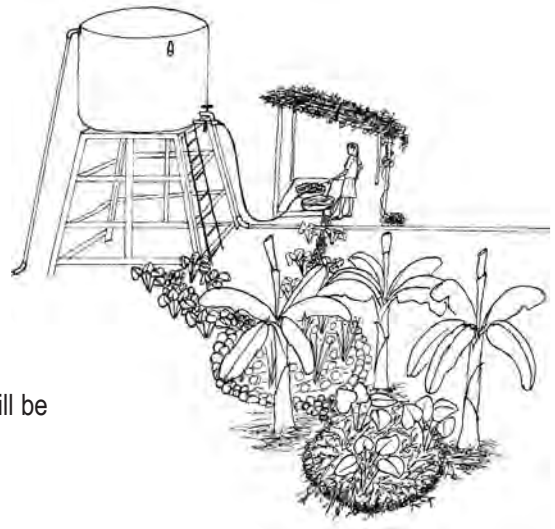


Water Filter
Cross Section



Reducing Mosquito Problems

Extra water in the wet season can be collected into ponds or into banana pits using trenches and swales. This prevents water from lying on the ground.



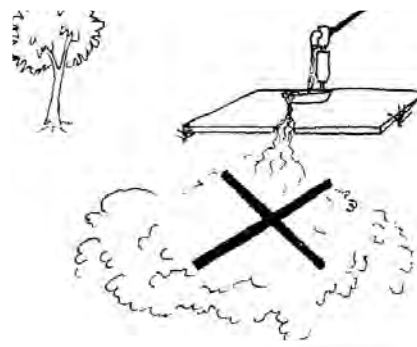
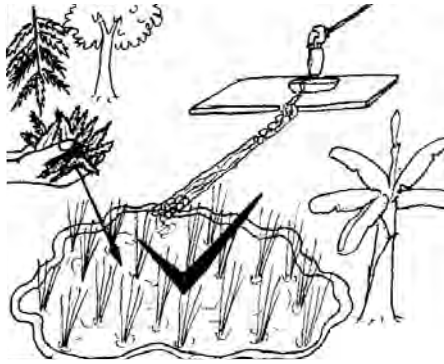
Mosquitoes will then only be able to lay their eggs in the pond.

The fish, frogs, small lizards and other insects that live in and around the pond will eat Mosquito eggs and larvae in the water. Therefore mosquito numbers will be reduced and diseases from mosquitoes will be reduced.

Everyone's health will benefit.

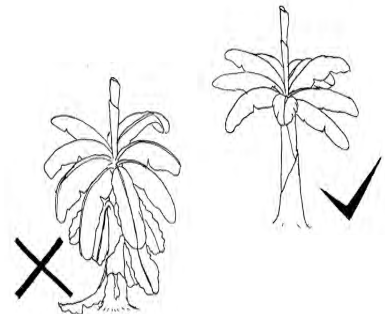
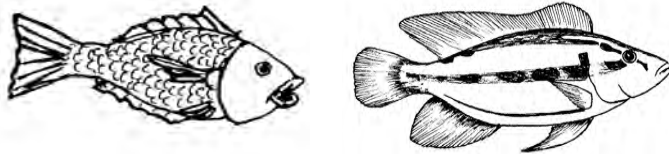
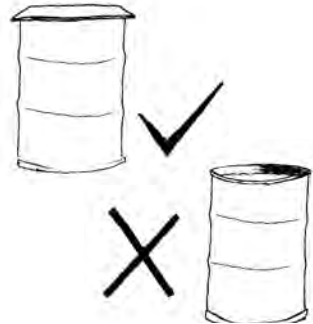
The insects and small animals will also eat some of the pest insects that eat your vegetables.

Beware: Chemicals from pesticides and herbicides can kill a lot of plant and animal life in ponds and aquaculture systems.



Other important steps for reducing the mosquito population:

- Don't allow water to lie in the open
- Treat all waste water properly
- Cover all water tanks and containers
- Small fish (Tilapia are best) can even be put into washing water and water containers that are not for drinking! They will eat the mosquito larvae.
- Fish in rice paddies will eat a lot of mosquito eggs and larvae.



- Prune off old banana leaves continuously.
- Add Neem leaves regularly to any ponds.
- For banana pits. Soak a big handful of neem leaves in a bucket of water for 2 days, then pour some liquid, with the neem leaves, in each pit. Repeat every 3 months.



Neem leaves

Reducing mosquito problems is also a community issue and a national issue. Education about disease prevention and mosquito lifecycles is very important.

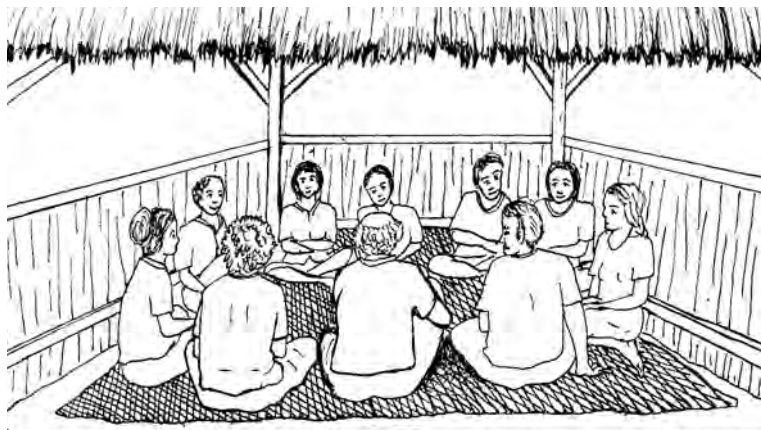
Also, keeping the community water supply free of mosquitoes will help a lot.



Community Buildings and Land

Community buildings and land are an excellent opportunity to give examples for how to improve the community.

- Examples of how to improve houses
- Compost toilets can be made by the community on community land
- Community buildings can be used to collect water
- Examples of stoves, ovens and other simple technologies.
- These can be combined with other ideas like gardens, nurseries, seed banks and so on
- Schools and churches can also be used to collect water and as examples for techniques



National strategies

National strategies for improving housing are important.

- Water supply.
- Rubbish
- Preventing disasters
- Promotion and education about good health and hygiene and disease prevention.

The sustainable agriculture collective Hasatil can be used to bring together groups and ideas and to educate. Communities also need to work together with the government to develop plans. But first the government must hear from communities about what is most needed and how the government and communities can work together. At the moment the government here doesn't have a lot of money or resources, so it is essential for the communities to work for themselves as well.

A Continual Process

Houses and water supply are a continual process and improvements can always be made, more beauty added, more time saved, more technologies used.

This leads to more benefits received.



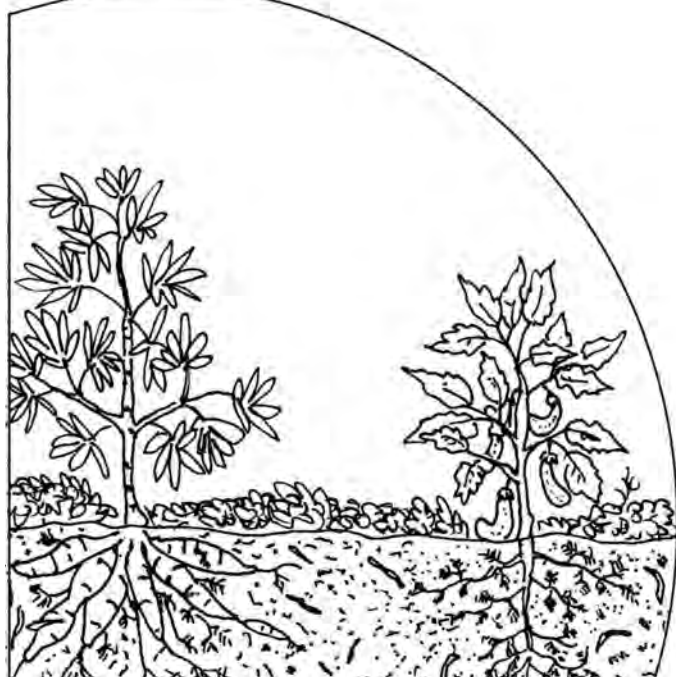
A Future Technology for East Timor:
Clay Flow Forms that help clean and add oxygen to water.





Healthy Soil

CHAPTER



About healthy soil

Healthy living soil is the basis for all agriculture. When growing healthy, productive fruit, grains and vegetables the soil is the most important factor. The soil must be replenished each season so that the plants have all the nutrients necessary to grow. It must be protected from erosion, to build up good topsoil, and from the sun and wind to save moisture. Very small soil animals and plants (biota), which are essential in a healthy, living soil, must be encouraged and protected as well.



Good soil quality is very important in all garden plots, big and small. The women of East Timor, who do most of the cooking, home gardening and educating about nutrition, also need to learn and understand more about soil quality and techniques to improve the soil. Most of the techniques are simple, don't require heavy work and use local materials.

This is because soil quality relates directly to good nutrition – better quality soil means better quality produce with more nutrients. And they taste better too! This is a direct way of improving health.

And improved health means less visits to the doctor, better concentration, more strength and energy and a longer life. Good quality vegetables will also make people more full when they eat, and will keep them full for longer.

In Timor soils are slowly disappearing and losing their nutrients, mainly because of burning and erosion. **THIS MUST STOP!!** Farmers need to protect their soil. The soil should be looked at as the most valuable asset on the farm! If good technique and management are used the soil will improve each year.

Improving the soil does not take a lot of extra work in small garden plots. The extra work will not only improve the amount produced but will also improve the quality. More work is needed for larger areas, but the benefits are many and especially important over time because the soil will get better and better.

What is a healthy, living soil?

- It contains humus. This is partly broken down organic matter (O.M.) compost and mulch, manures, plant roots and plant material. Humus provides food for the soil biota, which then becomes food for plants. Humus also stores other plant nutrients, helps to bind the soil particles together (improving soil structure) and soaks up water like a sponge.
- A healthy soil is alive! It contains billions of soil biota that turn O.M. and nutrients into plant food. Soil biota includes bacteria, microorganisms, ants, earthworms and many, many, many more very small organisms, insects and small animals.
- It contains a good mix of clay and sand particles, not too much of either. The clay holds minerals and the sand allows drainage.
- It should hold together loosely when pressed, not crumbly like sand or sticky like clay.
- It is composed of about 50% clay, sand, humus and O.M. & 50% air pockets!

The air pockets are very important because:

1. They provide space for the soil to hold a lot of water.
 2. The air provides oxygen that the plant roots need to be able to use the nutrients.
 3. They allow easy, fast and deep root growth. Therefore plant roots can gather more water and nutrients, and the plant is bigger and healthier.
- Healthy soils act as a nutrient bank by storing nutrients that are ready for plant use. The nutrients are not leached out of the soil.
 - A healthy soil has a balanced PH level. This means that it is not too acidic (like vinegar) and not too alkaline (like salt).



OR



The importance of worms in healthy soils

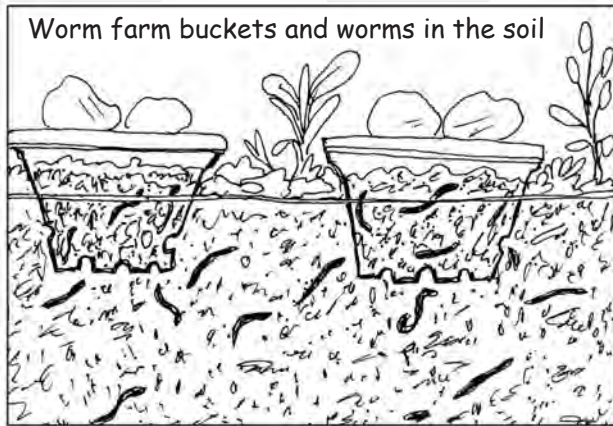
Worms are your best friends in the garden!

And these are different worms than the worms that make people and animals sick.

Many worms in your soil show that your soil is healthy. Worms eat and then cast out soil. As the soil passes through their body, the humus in the soil is changed to nutrients and the soil is improved.

In 1 year each worm can eat and cast out many tonnes of soil!!!

Every year each worm will produce 150 baby worms.



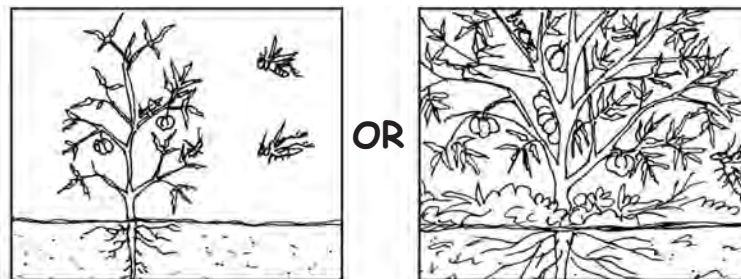
They continuously:

- Turn humus into nutrients that plants can use
- Dig and add air to the soil
- Improve soil structure and water drainage
- Bring up nutrients from deep in the soil to supply plant roots with food

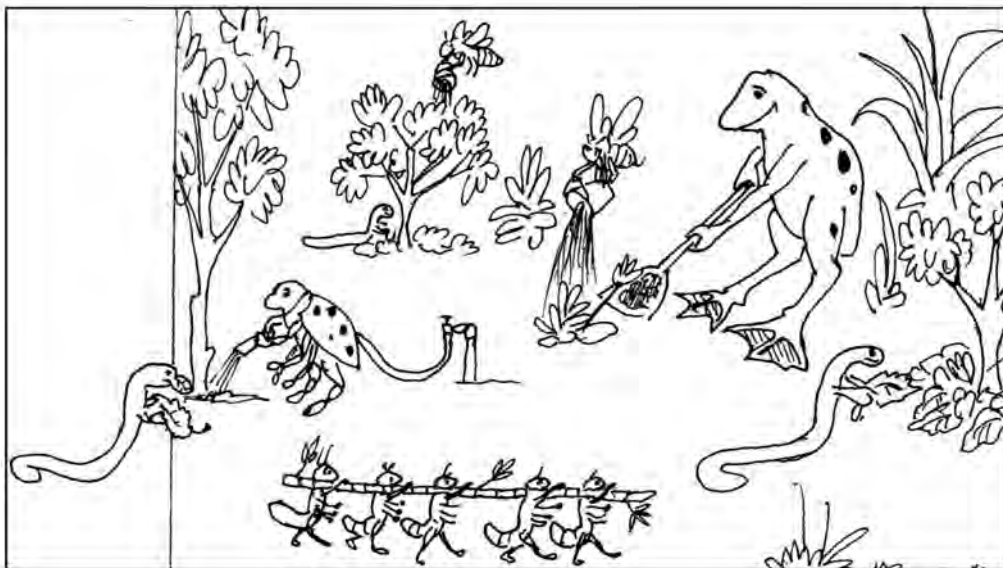
All they need is mulch and compost! But be careful because pesticides, herbicides and some chemical fertilizers will kill the worms in your soil.

Benefits of a Healthy Living Soil

1. Plants are more drought resistant. The soil can store much more water. The plants can send roots much deeper into the ground to find water and nutrients.
2. Plants are more disease and pest resistant because they have more water and all the nutrients they need for strong and healthy growth. An unhealthy person will become sick more often and it is the same for plants.



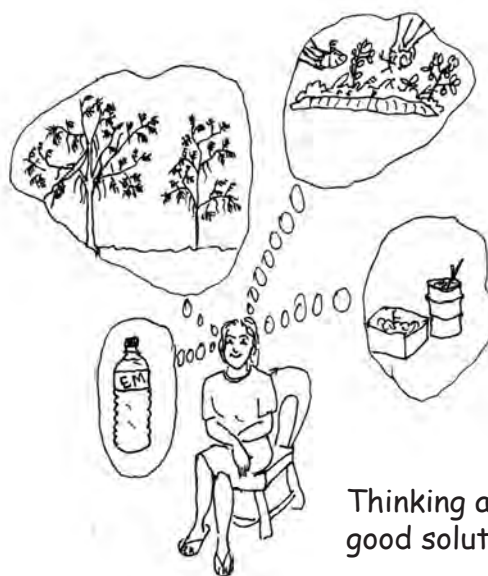
3. The food produced has more vitamins and minerals. This will improve the health of Timorese people, especially children.
4. Less watering is needed because the soil can hold and store more water. There is less evaporation of water from the soil.
5. You will have millions of soil workers that manage nutrient availability and storage for you. They will also help to increase the amount of air in the soil. Worms are particularly hard workers.
6. The soil is easier to dig and work with! This is because it has more air and better structure and it doesn't become dry and hard like cement in the dry season. This is very important and saves a lot of time and human energy.
7. A lot of money can be saved if most or all inputs are gathered locally and organically. A healthy soil needs very few external inputs if good techniques are used. Remember to collect and re-use all plant and animal waste.
8. The soil doesn't become water logged in the wet season. Even though the soil can store more water, the good soil structure allows for drainage if there is a lot of rain. Too much water can slow plant growth and can kill plants by drowning the roots. The roots need air too! In areas where there is a lot of clay water logging can be a big problem. Making raised garden plots will greatly reduce waterlogging problems as well. This means that you can grow a lot more types of vegetables in the wet season. This is very important for reducing hunger periods!



Soil workers and garden helpers

Do

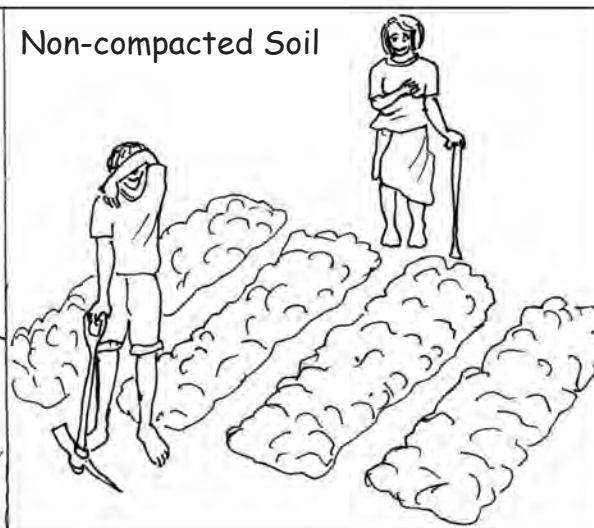
- **Use organic compost and liquid compost.** These provide a range of nutrients, are cheap to make, increase the number of soil biota and improve the soil structure and quality. Use them regularly to continually improve the soil quality.
- **Increase the number of soil biota, micro-organisms, bacteria and fungi in the soil.** This can be done by using natural fertilizers, mulch and EM – Effective microorganisms. This will improve soil quality and improve all forms of agriculture and animal production.
- **Use mulch to protect the soil** from direct sun, save water and to increase the humus content of the soil.
- **Recycle nutrients back into system** by recycling plants and animal manures back into the system.
- **Use legumes.** There are many different legumes to grow and they provide nitrogen for the soil, mulch and O.M., food for humans and animals, windbreak and soil retention, animal habitat, diversity and more.
- **Rotate crop production.** Different plants need different nutrients to grow. Rotating crops makes the nutrient use more balanced and easier to replace. Crop integration will also help.



Thinking about good solutions.



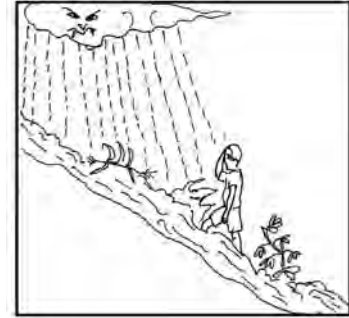
Compacted Soil



Non-compacted Soil

Don't

- **Compact the soil.** Soil compaction reduces root growth, water storage capacity and water drainage and damages soil structure. It also means that a lot of energy is used to dig the hard soil again and again.
- **Expose earth to the sun.** This will make the soil dry and hard. Therefore plant roots will suffer and the soil will be harder to dig.
- **Use anything that will kill soil biota.** They are your friends and helpers for building a healthy and balanced soil. Using pesticides and herbicides and even some chemical fertilizers will kill soil biota and create imbalance in the soil.
- **Don't waste water.** Water is precious and should be stored in the ground. Water run-off creates erosion, and the number of soil biota is reduced if the soil is very dry. They need water too!



DANGER!!! Must stop erosion!!!

- The first soil that is eroded is the topsoil and this is the most valuable soil!
- The topsoil contains a lot of nutrients and takes many years to replace.
 - Water can't be held where there is erosion.
 - Mulch and fertilizer are also lost to erosion.
 - Tree and plant roots become exposed, killing plants or slowing their growth.



DANGER!!! Must stop burning!!!

- Burning destroys valuable materials that make compost and provide mulch.
- Burning destroys valuable materials that provide nutrients for the soil.
 - Reduces the number of soil biota in the soil.
 - Exposes the soil to the sun.
 - Dries the soil and increases water loss.
 - Creates erosion.
 - Creates pollution.

Different types of soil - clay & sandy

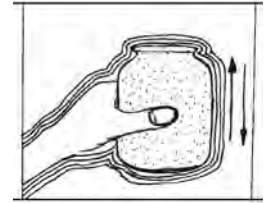
By using simple experiments you can identify the type(s) of soil that you have. This knowledge helps you to use the best method for improving your soil.

A simple test involves taking 3 or more different soil samples and putting them in separate clear jars or bottles. Fill the bottles to 2/3 full then add water to the top. Cover the top and shake the bottle thoroughly. Now let the soil settle and you can see what type of soil you have. Clay will always settle on top, then silt underneath, then fine sand. Coarse sand always settles on the bottom.



This is a great experiment for children to do as well.

Clay soils hold nutrient well, but don't have much air in them and can become waterlogged in heavy rains.



Sandy soils drain well and have a lot of air but nutrients are easily leached out and they become dry quickly.

Soil identification

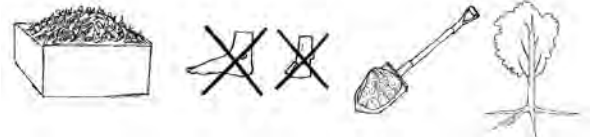
To improve your soil structure

If you have sandy soils or clay soils, the best solution is the same. Mulch, compost and liquid compost. Compost, liquid compost, organic matter (O.M.) and mulch will:



- Improve the structure of the soil and amount of air in the soil.
- Increase the number of soil biota.
- Increase the nutrient content and availability.
- Increase the water storage capacity.

More ideas for improving clay soils



- Reducing compaction is very important because once soil is compacted it sticks together. This makes root growth very difficult for plants and digging very hard for people.
- Adding sand will improve soil structure.
- Green manure crops and crop rotation help to improve soil structure over time. Read the Legumes section later in soil chapter for techniques.
- Trees and deep rooted plants help to improve clay soils. Mulch is provided and tree roots will break up clay soils. Trees can be combined with annual crops or even grown instead of annual crops.
- Gypsum sprinkled over soil at 1kilogram per square metre and dug in will help to improve drainage and soil structure. This technique improves clay soil structure quickly but is expensive. It doesn't work well if soils are too alkaline. (See Soil PH)

More ideas for improving sandy soils

- Use 3 shovels of clay in liquid composts. The nutrients will bind to the clay and when the liquid compost is used the clay will stay in the sandy soil and hold the nutrients in the soil.
- Mix 1/2 shovel of clay in a large bucket of water and spread over soil. Liquid compost is much better but this technique still adds valuable clay particles.
- Green manure crops will help to add humus to the soil that will improve the structure.
- Trees and tree crops will help. In dry areas that are sandy it is better to grow tree crops than annual vegetable crops.

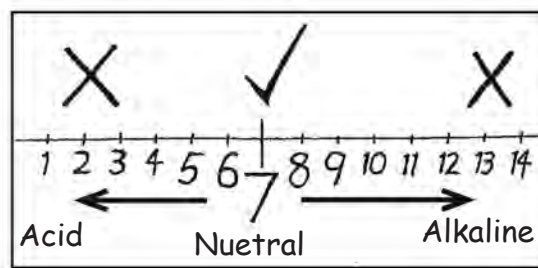


Adding clay to liquid compost

About Soil PH - acid and alkaline

The soils' PH level is a measure of the acidity (like vinegar) or alkalinity (like salt) of the soil. It is good to compare soil PH with a person's stomach.

If your stomach is not in balance it doesn't work well. It will cause problems for the stomach and the rest of your body. It is the same for soil. It needs to be in balance to work properly.



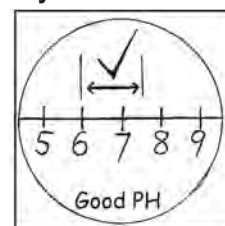
PH chart

If the soil is acidic, then nutrients are easily leached out of the soil. Productivity will be reduced and if the soil is very acidic then only a few plants can grow.

If the soil is alkaline then there are many nutrients in the soil but they are "locked up" and not easily available for the plants to use. Productivity and amount of different plants that can be grown is greatly reduced.

If you add a lot of mulch and compost you will create more humus that will balance the PH as well as adding a wide range of nutrients.

If you add fertilizer when the soil is acidic or alkaline, a lot is wasted because of leaching or "locking up" of nutrients.



In East Timor a lot of the soils are alkaline because there is a lot of coral and alkaline rock present. The large amount of coastline also increases the percentage of alkaline areas. Also, the high calcium content in the ground water points to a high percentage of alkaline soils.

Identification of soil PH

Acid soils:



- More common around wetland areas, higher rainfall areas, mountains.
- Tastes "sour" like vinegar.

Alkaline soils:



- More common in dry lands, coastal and areas of alkaline rock. E.g. limestone, coral.
- Tastes "sweet"

Soil PH tester

Soil PH can be accurately identified using a PH tester. A PH tester will give a number reading from 1 – 14, 1 being the most acidic and 14 being the most alkaline. An "ideal" soil is generally considered to be about 7 or "neutral" soil because it is neither acidic nor alkaline. Between 6 and 7.5 is still good. Some Government Agriculture workers and NGOs have the testing equipment. However by identifying landforms (e.g. swamps,), rocks and common trees you can identify the general PH without needing the equipment.

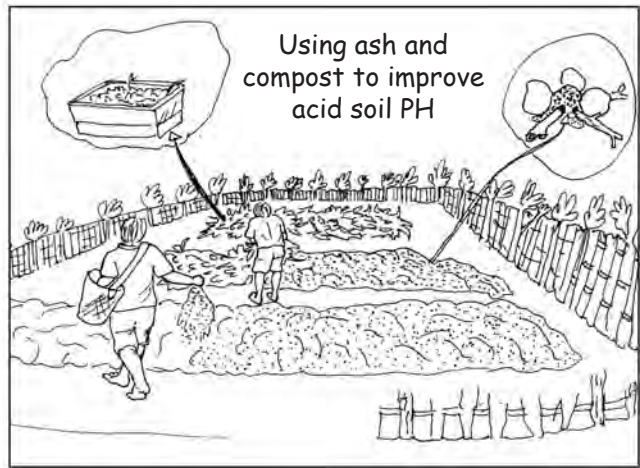
PH Balance Solutions

The BEST solution for acid or alkaline soils is to increase the humus content in the soil.

This is achieved by the use of mulch, compost, manures and green manure crops. Over time these techniques will make the PH neutral and allow more nutrients to stay in the soil and be available for plants. Recent soil tests completed at Fuloro show that soil there is neutral to alkaline. The recommended solution for PH balance in Fuloro is to increase the humus and nutrient content of the soil.

Other solutions for acid soils

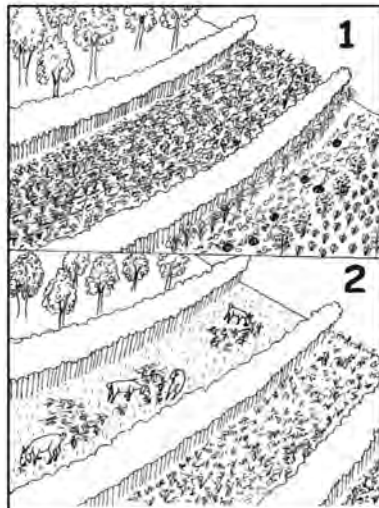
- Ash from wood fires (NO ASH FROM BURNT RUBBISH) can be spread on the ground. Use no more than 1kg (large bucket) per 30 square metres each year. Don't burn grasses or plant materials to make the ash because the grasses and plant materials are also very important for PH balance.
- For small areas of acid soils, crushed seashell will provide lime to help balance the soil.
- For large areas dolomite can be used. Lime can also be used but dolomite is better because it contains Magnesium nutrient and lime can burn plant roots. Both are expensive to buy and should only be used if PH tests are used first.



Kilograms (kg) of Dolomite needed to raise Soil PH to 6.5 per 30 metres square.

Soil PH	Sandy Soil	Loam Soil	Clay Soils
6.0	1 kg	1.5kg	2 kg
5.5	2 kg	3 kg	4 kg
5.0	3 kg	4 kg	6.5 kg
4.5	3.5 kg	6.5 kg	9 kg
4.0	4 kg	8 kg	10.5 kg

Improving soil PH
with -



Green manure crops



Soil from fish ponds

Other solutions for alkaline soils

- Use 6 kg of compost per square metre to lower Soil PH by 1 unit. (Example: 8.5 down to 7.5). This doesn't have to be applied all at one time.
- Use 2kg of manure per square metre to lower Soil PH by 1 unit.
- Iron Sulphate or Elemental Sulphur can be used but they are expensive to buy. PH tests need to be used first.

Kilograms (kg) of Iron Sulphate or Elemental Sulphur needed to lower PH by 1 unit per 30 square metres.

Iron Sulphate		Elemental Sulphur	
Sandy/Loam Soil	Clay Soil	Sandy/Loam Soil	Clay Soil
2kg	8kg	300g (1/3kg)	1kg

Cycling of Nutrients

All plants use different nutrients and different amounts of nutrient to grow. Some of these nutrients become stored in leaves, fruit, stems, trunk and roots as plants grow. Trees and deep-rooted plants can bring up minerals (nutrients from rock) from deep down in the soil, through the roots. These minerals are often not present in topsoils. Trees also draw up water from deep in the ground, acting like a big pump.

Some of the nutrient is used up in the process of a tree's growth, and some is used up by making the fruit or seed, or is stored in the fruit or seed. This is the same for vegetables and smaller plants. This nutrient is lost from the system and needs to be replaced.

A lot of nutrient can be recycled back into the soil through humans, animals and compost and mulch. The nutrient that is lost can be replaced by using the soil improvement techniques that are explained later in the chapter. In tropical climates a lot of nutrients are stored in the trees, and not much is stored in the ground.

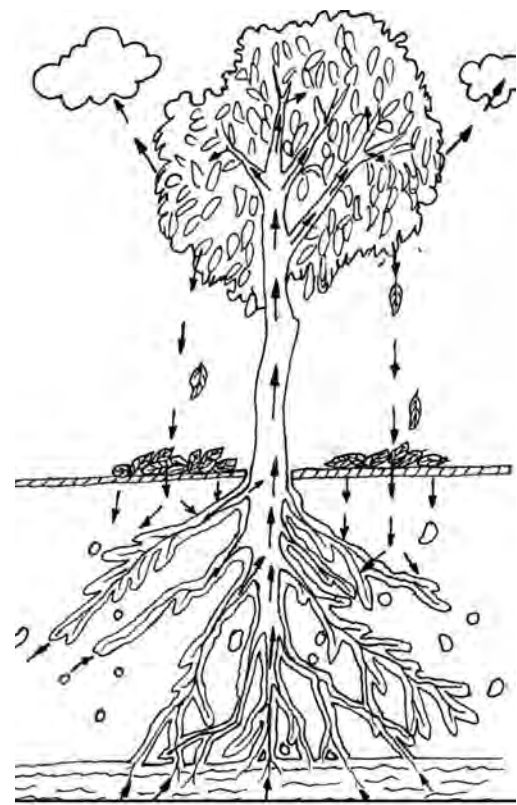
Therefore cutting down forest and trees means that nutrients are being lost from the system. The land will be good for growing crops for one or two years and then the soil becomes very poor.

At present East Timor has very little forest remaining so all that is left needs to be preserved. A lot of land is bare and needs reforestation, which will then help to restore the supply of nutrients.

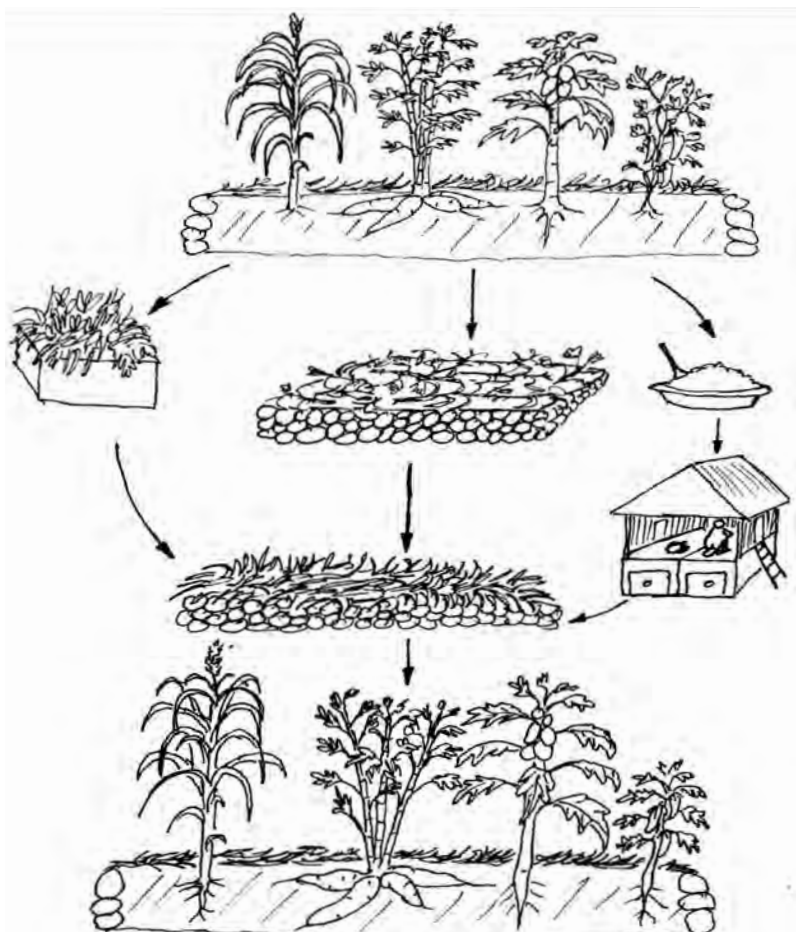
Burning is a very big problem in Timor and removes valuable nutrient from the system. Each time that the land or leaves and plant material is burned, nutrients that are stored in the plants are lost. This occurs both on agricultural land and on tree and animal grazing land. The ash does provide a small amount of potassium and minerals but this can be easily replaced by putting the ash from cooking fires into liquid compost or compost heaps. If there is a lot of ash from cooking fires then it can be spread lightly on the ground as well.

The amount of nutrients lost from burning is far greater than the benefit gained from the ash. Plant material, unlike the ash, is not easily replaced.

Remember, the more that nutrients are recycled back into your system and the more that the soil is improved, the less outside inputs that are needed.



Tree cycling water



Nutrient Deficiencies

In East Timor many soils are deficient in nutrients. Sometimes the soils are deficient in a lot of nutrients, and sometimes just 1 or 2 nutrients.

Like humans, plants also need a range of vitamins and minerals to grow well. If nutrients are not available plants will be smaller, produce less, and be more susceptible to drought, pest and disease.

Plants show distinctive signs when they are missing a nutrient.

Nutrient missing	Plant Characteristics
Nitrogen	<ul style="list-style-type: none"> • Yellowing and paleness of all leaves and new growth. • Early maturing and small size of fruit or flower.
Potassium	<ul style="list-style-type: none"> • Leaves are small, darker in colour than normal. • Older leaves can be blue/purple colour with yellow edges. • Plant growth is slow.
Phosphorus	<ul style="list-style-type: none"> • Fruit size is small and poorly coloured. • Burnt leaf edges and yellowing of old leaves.
Magnesium	<ul style="list-style-type: none"> • Edges of leaves turn yellow, yellow spots, but veins stay green. • Brown spots on leaves can also occur. • Old leaves drop off trees early.
Sulphur	<ul style="list-style-type: none"> • Dull colour of all leaves.
Calcium	<ul style="list-style-type: none"> • New leaves and new shoots grow badly and are underdeveloped. • Fruit growth can be unusual.
Micro-nutrients	<ul style="list-style-type: none"> • There are many different micronutrients that plants need. • Symptoms of problems are different too.

It is not good to simply add a basic fertilizer if plants are sick or not producing well. This approach can do more harm than good. It is much better to try to identify the exact deficiencies and problem. The solution will be more effective and cheaper.

For example, soil tests recently completed at Fuloro show that the soil is low in most nutrients and low in humus content. The calcium content is too high and is causing problems with soil nutrient balance. Magnesium and calcium need to be balanced in the soil. Therefore a magnesium deficiency needs to be corrected to balance the calcium.

Organic Soil Improvement Strategies



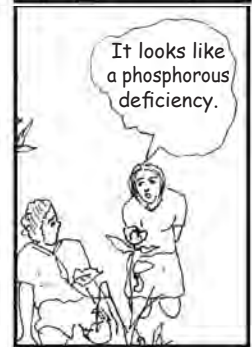
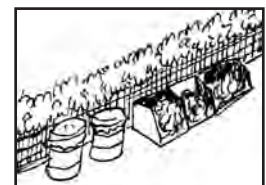
If land is under cultivation then nutrients are being used, and must be replaced. You should not only be replacing the lost nutrients but also slowly improving the soil so that it can hold more nutrients and water to increase production in the future. Organic natural fertilizers can be used regularly and can be applied before, during and after cropping.

Nutrients that are not used are stored in the soil for later. The organic fertilizers will help to improve the soil in the short and long-term.

It is always better to compost manures before using them as fertilizer. If manure is fresh, especially bird manure, it can burn small plants and young vegetables. Also, the nutrients are not yet easily available for the plant to use. Composting materials will concentrate the nutrients and make them available for plant use. It is the same as humans trying to eat uncooked rice, corn or meat!!



There are many different composting methods, some of which we will now explain. Over time by experimenting, you will find out what works best for your land, climate and needs. This could be new techniques, traditional techniques or a combination of both.



Natural Nutrient sources

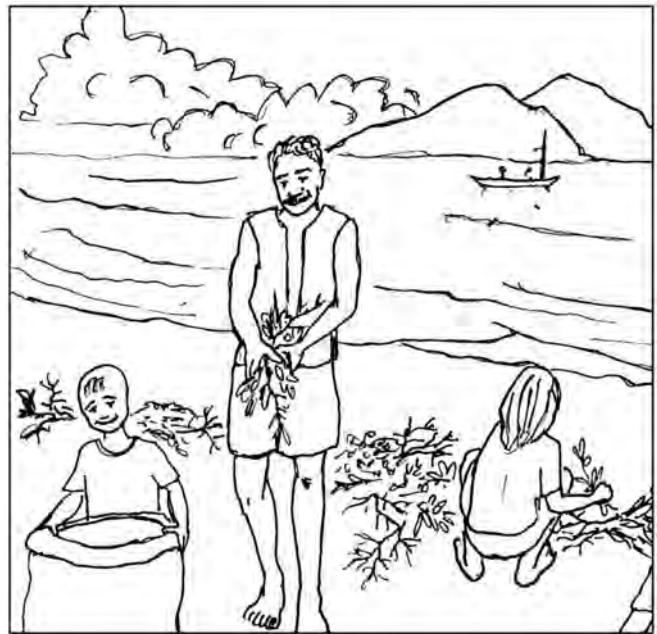
Most nutrients can be replaced by using compost, liquid compost and mulch. This is the best and most balanced method.

Sometimes a specific nutrient or nutrients are not in the ground or in the plants due to erosion, deforestation or poor soils. The nutrient needs to be reintroduced to the system and then added again once or twice a year for best results.

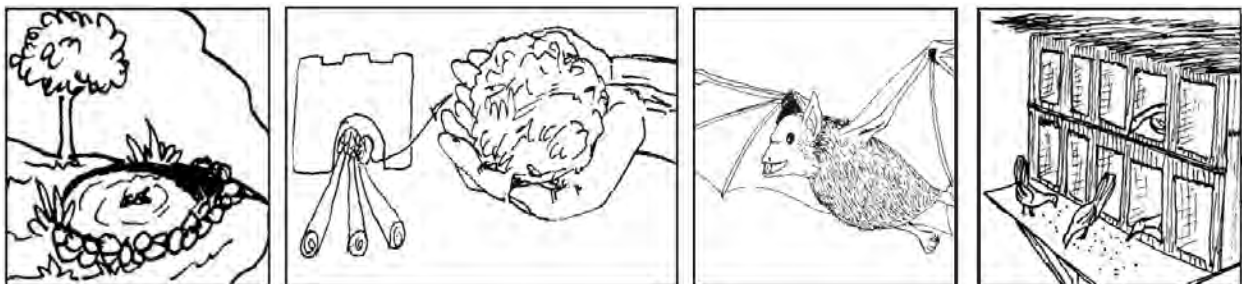
The new nutrients should be recycled in the system as much as possible to reduce the need for further inputs.

Different ways to introduce new nutrients

- Seaweed contains many nutrients. A lot of nutrients are washed out to sea with water and eroded soil. Seaweed uses and stores many nutrients and therefore can help to replace nutrients that are lost. It is a good source of micronutrients.
- High concentration manures – Bat, pigeon, chicken and duck manure. Bat and pigeon manure are best, but all are good because the manure comes from sources such as insects, seeds, tree leaves, etc. The manures will contain many more trace elements and concentrated nutrients.
- Animal bones, carcasses and innards are a highly concentrated form of nutrients and can provide a lot of micronutrients. They can be composted, put in liquid compost or buried under new fruit trees.
- Bring in mulch or manures from other areas.
- Grow legume trees to add nitrogen to the soil.
- Wood ash from cooking fires provides potassium.
- The soil from the bottom of a well-managed fish pond will contain a lot of nutrients. (Read CH 11)
- Use ponds to make mulch. Water plants are excellent at taking and storing excess nutrient of all types from water that can then be used on the garden.
- Trees leaves will provide different minerals as trees bring them up to use them from deep in the ground. Some of these minerals are stores in the leaves.
- Use a specific micronutrient fertilizer (preferably made from seaweed or rock dust) to replace nutrients. This is not a usual fertilizer, the usual fertilizers, including urea, will not replace rare nutrients.



Collecting Seaweed



New nutrient sources

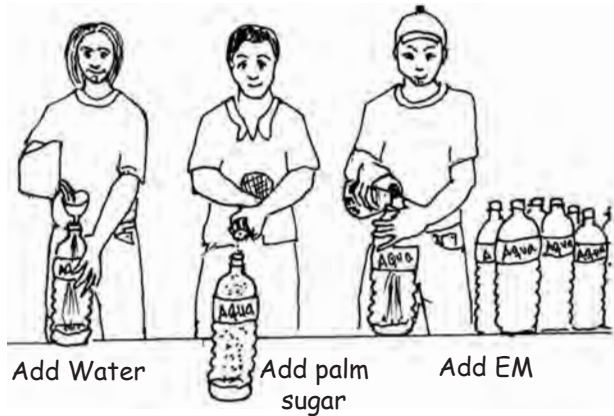
EM – Effective Micro-organisms

All organic composts provide micro-organisms, bacteria, soil biota and fungi to the soil. These are essential for improving the soil structure and quality.

EM (Effective Micro-organisms) is a liquid that can be added to any compost, liquid compost or straight into the soil. It contains microorganisms for the soil.

EM will:

- Speed up the composting process.
- Improve the quality of the natural fertilizer.
- Make the nutrients more available to the plants.
- Improve all aspects of soil quality.



It can be bought from agriculture shops in East Timor, for \$6 a bottle. **Importantly, that bottle can be used to make more bottles of EM. This is because the bacteria and micro-organisms will easily multiply.**

Only 1 bottle is needed to have a continuous supply.

How to make EM

You will need: Aqua bottles • Water • Palm sugar • 1 bottle of EM

Method: fill the empty bottles with water. Add 1 piece of palm sugar and shake very well until the sugar is dissolved. Add 1 capful of EM.

Gently mix. Leave the new EM bottles in a dark place for 2 weeks.

The Micro-organisms and bacteria will multiply quickly because they feed on the sugar. When they are ready the new bottles can be used. They can also be used to make more bottles of EM.

How to use EM

Liquid Compost – add 1 bottle to a liquid compost.

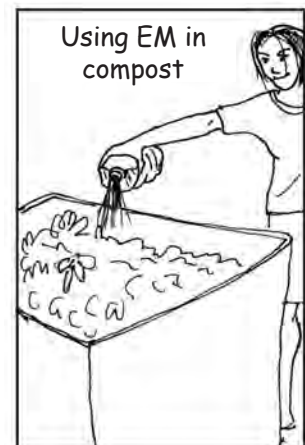
Compost – add 1 bottle to small composts and 2 bottles to large composts.

Soil – spread EM over any agricultural land and around fruit trees. Only a small amount is needed because the microorganisms will multiply. It is much more effective to use at the same time as when mulch and compost are added.

Rice paddies – Add a few bottles into the irrigation water. EM is much more effective when combined with the SRI – System of Rice Intensification Technique that is explained in the Large Scale Agriculture Chapter (CH 9).

Compost toilets – add 1 bottle every month to reduce the smell and improve the composting process.

DANGER: EM Microorganisms will be damaged or destroyed by burning, pesticides, fungicides and some inorganic fertilizers.



Liquid Fertilizer

Liquid fertilizer is easy to prepare and is very useful for everything from nurseries, small gardens, large crops, rice paddies, fruit trees and other tree crops. It is a good way to make nutrient rich fertilizer from small amounts of manure and ingredients.



It can be spread easily over a large area. It is made very strong so that it can be mixed with water, and therefore it lasts longer.

Liquid fertilizer can be made in any size container from a bucket to a steel drum, the larger the better. The fertilizer can be made and stored anywhere on the farm where the fertilizer is needed, but must be near a water supply.



STEP 1:

Cut lid off oil drum using an axe and hammer. Be sure to hit down any sharp edges.

STEP 2:

Clean inside of drum thoroughly with detergent and water and then leave in the sun for 2-3 days. This is to make sure all the old oil or petrol is removed.



STEP 3:

Fill container 1/3 full with manure.

Fresh manure has more nutrients than dry manure.



Mix different types of manures for a better result as different manures have different nutrients.

Bird manure (pigeon, bat, chicken, duck) is strongest, and then pig, goat, cow and horse manure. (The smaller the animal the stronger the manure. Mouse manure is great, if you can find any!!) Therefore you need less of the bird manure than of cow or horse manure.



STEP 4:

Fill the next 1/3 with grass, plant materials, weeds, leaves and seaweed. Weeds with long and thick tap roots (the main long center root) bring up minerals from the ground and store some of them in the plant. These weeds are good to add to liquid composts. Running weeds, like couch and kikuyu, and problem weed seeds can be easily killed and turned into useful fertilizer.



Don't use branches because they take a long time to break down and will take up valuable space. They also make stirring your liquid compost difficult.

Seaweed has valuable minerals and nutrients that are important for plants and that are sometimes lacking from soils, manures and plants. The seaweed MUST be washed well first to remove the salt because the salt will badly affect soil quality and plant growth. Only collect fresh seaweed because dry seaweed stores the salt as it dries.



STEP 5:

Add 2 or 3 shovels of healthy, living soil. This soil contains a lot of soil biota that will speed up the process of turning the ingredients into liquid fertilizer and help make the nutrients ready for the plants to use.

As the biota “eats” the ingredients, the biota will continue to multiply. Putting soil biota in the soil is just as important as giving nutrients to the plants.

**STEP 6:**

Fill the container with water.

**STEP 7:**

Other ingredients that can be added are:

- 1/2 to 1 shovel of ash, to add minerals and potassium.
- 1 or 2 shovels of soil from fishponds.

**STEP 8:**

The final ingredient that can be added is a dead animal! It is not essential but will help a lot. Rats, mice, fish heads, chicken carcass and innards or other small amounts of animal carcass can all be used. This adds nutrients and minerals but more importantly adds a lot of bacteria that will help to decompose the fertilizer ingredients.

**STEP 9:**

Cover the container to keep animals out and stop rain from diluting the fertilizer.

**STEP 10:**

Stir the container with a long stick for 5 to 10 minutes everyday for 2 weeks.

This MUST be done to add oxygen to the fertilizer. Oxygen will help to make the fertilizer nutrients ready for plants to use. Stirring to add oxygen will also importantly stop the smell!!!

**STEP 11:**

Mix with water and use. Mix 1 part of liquid fertilizer with 20 parts of water. (1 : 20)

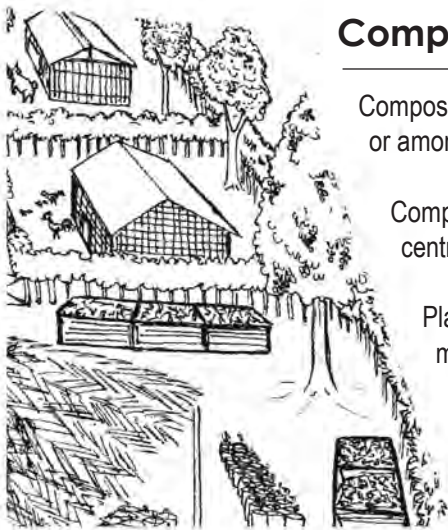
This must be followed because if the fertilizer is not diluted properly then plant leaves and roots could be burned from too much nutrient at once. Young plants are more sensitive than older, established plants.

You can use the fertilizer every 2 weeks to 1 month for vegetables and small plants and trees, giving them the same amount as when watering.

Once every month to 2 months is good for established fruit trees.

**STEP 12:**

As the fertilizer is being used you can add more ingredients, as they are needed. Try to keep balance of 1/3 manure, 1/3 plant materials and seaweed and 1/3 water. Don't forget to continue stirring!



Compost

Compost is broken down organic matter that can be added at the bases of fruit trees or amongst vegetable crops to provide extra nutrients.

Compost is made by soil biota (animals) that break down organic matter into a concentrated, rich nutrient source. Its main components are carbon and nitrogen.

Plant material is mostly carbon and a small amount of nitrogen, manures are mostly nitrogen and a small amount of carbon.

Compost also contains many other nutrients, minerals, trace elements and soil biota.

Compost not only provides your vegetables and fruit with nutrients but it also improves the soil. This is very important for future crops.

There are many different ways to make compost heaps, from a simple mix of rice husks and cow manure to lots of different materials. It depends on what materials are available. Experiment for yourself.



Cross section of pit compost

Quick Compost Heaps

- A compost heap works best if it is made all at once.

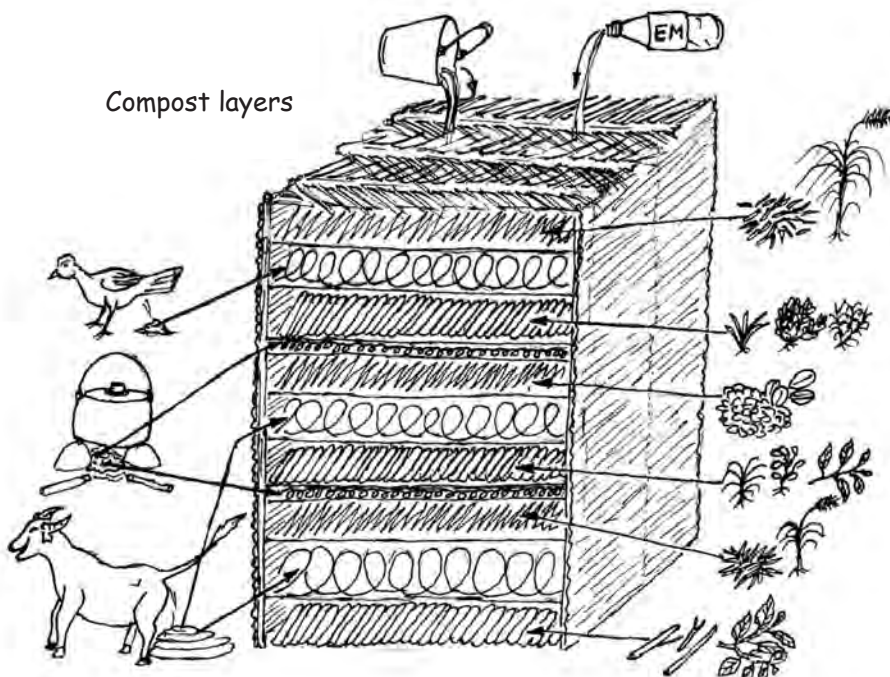
This means collecting all the materials first, then making the compost heap in layers.

- The compost heap should be at least 1 metre wide, 1 metre long and 1 metre high so that it can become hot enough to break down properly.

- You can use many different materials: manures, grasses, weeds, water plants, leaves, seaweed, soil, rice husks, coffee husks, wood ash, dead animals (mice, rats, fish, chicken etc.), urine, feathers, human and animal hair, small amounts of torn up paper and cardboard and any other natural materials you can find.

- Try to mix about 1/3 manures, 1/3 fresh leaves, seaweed, water plants, weeds and about 1/3 dry leaves, coffee and rice husks. This doesn't need to be exact. **Use your intuition.**

Compost layers



- Use smaller amounts of bird manures (bat, pigeon, chicken and duck) and larger amounts of animal manure.

- Add materials in layers of 5-10 cm starting with a 10 cm layer of small sticks and small branches. Then add layers of manure/dry material/wet material/manure/dry material/wet material and so on. Add soil and small amounts of ash throughout the compost. This technique of layers will allow for air to stay in the compost, which is VERY important. The compost must have good air flow to decompose properly. Spearing the heap once a week with a pole is important and will help air flow as well.





- Add water twice during compost construction. First add 2-3 buckets when compost is half made, then another 2-3 buckets when finished. Water is essential for composting process, but not too much. The compost should be moist but not wet.
- Cover the compost to keep rain, direct sun and animals out and to keep the heat in. It can be covered with palm fronds, old material, old tarpaulin, banana skins or leaves, or a thick layer of leaves. Old tin roofing if available is excellent in the wet season for keeping off rain and keeping animals out.
- If all the steps are followed then the compost will become very hot (about 65 to 68degrees Celsius!!!!!!), because of the bacteria activity, and cook itself into ready to use natural fertilizer and soil improver. It will cool down again after 2 to 3 weeks.
- The compost now needs to be turned inside out because the outer area does not get as hot and is not properly composted. Once the compost is turned add 2 buckets more water, only if needed, and then re-cover. The compost heap will reheat and cook for 2 weeks more.
- It is then ready to place on the garden.



Turning compost

Slow Composts

You can make composts out of only 2 or 3 ingredients, but you need to balance the amount of manure to plant material. A good mix is about 1/3 manures and 2/3 plant materials. These composts will take more time before they are ready to use. You can also make composts just from different plant materials. This takes 2 to 3 months to be ready. These are not as nutrient rich but are still very good for improving soil.

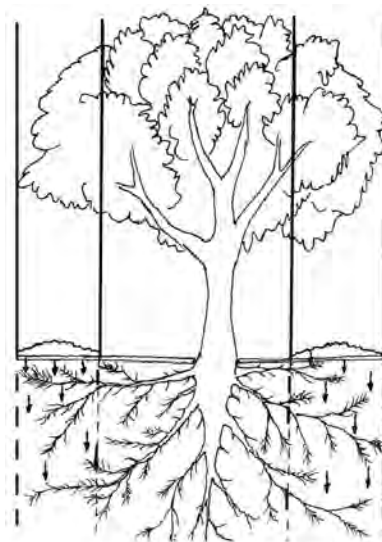


Using Compost

- Use about 2 big handfuls for each seedling and 4 big handfuls for each mature vegetable. A layer of 3-5cm on a whole garden area and around fruit trees is good.
- Put compost on plots 2 weeks before planting seedlings or direct seeding of corn, beans, pumpkins and so on, to allow nutrients and compost to infiltrate the soil. Wait 2 weeks after planting seedlings before adding more compost.



- The best place to put the compost to feed a tree is directly under the outside leaves, not around the trunk of the tree. Under the outside leaves is where the trees roots feed from most. This is the same for ALL fertilizer use.
- Put a mulch layer on top of the compost layer to protect the compost and improve the results.



Feeding zone for trees



SMART IDEAS:

- Start a new compost heap when one heap is half completed. This will ensure a continuous supply of compost. Plan ahead.
- Do not let the compost touch the trunk of the tree because this can cause rotting of the trunk.
- If the compost smells very sour then there is too much manure used and if the plant material is not decomposed then not enough manure is being used.



Compost Baskets and Trenches

Information taken from FAITH GARDEN MANUAL, written by Mindanao Baptist Rural Life Center, Bansalan, Philippines.

STEP 1: Dig holes in the middle of the garden plot, at least 1 large hand length deep, 3 hand lengths wide and 1 metre (about 1 large step apart). Or dig one long trench down the center of the plot at least 1 hand length deep and 2 hand lengths wide.

STEP 2: put bamboo stakes around the edge of the holes or trench. The stakes should be about 1 hand length apart and 2 hand lengths higher than the ground after placement.

STEP 3: Weave flexible bamboo or grasses through the stakes to make a basket or fence.

STEP 4: put in the holes or trenches:

- First -small layer (5cm) of thin branches or dried grass stems to provide air.
- Second - Different manures.
- Third – grasses, weeds and leaves and washed seaweed.
- Fourth – you can add ash (from wood fires only) as well, at 1 handful per basket or 1 metre of trench.

STEP 5: There is no need to turn the compost. As the old materials decompose just keep adding new materials, in the same layers as before.

STEP 6: Plant vegetable seeds or seedlings when the materials at the bottom are nearly decomposed. To be able to plant at the beginning of wet season, make the compost baskets or trenches 1 month before planting time. Plant the vegetable seedlings or seeds 1 hand width away from the basket or trench.

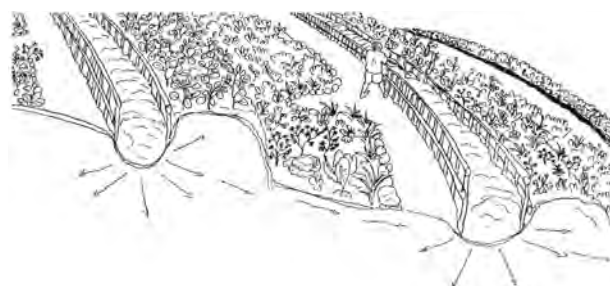
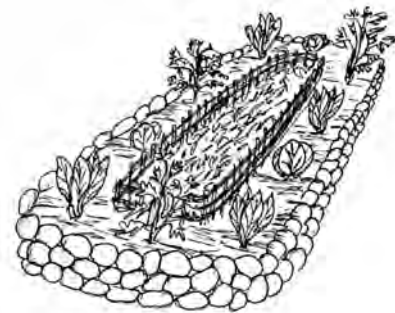
STEP 7: Water the plants for 2 weeks after planting. Then you can water directly into the compost baskets or trenches, not on the plants. The plants roots will then grow into the baskets or trench. This will improve plant growth and save water.

STEP 8: When the crop is harvested, the compost from the baskets or trenches can be dug out and placed on the garden plot to add important humus to soil. Then new ingredients can be added for the next crop.



SMART IDEAS:

- This technique can also be used for young fruit trees.
- To allow for continuous cropping, fill the baskets or trenches at different times. Each plot could be filled 2 weeks to 1 month apart.
- The basket or trench support poles can be extended much higher and used to grow beans, cucumbers and other climbing vegetables.
- Swales can be used as compost trenches for sloped land cultivation.

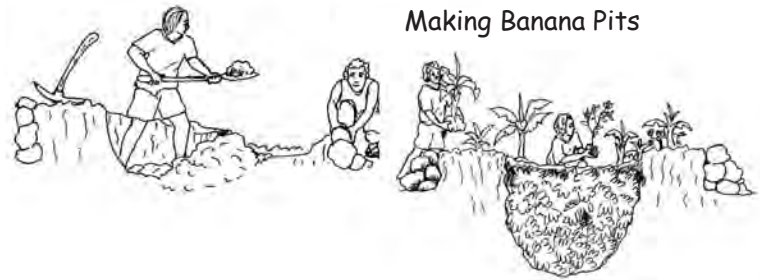


Banana Pit/ Pit composting

The Banana pit/Compost pit is an excellent way to feed vegetables and trees.

Bananas and papayas especially like the compost pits. Leaves, weeds, manure, rice and coffee husks, paper can all be added. Urine, diluted with water is also recommended.

The compost that collects in the bottom of the pit can be dug out each year and used on other vegetables and trees.



Benefits:

- A good way to deal with problem weeds and weed seeds.
- Can be easily made into a toilet or washroom. (Read Houses and Water Supply (CH 13))
- Can be used to collect and utilize excess water.
- Stores more water in the soil and in the compost material so that the wet season is extended and full benefit is gained from any dry season rains and dry season watering.

SMART IDEA:



To reduce mosquito and pest insect problems:

Soak a big handful of neem leaves in a bucket of water for 2 days, then pour some liquid, with the neem leaves, in each pit. Repeat every 3 months.

Direct Composting

Composts of manures, washed seaweed, plant materials and rice/coffee waste can be made on top of garden beds or on land where you are going to make garden plots.



The soil underneath will benefit from leached nutrients and increased soil biota. The compost can simply be spread out when it is ready.

Diluted Urine

This is an easy, free and continuous nutrient source.

Urine is very high in Nitrogen. If it is diluted in water (10-20% urine to 80-90% water) it makes an excellent fertilizer for fruit trees. Citrus trees especially respond well. It can also be added to banana/compost pits and compost heaps.

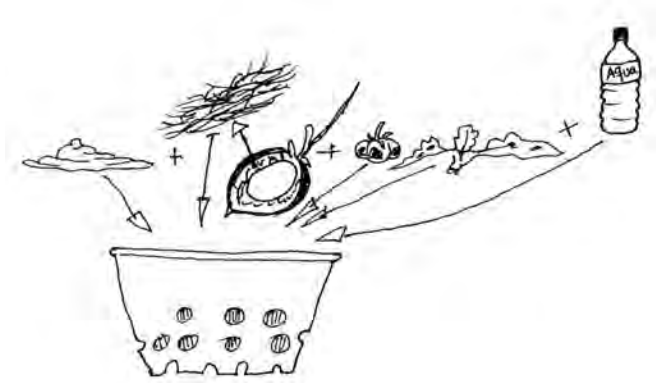
It is not recommended for use on vegetable gardens.

Mature fruit trees will benefit from direct urination, but not in the same spot each time. Again, citrus trees will benefit most. This is what we call direct nutrient recycling!



Worm Farms

Earlier in the chapter the benefits of worms was explained. More worms means better soil. There is a simple way to quickly increase the number of worms in your soil – a worm farm!



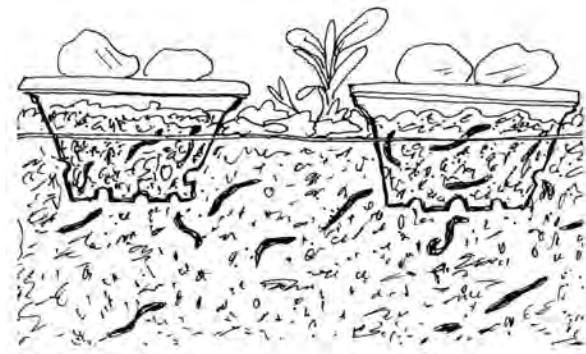
You will need:

- A old bucket.
- Coconut husk fibre.
- Fresh cow or horse manure that has been soaked in water.
- Vegetable scraps from the kitchen.
- A flat piece of wood or metal and a large rock.

How to make a worm farm

- Make about 10 large coin sized holes in the bottom and sides of the bucket.
- Dig a hole in one of your garden beds so that the bucket can fit in the hole with about a hand width of the bucket above the soil.
- Fill the bucket with the coconut husk fibre, then vegetable scraps, then manure. Use about the same amount of each.
- Cover the bucket with the piece of wood or lid so that animals can't enter and put the large rock on top.

The worms will come and eat the materials in the bucket and move back into the soil too.



Cross section of worm farm buckets

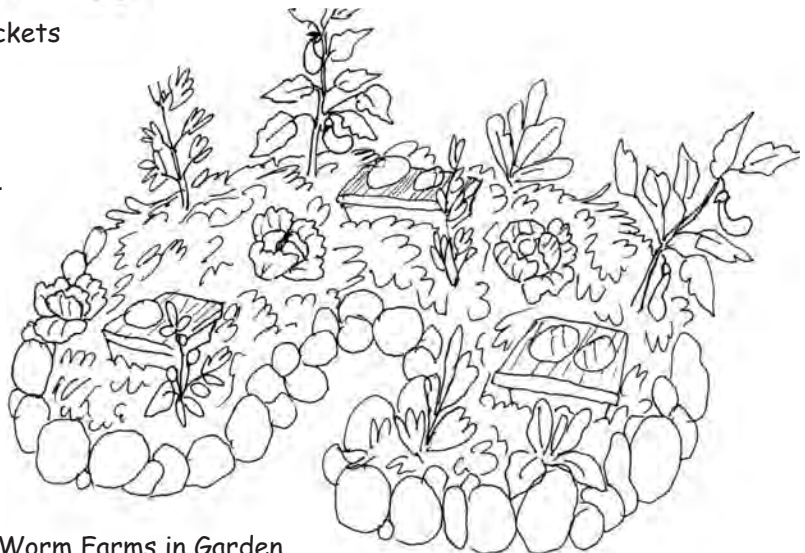
Make sure the ingredients in the bucket are moist, especially in the dry season, and add more when needed.

Once every few months you can clean out the bucket, which will have nutrient rich compost in the bottom, and add new materials.

The more worm farms you make the better.

They can be used for big or small gardens and even for rice paddies.

The result will be many more worms, better soil and healthier plants!



Worm Farms in Garden

Mulch

What is Mulch?

In natural forests, leaves, rotting trees and materials, animal manures and even dead animals all make a cover of mulch on the ground, LIKE A SKIN. This skin is continually being added to and continuously decomposing.

The mulch (skin) provides nutrients and humus to the soil and thus to the plants and trees, as it decomposes. It also provides continuous food supply for soil biota. By copying nature, and growing, making and using mulch you will provide a skin for the soil. This skin is important natural protection for the soil, from drying from the sun and erosion from the rain. It provides food for the soil biota (animals) in your garden.

Mulch to use on gardens, agricultural land, tree crops and reforestation areas can be cut grass, tree prunings, leaves, compost, decomposed manures, rice and coffee husks, old newspaper and cardboard, rocks, animal bones, whatever you can think of.



Only organic, natural materials should be used. No plastic bottles, plastic bags, cans, batteries, bottles, packaging or any other plastic rubbish.

Why Mulch?

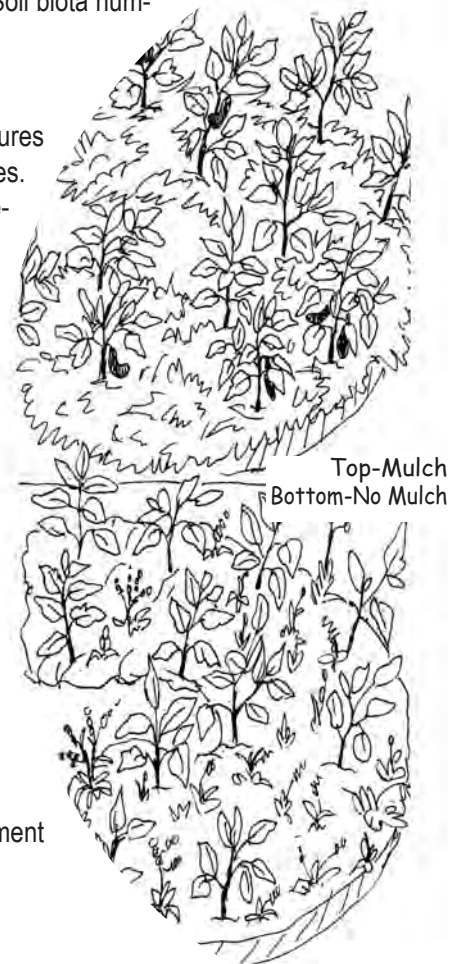
- A thick layer of mulch greatly reduces the amount of weeds that can grow. Lack of light prevents weed growth. Therefore a lot less time is needed for removing weeds and maintenance. Also, weeds that do grow are easier to remove. This helps a lot in larger vegetable areas, for fruit trees and plant nurseries.
- Mulch provides valuable organic matter and nutrients for the soil.
- Mulch will become humus and will improve soil structure and aeration. Soil biota numbers will increase.
- To increase the water storage capacity in the soil.
- Soil temperatures will be moderated. This means that the soil temperatures stay much cooler in hot temperatures and warmer in cold temperatures. More moderate temperatures mean happier plants and better growth. Remember the story, it is the same as people
- To balance soil PH levels.
- Soil will become easier and easier to dig and manage each season.
- Erosion will be reduced.
- Yields will increase.

Experiment for yourself.

Try a simple mulch test and compare the difference after 1 week, 2 weeks, 1 month, 3 months and so on. Experiment in the dry season and in the wet season. Perform the experiment in 3 different areas for best results.

YOU MUST:

- Have the same size plots
- Have the same soil type within each experimental area. Different experiment areas can have different soil types.
- Use the same amount of water for each plot for accurate results.
- Use the same soil preparation or non-preparation for each area.



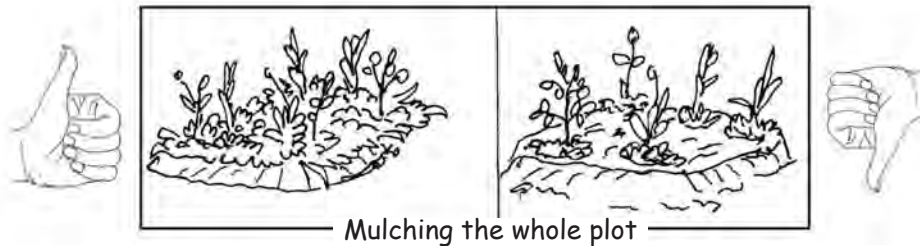
LOOK FOR:

- Differences in water content in soil.
- Differences in soil temperature.
- Differences in number of weeds and how easy they are to weed.
- Differences in plant growth and health.
- Differences in soil structure. (After 3 months or longer as this takes more time to achieve).
- Differences in soil biota close to the surface and further down in the soil. (This takes time as well and as a lot of biota is too small to see you must look very closely!)

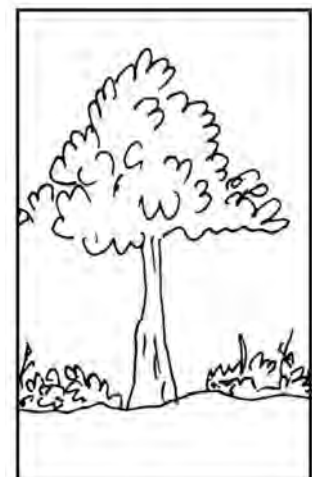
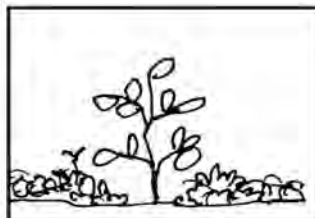
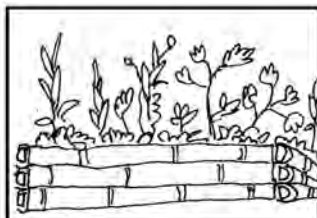


How to Mulch

- Mulch continuously, and as thickly as possible. 5-10cm is great! For fruit trees up to 20cm is even better!
- For seeds and seedlings it is easier to mulch first and then plant.
- Mulch the whole plot not just around the vegetables or plants.



- Use finer (smaller size) mulch for vegetable beds and coarser (larger size) mulch for large crops and trees.
- For trees, underneath the outside leaves is the most important area to mulch. Continuous mulching will improve tree health, and productivity.
- For vegetables, plants and trees DO NOT let mulch touch the stem or trunk. This is very important in the wet season to prevent rot and mould.
- Use rocks, thick branches, and whatever you can find to make garden borders. This will help to hold the mulch, give room for soil to build up and prevent erosion.
- Mulching the paths as well will help save water.
- If you have compost and mulch, put the compost under the mulch to maximize the benefit of the compost.
- When you use weeds, separate seeding weeds and give these to animals or put in liquid compost. This will reduce future weed growth.
- GROW YOUR OWN MULCH! All legumes, grasses and many other trees and plants can be grown to produce mulch. Remember to think multifunctional. Mulch plants can also be animal fodder plants, windbreaks, fences, erosion control, soil improvers (legumes), food production trees, timber production trees and more.
- Rice and coffee waste need to be composted or dried before using as mulch. They should be put in a big pile for 1 month or more before use or composted with manures and other plant materials.



Legumes



Legume plants are plants that PUT nitrogen in the soil. There are many different legumes in Timor, annuals and perennials. They are a very important part of any farm or system and can be used in many ways.

How do they work?

Legume plants work by “fixing” nitrogen from the air in the soil into nodules attached to the plant roots. This means that they take nitrogen from air and store it in very small storage balls called nodules. A bacteria called Rhizobium attach themselves to the roots of legumes. The nodules are the size of match heads or smaller. The nodules provide nitrogen for the legume plant.

Extra nitrogen that the legume plant does not use goes into the soil and is available for other plants to use. The bacteria is only available in the soil when the plant dies or when it sheds roots.



Legumes in Timor Leste

- **Annual Legumes:** All Beans, All peas, peanuts, clovers, crotalaria.
- **Perennial Legumes:** All Acacias, Pigeon Pea, Leuceana, Albizia, Casurina, Sesbania, Moringa, Gliricidia, Tamarind etc

Legumes can provide many other products and functions as well.

- **Products:** Food, animal food, mulch, compost material, timber, firewood, medicine.
- **Functions:** Windbreaks, living fences, shade trees, trellising.

Annual legumes can be grown together with:

- Vegetables, annual crops and with trees.

Perennial legumes can be grown together with:

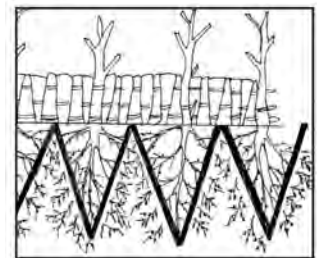
- Annual crops fruit trees and other trees.



SMART IDEA: Legumes give the best results when....

Perennial Legumes

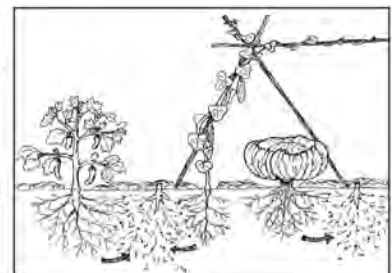
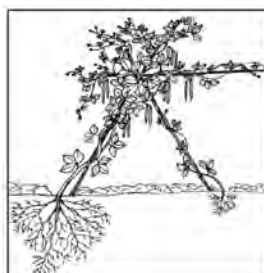
- For perennial legumes prune them 3 or 4 times a year.
- When a legume tree is pruned the roots will die back the same amount as the amount that is pruned. Therefore the roots will release nitrogen into the soil. Other plants can then use this nitrogen.
- The prunings can also be used, as mulch, animal food or compost material. As the legume trees grow again, the roots grow again and new nitrogen nodules are produced. This is a continuous cycle.
- If a legume tree dies or is removed from the land it will still provide nitrogen from its old roots for a long time afterwards.



Roots dying back

Annual legumes:

- Plants that are grown for nitrogen fixing only, not for food, should be cut back just after first flowers. This is because the plant will use a lot of the nitrogen during seed production, so not much nitrogen is left in the soil for other plants.
- Cut beans and peas off at the base or turn them into the soil when finished rather than removing the roots. This will provide some nitrogen for the next crop.



1. Beans Growing

2. Bean roots provide nitrogen for next crop

Techniques for Using Annual Legumes

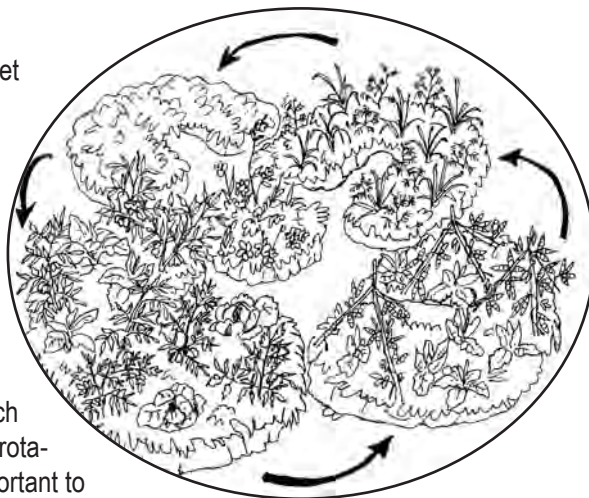


Rotation of crops

Different crops use different amounts of nutrient to grow. If you grow the same crop over and over again on the same plot then some nutrients will become depleted. The soil and its nutrients will become imbalanced.

For example:

- Pumpkins and melons love as much nutrient as they can get
- Corn, potatoes and tomatoes use a lot of nitrogen and some other nutrients
- Other vegetables use nutrients but not as much
- Beans and peas use nitrogen and other nutrients but give back nitrogen too
- Carrots and radishes like soil with less nutrients



Therefore it is good to rotate the crops from plot to plot each season or, even better, to grow different crops together. Crop rotation also helps to reduce pest and disease problems. It is important to include “rest time” in a crop rotation cycle. Rest time means that nothing is grown for a period, or a green manure crop is grown. In this rest time, mulch, manures and compost are applied and can be left on top of the soil or turned into the soil.

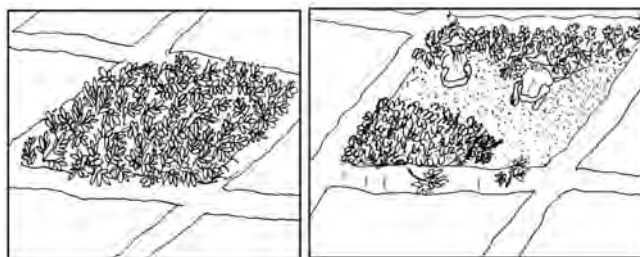
Animals can also be used in the rest time to add manure, improve the soil and reduce weed problems. Read in CH 12 about animals and crop rotation systems. Rest time allows soil to recover and means that production rates are increased for the rest of the year.

Green Manure Crops

When not using land for growing rice, corn or other vegetable crops, the soil will be improved and better prepared for the next crop if you plant a “green manure crop” of annual legumes. The green manure crop should be planted thickly and cover the whole area. A mix of legumes, annual grasses and other annual plants can also be used.

The green manure crop is not grown as food for humans, but food for the soil. Just after the first flowers appear cut back and the crop and leave it as mulch. It can be turned into the soil but continuous turning of the soil will degrade soil structure. This technique does take some time and labour, and maybe even a little bit of money, but the benefits are many:

- A lot of nitrogen from the nodules of the legume is left in the soil for the next crops
- A lot of mulch from the green manure crop has been produced
- This mulch can also be used as compost material
- The roots provide more organic matter in the soil
- Humus and soil biota increase



Green manure crop: growing and cutting

These benefits all help to improve the soil and soil structure and increase production of the next crop. Thus production more than pays back your work and time spent on the green manure crop. Remember to leave about 10%-20% of the crop to go to seed. This is to be collected and stored for next year’s crop.



SMART IDEA:

Green manure crops can be used on land that has not be used for grains or vegetables before. This technique helps to prepare the soil for future production.



Annual Crop Integration

Legumes can be integrated with other grain and vegetable crops at the same time. This technique will increase diversity and yield from a plot. The other crops growing with them will use extra nitrogen that the beans and peas produce. Even perennials like Pigeon pea can be used if they are regularly pruned. Traditionally in East Timor beans, corn and pumpkins are grown together, and there are many other combinations that can be used as well.

Integration can be mixed, in rows, in blocks, or in WHATEVER pattern suits the plants grown and the shape of the plots and the land.

Techniques for Using Perennial Legumes

Living Fences

Legume living fences are easy to grow from seed or cuttings. If they are continuously pruned they will turn into a thick hedge. The fence can also be a windbreak for vegetable plots, chicken and animal systems, aquaculture and nurseries. Importantly they are fast growing. The prunings make excellent animal food, mulch or compost material. Near the house and for vegetable plots, they will also protect the crops from animals. On sloping land the legume fences can be used to stop erosion.



Legume Tree Terraces

Plant legume trees to create living terraces.

- Plant the seeds on contour with the land
- Plant very close together. (3 – 5cm)
- Can be combined with small swales to improve results. CH 5, 7 and 9 have many examples and explain how to make them



Tree Terrace just planted

Perennial Crop Integration

Legume trees can be integrated with fruit trees, nut trees, coffee plants and vegetable and grain crops. The legume trees will provide nitrogen, mulch, protection from wind and erosion protection. They can be integrated in rows, blocks, mixed or a combination. It is up to you!

Taller legumes like the Mother of Kakau, Casurinas and Sesbanias provide shade for coffee plants, vanilla and other crops that like shade. Animals need some shade as well and legume trees can provide this function quickly.



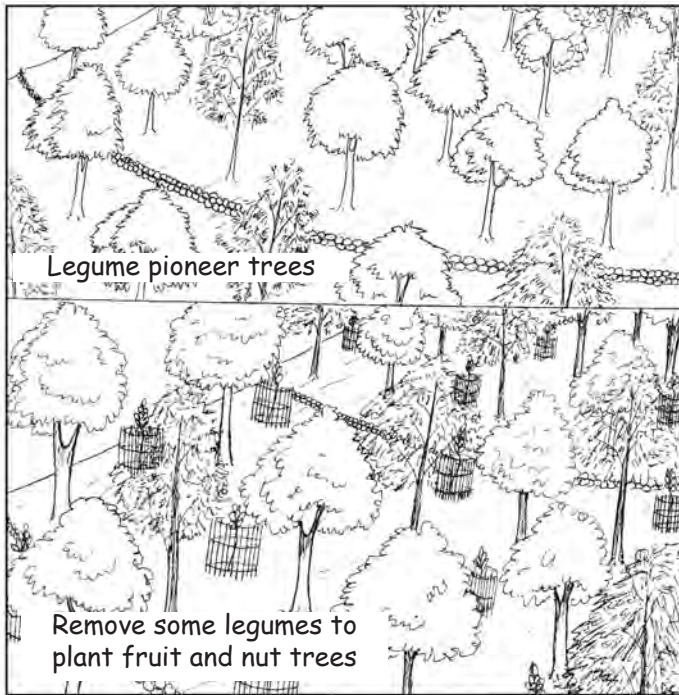
Pioneers

Pioneer trees are trees that are planted first in a system. Pioneer trees can be used in reforestation and in any tree systems. They are used to stop erosion, provide protection for future trees, improve the soil and provide mulch. Because pioneers often grow in hard conditions, pick trees that don't need much water and that can stand hard conditions best. The pioneer trees make the conditions better for future trees.



Legumes make the best pioneers because they:

- Are easy to grow from seed or cutting.
- Grow quickly.
- Provide nitrogen for other trees.



SMART IDEAS:

- Legumes are mostly short-lived trees. Use the trees with short lives for pioneers (e.g. acacias, pigeon pea but longer-lived casuarinas and Leucaena make good pioneers too) and legumes with longer lives for living terraces, wind-breaks, shade and living fences. (E.g. Leucaena, albizia, sesbania, casuarinas, gliricidia.)
- Plant many more legume pioneer trees than you will need. Then after the 1st and 2nd years, cut out the weaker, smaller trees to provide mulch and give room for the next trees.
- If legumes are planted on sloped land, when nitrogen is released it will slowly filter down the hill in the soil. This can be used to feed plants below the legumes.
- Remember that legumes are multifunctional. They provide MANY different benefits. Make use of as many of these benefits as possible.

Non-organic Fertilizers

Over recent decades the practice of using non-organic fertilizers has increased dramatically in Timor Leste and all over the world. If used correctly they provide short-term benefits for farmers. However, there are problems connected to the use of non-organic fertilizers and this information should be understood.

Soil structure is adversely affected by non-organic fertilizers because soil biota is killed. Long-term use of non-organic fertilizers promotes acidity in soils and therefore leaching of nutrients from the soil. Many non-organic fertilizers do not provide all the nutrients and minerals needed by plants.

In many countries the information and safety equipment needed to use these products properly is not easily available. This can lead to overuse problems (too many nutrients) for the farm and health problems (skin, lung problems and more) for the people that apply them or consume the produce.

If there are too many nutrients in the soil:

- Nutrient "lock up" will occur. This means that nutrients are in the soil but are not available for plants to use.
- Excess nutrients, especially nitrogen will be washed away into ponds, rivers and oceans. This causes problems with the water quality and will affect fish, water animals, water plants and humans.

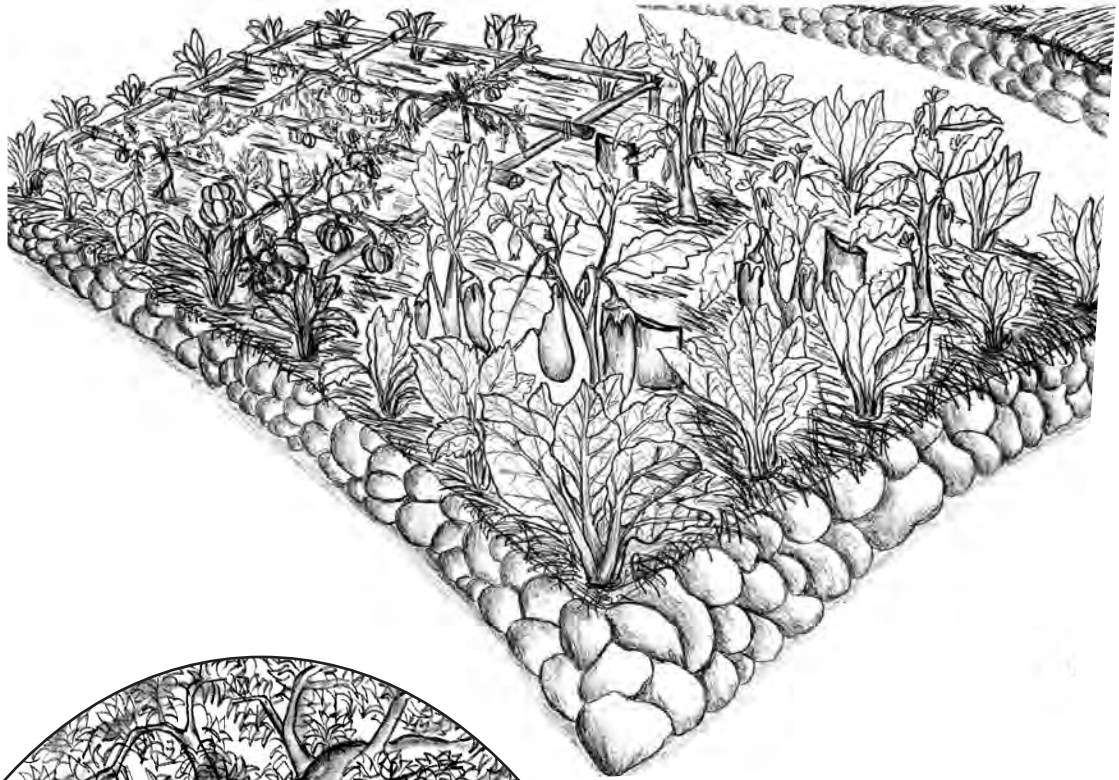
Most importantly non-organic fertilizers are expensive and must be imported into East Timor. Organic fertilizers are cheap or free and can be grown or collected locally. Remember, even if the chemical fertilizer is paid for on loan it still must be paid back. Even if the crop fails because of pests, disease or drought, and you have no produce to sell, the fertilizer still must be paid for. A lot of pollution is created when the non-organic fertilizers are made and transported. The pollution enters the air, land, rivers and oceans and is responsible for a lot of damage to the environment.



Living Soils

To end this chapter we return to the most important idea. If we have a healthy living soil then this is the base for productive and sustainable agriculture. This is true from small home gardens to large grain crops, rice paddies, trees crops, bamboo and animal raising.

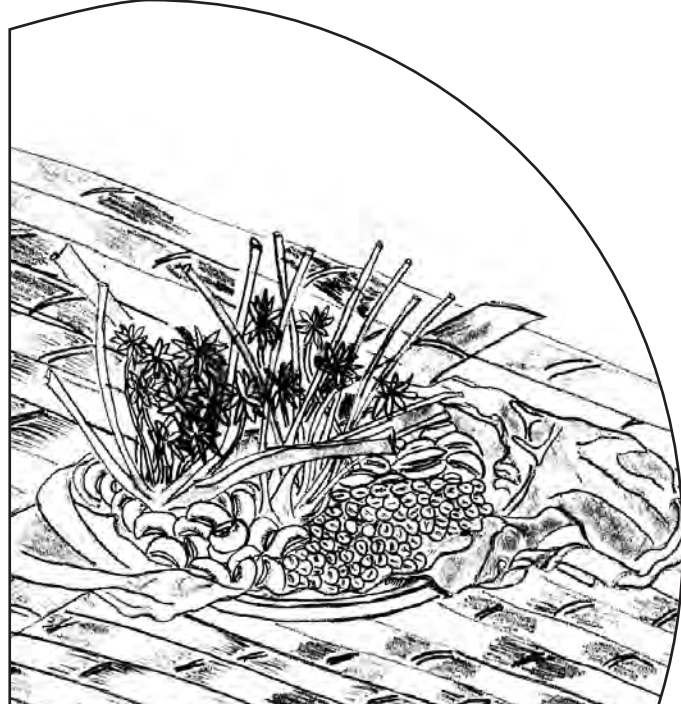
If the soil is well managed in a healthy farm system, the soil will become more fertile over time and continually produce healthy food and crops.







Seed Saving & Nurseries



CHAPTER

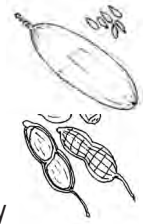


Saving and using local seed is one of the most important methods of strengthening East Timorese agriculture and increasing the number of different plants.



WHY?

- All people can collect and save seed. It is cheap and easy to do.
- Saving and exchanging local seed will increase the amount of food that can be grown and the range of foods that can be grown.
- Seeds are valuable and can be exchanged for other seed or sold through a community seed bank.
- When good techniques are used for selecting and saving good seed, the plant quality will naturally improve each year.



Local seeds are adapted to local conditions. This means that they are used to the climate and the soils where they grow. Each year that seed is collected and planted, the planted will become more adapted and stronger. If someone from Los Palos goes to live in England it will take them many years to adapt to the cold climate, people, language and culture! It is the same for seeds and plants.



The plants that grow the healthiest and strongest are the plants that the seed must be saved from.

Pollination

Pollination is the process a plant uses to make fruit and seeds.

During pollination, the pollen from the male part of the plant fertilizes the female part of the plant. These pollinating parts are usually found in the flower. Once the female part of the plant has been pollinated the plant will produce the fruit and/or seeds.



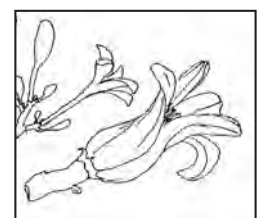
Different plants use different pollination techniques to produce seed.

1. Beans, lettuce, tomatoes, cabbage and chilli are examples of plants that have the female and male parts in the same flower.
2. Pumpkins, melons, cucumbers and corn are examples of plants the have separate female and male flowers on the same plant. These plants all require insects, wind or hand pollination by humans to fertilize.
3. Papayas are an example of plants that have separate female and male plants, and therefore require more than one plant to pollinate.



SMART IDEA:

- More insects in the garden leads to a better pollination rate that leads to more and better quality seeds. Flowers, food and water attract insects. If you have healthy soil and a large variety of trees and plants then you will have plenty of insects to pollinate your plants. A pond(s) will also help.



Cross pollination

Cross pollination is the transfer of pollen from the male part of the flower of one plant to a the female part of the flower of another plant. It occurs naturally or it can be induced.

Cross pollination of different types of plants occurs when two different but closely related varieties pollinate each other. For example: 2 different types of green-leaf vegetables, or 2 different types of corn, or a pumpkin plant and a squash plant. If this occurs, the seeds that result might be good but they usually will be weaker than the parent plants or they may not grow at all. Therefore it is best to try to prevent cross pollination of different types of plants from occurring.

Some techniques to reduce the chance of different types of plants cross pollinating are :

- Grow one type of each plant at a time. E.g. one type of corn or one type of pumpkin or squash or one type of eggplant.
- Plants like green-leaf vegetables, lettuce and cabbage flower at the end of their life. Let only one type of green-leaf vegetable or one type of lettuce or one type of cabbage flower and seed.
- If different types of a plant (e.g. beans) are far apart from each other, an many other plants are grown in between then the chances of cross pollination are reduced.
- **Hand pollination. Pumpkins, melons, luffas, gourds, chokos and cucumbers can be pollinated by hand.**

If they are pollinated naturally these vegetables can cross-pollinate with other types of the same vegetable. They cannot cross-pollinate with other vegetables. E.g. only pumpkin-pumpkin, luffa-luffa etc. Hand pollination allows you to choose the exact type of seed you want to collect.

METHOD: These plants have male and female flowers. (The female flowers have the small fruit below the flower.) Late afternoon, choose a male and female flower that are just about to open. Tie them closed so that insects or bees cannot enter.



Early next morning open the flowers. Carefully pick the male flower, pull off the petals and rub the pollen covered middle (stamen) inside the female flower.



Retie the female flower.



When the fruit starts forming tie a piece of string or material around the base of the fruit for identification.



SMART IDEAS:

- Repeat the process on other female flowers using male flowers from different plants of the same type. E.g. from different pumpkin plants that all produce the same type of pumpkin. This will help to keep seed quality and diversity.

You can use this method to try cross-pollinating and creating new types of vegetables. E.g. a new type of cucumber. But be aware that the results are unknown. It may grow well or it may not.



Introduction of new seeds & plants

East Timor already has a large range of fruit, vegetables and grains and other crops. These plants can be named to make trading and identification easier. (E.g. Maubissi Broad Beans). New varieties of plants can also be grown to add to the range of different plants in East Timor. E.g. Okra. Sometimes introducing a new type of a type of grain, fruit or vegetable can increase the yield of a crop. E.g. a new type of pumpkin.

To improve production, first consider soil quality, amount of nutrients, amount of water and sunlight. Usually these are the most important factors. Then think about the type of seed. It is important to consider all the issues.

If a new type of seed or plant is introduced:

- Always use non-hybrid varieties of seed. Non-hybrid seed can be saved each year and will grow the same each year. Hybrid seeds are produced from 2 or more varieties of a plant. Hybrid plants might not produce seeds for the next crop. If seeds are produced, they might not be the same type of vegetable or grain as the original. If this happens the quality of the next crop will be much lower. Hybrid seeds must be bought every year. Non-hybrid seeds can be saved and re-planted year after year. All of East Timor's traditional varieties of vegetable, grains and fruit seeds are non-hybrid.
- **Grow a test crop first** to find out if the plant grows well and produces well. A simple test is to grow 3 small plots of a new type of vegetable in garden plots of 3m x 1m each. Each test site should be in a different area but using the same techniques. If the crop grows well it can be grown in large plots the next year. This idea will help to increase the variety of crops grown but will not waste a lot of time, work and money if the crop doesn't grow well.



Be careful not to introduce new pests or diseases.

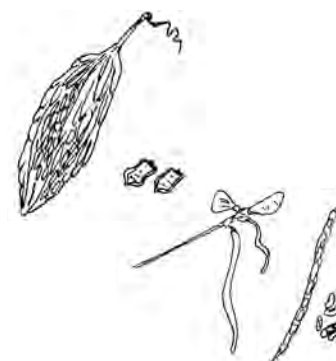
1. From one district to another. Check seed for insects and insect eggs. Remove seedpods and any plant materials. Wash seed well and re-dry. Coat seeds with a fine layer of wood fire ash to help stop further insect problems. A few dried and crushed neem leaves mixed with the seeds will also help to kill insects or eggs.
2. From overseas. The East Timor government has recently opened a quarantine department. Their regulations should be followed to ensure that new diseases and pests do not enter East Timor.

Research about potential problems

Any new plant or tree that is introduced could be a problem in the future. Plants could spread and become weeds, and could disrupt local environments. This can happen with all types of plants, and even very productive trees and plants could become problems.

Research about any new plants to find out:

- What their growing habits are.
- If they spread naturally. E.g. birds or animals eating and spreading seeds.
- Whether they have caused problems in other places.
- If they suffer from diseases that could spread in a new place.



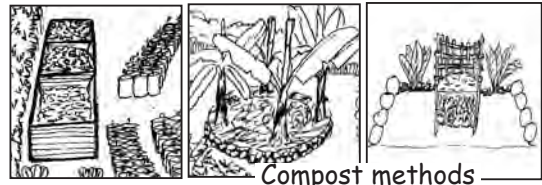
This is very important for protecting the environment and resources for the future.

How to Save Seed

Saving your own seed and storing it well will provide you with free, good quality seed that you can use for many seasons.

STEP 1: Healthy Plants

To produce quality seeds, the first step is to grow healthy plants. Healthy soil, compost and mulch are the best way to produce healthy plants. Look in the Soil Chapter (CH 4).



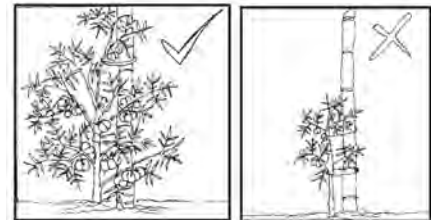
Compost methods

STEP 2: Choose the best seed.

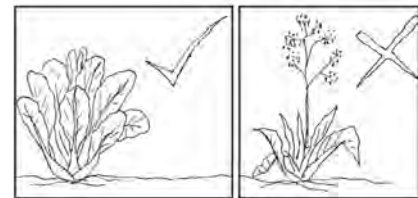
Always pick the **BEST** plants to collect the seed from.

The best and healthiest plants will:

- Produce healthy and tasty fruit or leaves.
- Be disease free and naturally resistant to pests.
- Be able to withstand extremes. E.g. able to cope with very dry or very hot conditions or still grow well in rocky soil.
- Be slow to go to seed. For green leaf vegetables, lettuce and similar vegetables collect seed from the plants that are the **LAST** to produce flowers and seed, not from the first.



Choosing good plants for seed collecting



Select seeds from many plants to ensure a healthy seed supply for the future.

If you are growing trees, for example Teak, select seeds from many different Teak trees. It is the same for all vegetables, fruit, grains and other plants. When you collect seed you will pass on the characteristics of the plant to the next crop. If you choose healthy plants you will pass on good quality characteristics, if you choose unhealthy plants you will pass on inferior characteristics.

STEP 3: How to collect the seed

Label the plants that you want to collect the seed from so that they won't be harvested for food. Wait until the plant is ripe before picking. This means leaving the vegetable/fruit/grain until it is past the edible stage. Young edible fruit has young seeds that may not germinate. The best time to pick the seed is mid-morning on a dry and sunny day. In the wet season if the rain is continuous, you can pick the fruit, seed, or preferably the whole plant and hang it up next to a fire. Even a small amount of moisture will make the seed go rotten.

PLANTS	WHEN TO PICK FOR SEED	HOW TO PICK THE SEED
Tomato, Eggplant	When ripe on the plant, slightly soft but not rotten.	Hand pick the best fruit from the best plants.
Cucumber, Melons, Zucchini	Pick about 1 month after you would pick for eating. (The seeds need to mature)	Choose the best fruit from the best plants to leave for ripening.
Capsicum, Chilli	When ripe on the plant (red).	Hand pick the best fruit from the best plants.
Lettuce, Green-leaf vegetables	Wait until seedpods are brown and dry but not yet open.	Cover seed heads with a bag then break main stem. Therefore no seeds will drop during collection.
Beans, Corn, Sunflowers	Leave to dry on the plant in dry season, pick when ripe in wet season and dry near a fire.	Hand pick when seeds are ready.
Pumpkins	When ripe on plant, then leave for 2-3 weeks before removing seed.	Hand pick the best fruit from the best plants.



SMART IDEA:

- Always pick more seed than you will need for the next season. This idea will help to prevent shortages due to insect or animal damage or seeds going rotten and allows for re-planting if some of the crop doesn't grow. Extra seed can also be exchanged or sold through a community seed bank.

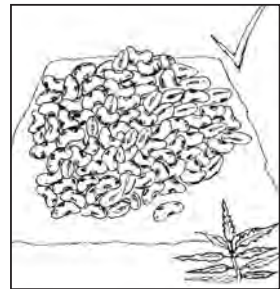
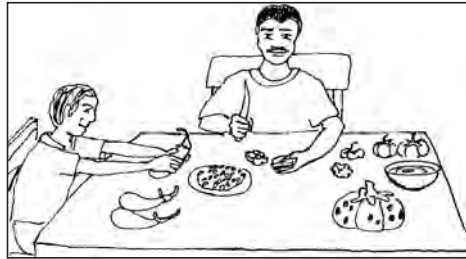


STEP 4: Cleaning the seed

1. Seeds that have a dry pod/shell or husk can be removed and separated by hand. Small seeds and pods can be placed in a bag and gently rolled and crushed to separate seeds. Any left over plant materials need to be separated from the seeds by winnowing or by hand.

2. Seeds like tomatoes, cucumbers and pumpkins need to be scraped out and placed in a bowl of water. The seed must be cleaned well and then rinsed so that all the flesh is removed from the seed. The seed can then be placed out to dry.

3. Tomato and cucumber seeds can be "fermented" to remove some diseases. First remove the seeds and some flesh from the ripe fruit. Mix the seeds and flesh with some water and leave in a bowl for a few days. Foam will form on the surface showing that fermentation has happened. The seeds can now be rinsed very well with water to clean them. All the remaining fruit flesh must be removed. The seeds can then be spread onto hard plastic, wood or metal, and put in the shade to dry.



Cleaning seed from vegetables

STEP 5: Drying the seed

This is a very important part of the seed saving process.

If the seed is not properly dried then it will go rotten when it is stored.

Seeds can be dried in whatever way you find best but it is necessary to follow some practical guidelines for the best results.

- Spread out and air the seeds. Shallow bowls, woven trays, old paper and wire mesh can be used or large seeds can be put in woven bags and hung up to dry. The more air the better. Turning them once or twice a day will allow all seeds to dry.
- Protect the seed from animals, especially mice and rats.
- Protect seeds from the wind, especially small seeds.
- Small seeds generally need about 1 week to dry and large seeds generally need 1-2 weeks to dry properly.
- Start the drying process for 2 days in the shade or inside. You can then place the seeds in the sun for half of each day. This will help to kill insects and their eggs. Bring the seeds back inside each night. In the wet season it is best to dry seeds near a fire.

Use the bite test to know if seeds are dry or not. Bite firmly on a seed. If the seed is hard and you leave no marks on the seed then they are ready for storage.

If you leave teeth marks on the seed then they need more drying time.



STEP 6: Storing the Seed

After the seed is dry it needs to be stored well.

If seed is stored well then many more seeds will grow next season. Because of the climate in East Timor seeds will go rotten quickly if they are not stored well. When in storage seed needs to be protected from:

- Air – will reduce the lifetime of the seeds
- Moisture – will make seeds go rotten
- Heat – will reduce the number of seeds that grow next season
- Animals – can damage or destroy seed
- Insects – can eat and damage seeds. If insect eggs are laid inside the container they can hatch and the young insects will eat the seed
- Light – will damage seed and reduce the number of seeds that grow next season

To prevent these problems first make sure that the seed is well dried and clean.

Then, on a dry, sunny day if possible, place the seed in a container that will stop air from entering.

To reduce moisture problems you can cover the bottom of the container with wood fire ash (not hot!), milk powder or very dry grain. These will absorb extra moisture.

Methods to reduce insect problems

Wood-fire ash: Coat the seeds lightly in wood-fire ash and put some ash at the top and bottom of the container. DON'T use ash from rubbish fires.

Neem: Put 1cm of dried neem leaves at the bottom and on top of the seeds. **Bay leaves or guava leaves** will also help.

Tobacco: Only use old, dry tobacco leaves. Place about 1cm at the bottom and on top of the seeds.

Gamal: Put about 1cm of dry Gamal leaves at the bottom and on top of the seeds.

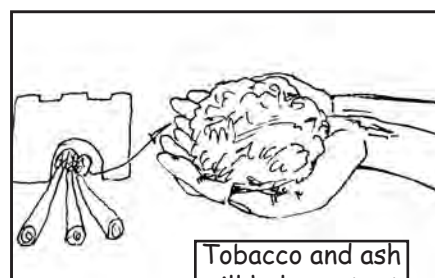
Cold: In places where it gets very cold at night, put the seed containers outside each night for a week. Put them inside again each morning. This will kill weevils (small white grubs/worms).

Salt: A small amount of salt mixed with the seed also provides pest control.

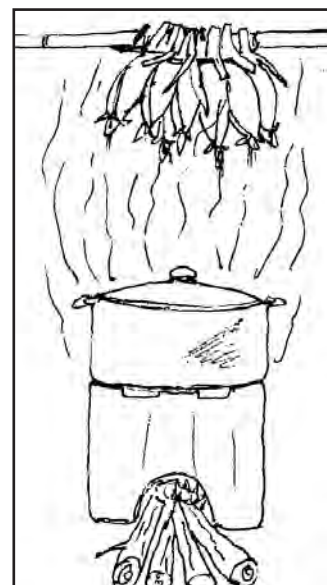
Smoke: Smoke is a preservative and a pest repellent. You can hang corn, seed pods and even whole plants above a fire as it dries to help protect them from pests.

Oil: Large seeds can be coated with coconut oil to kill insect eggs. Put a small amount of oil in a large container, add the seed, close the lid and shake until the seeds are coated with oil. Small seeds cannot be treated in this way.

Larger seeds will generally last longer than smaller seeds.



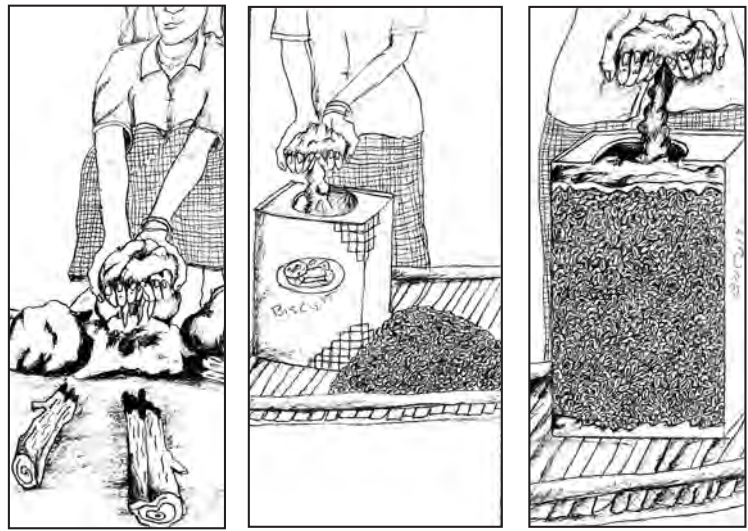
Tobacco and ash
will help protect
your seed



Containers for Seed Storage

Good containers that can be used are bamboo (+ gourd) storage containers. Important: bamboo that is correctly harvested and borer resistant is best – look in the Bamboo Chapter (CH 8) for details. You can also coat the bamboo in tree resin, coconut oil or wax and then dry in the sun. This will make the container last much longer.

Tin cans and glass jars that have good lids are also very good to use. Water bottles, oil bottles and old photo film canisters from photo shops are also good but be careful of rats and mice eating through the plastic.



Using Ash For Seed Storage in Containers

Glass and plastic bottle containers need to be put in a box to stop direct light from damaging seeds. Anything that is dry and can be sealed can be used as a container. Plastic bags can be used only if nothing else is available, but need to be put into a container that stops animals.



One large sealed container can store many small bags of seed. Store the containers in the coolest, driest and darkest place you can find. Protect from animals.

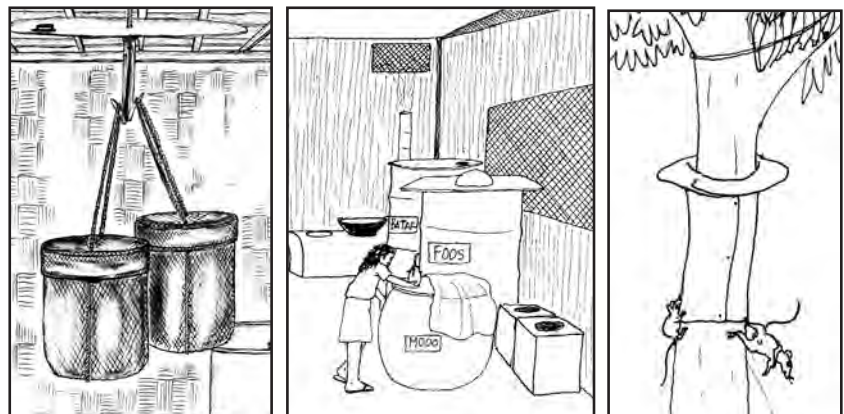
Check the stored seed occasionally to make sure there are no problems.

For larger amounts of seeds biscuit tins, oil containers and large plastic containers are excellent. Metal drums are also good but are expensive. Blacksmiths in East Timor are now making Grain/Bean Storage Silos. They can be used for large amounts of corn, beans or rice. For more information about the silos, read in the Large-Scale Agriculture Chapter (CH 9).

Traditional corn storage is a good example of easy, simple and effective storage from season to season but is not good for long-term storage.

Storage containers will reduce the number of seeds eaten by animals. Or a tin plate approximately 1m long wrapped around the tree trunk will help stop rats and mice. Fold the top of the tin over.

Most fruit trees in East Timor have seeds that should be planted straight after eating the fruit because the seed is damaged if it is dried.



Protecting stored food from animals

Live Plant Storage

Cassava, sweet potato, taro and yams form a vital part of the food crop in East Timor. The best way to store the supply for next season's crop is to leave it in the ground and use it when you need.

Spices like ginger and turmeric are the same. If you need to store some roots out of the ground, put them in an animal proof container that has air holes that are too small for rats and mice to get through. The air holes are essential to let air through and stop the roots from going rotten. A fine layer of wood-fire ash will help to stop insects, mice and rats from eating the roots.

Community Seed Saving Group



A community seed saving group is an excellent way to share excess seed and increase the variety of seeds available to everyone in the community. Community seed saving groups can also buy, sell or trade with other districts to bring in new plant varieties. Planting material can also be traded and sold. Plants like bamboo, bananas, yams, arrowroot, sweet potato, potato, cassava, taro and many more provide planting material for new plants and crops.

A community seed saving group is like starting a bank for seeds and planting material. The group collects and stores the best seeds and planting material. It is saved for the future, to grow, exchange or sell. The whole process of choosing, collecting, drying, storing

and then distributing seeds is a lot easier as a community group. It will also speed up the process of improving seed quality and therefore improving crops. Look in the Community Groups and Cooperatives Chapter (CH 15) for ideas on how to set up a community group. There are many functions that a community seed saving group can provide.

1) Seed Exchange

It can start as being a way for people to bring in their extra seed or plant material and exchange it with other people who have something different. This will increase the variety of plants that people can grow.

2) Seed and Plant Selection

Collect the seed from the healthiest, most disease resistant crops or crops in the community. 2 or 3 crops is best. Only 5 – 10 % of the crop needs to be left for seed. The families that grow the crops that seeds are collected from can be compensated by selling or trading the seed to the group. The trading could include labour, time or other products.

As well as improving the seed stock for the group it is important to find out why the crop grew well. E.g. good soil, pest predators, amount of water or sun, terracing etc. The same selection techniques can be used to improve planting material quality as well.



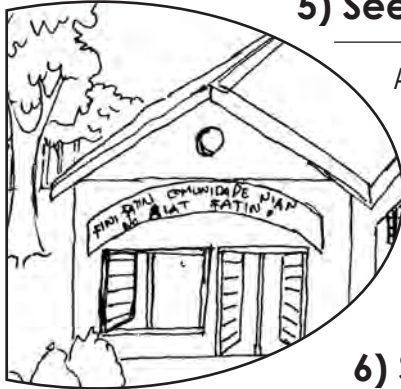
3) Seed Collecting and Drying

This becomes a much easier and quicker task if performed by a group or community. Especially for collecting tree and plant seeds and propagation material from community land.

4) Seed drying room

A seed drying room will provide a space for drying large amounts of seed, especially in the wet season. It will protect seeds from the rain and animals. Good ventilation is very important to protect seeds from too much moisture.

5) Seed Storage



A community hall or agreed upon house can be used for seed storage. Seed storage is quicker and easier if done by many people at once. Buying or collecting storage containers for large amounts of seed is much easier and cheaper if bought by a community group. Seed storage silos are now being made by blacksmiths in East Timor and are very cheap to buy, especially as a group. They are excellent for seed storage. Read in Large Scale Agriculture Chapter (CH 9) for more details. Large plastic containers and biscuit tins are also good, and better for most types of small seeds.

6) Seed Supply

Any seed that is saved must be used wisely. First, the seed should be distributed evenly among group members so that each member has enough for their own land. This includes community land. If the amounts vary a lot then other exchanges could be worked out. All members who receive seeds need to provide something to the group as well. This could be producing the seed, labour, manure, compost, land, storage containers, etc. Second, if there is extra seed, some can be kept in case of problems with collecting next years crop. If possible, it is good to always keep enough seeds for one more crop. Third, if there is more, the seed can be used for trading and selling.

7) Seed Garden

Having a community garden that is used just for producing seeds will benefit the whole community by providing good quality seed for people to grow. It also makes it easier to reduce cross-pollination and to pick from the best plants. The seed garden can also be used to grow planting materials.

8) Seed & planting material list

A list of plants, seeds and planting materials will help to show people in the group what is available to grow. It can also provide a list for people in other communities and groups of what is available for buying or trading.

Important information that is included:

- a. **Name:** Local name, Tetum name, Bahasa name, botanical name (if possible).
- b. **Plant description:** how it is used.
- c. **Plant size and shape.**
- d. **Time to fruiting:** How long after planting as a seed does the plant produce fruit or leaves.
- e. **Amount produced by each plant:** large or small.
- f. **Eating quality:** Is the variety of plant considered good to eat?
- g. **Does to plant have other uses:** E.g. medicine, building material.
- h. **Insect and disease resistance.**

If there are 2 or more types of the same plant (e.g. tomato) then write these separately as different plants with different names. E.g. Round Red tomato and Bell shaped Yellow tomato. This is because the different types will have different amounts of produce, different disease and insect resistance, and different time to fruiting and even different eating quality.

Name	Description	Size and shape	Time to fruition	Production Quality	Pest/Disease resistance	Eating Quality	Other Uses
Roma Tomato	Fruit	Oval Shaped fruit	3 months	High	possible rust disease	great for cooking	natural pesticide
Yellow Passion-fruit	Fruit	Vine, large yellow fruit	1 year	very high	possible pest problems when seedling	sweet	shade

Other benefits include:

- * Helps to identify the best place to grow each type of plant.
- * Identifies differences in types of plants.
- * Can be combined with other plant lists to form a district or national plant list.
- * Helps to assess what a community can produce and what needs to be introduced.
- * Helps to keep local plant types in the ownership of East Timorese.

9) Seed Testing

Seeds can be tested to find out how many will grow.

There are 2 good methods for testing seeds.

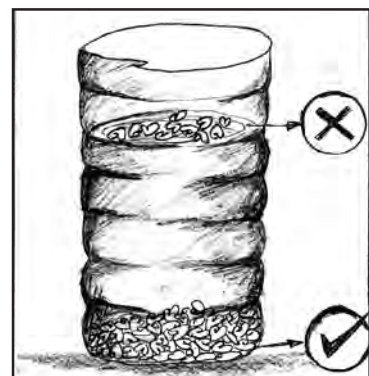
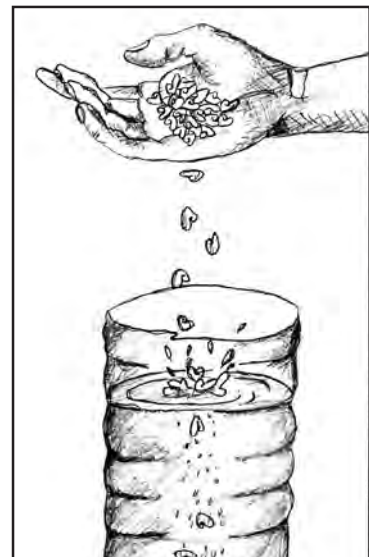
- 1. For growing your own crops.** Place the seed in a container of water. The seeds that sink are good and can be planted.

The seeds that float at the top are no good and can be thrown away. Usually, most of the seeds will sink.

- 2. For selling and trading seed.** Seeds that are sold or traded can to be tested first to find out the viability rate of the seeds. That is the percentage of the seeds that germinate and grow.

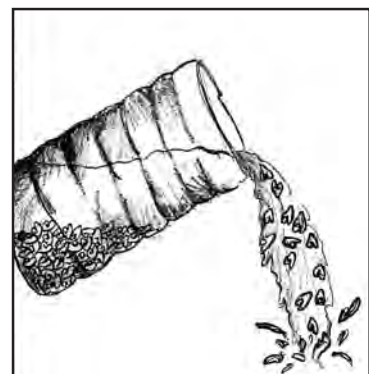
The viability rate is then written on the packets. There are different methods to do this. The basic idea is to count a number of seeds (e.g. 50 bean seeds), then plant the seeds and find out how many grow. (e.g. 40 bean seeds grow).

The number that grows is divided by the number that you planted, to find the percentage of beans that grow. (40 divided by 50 equals .8 Then multiplied by 100 to find the percentage: 80%.) This is the viability rate (80%).



Another example

30 Eggplant seeds planted
 27 Eggplant seeds germinate (grow)
 27 divided by 30 equals 0.9
 0.9 multiplied by 100 equals 90
The viability rate is 90%



It is very important that you use a good quality soil mix and that the seeds are watered every day and well cared for. Prevention of insect attack, e.g. snails, slugs or ants is very important as well. Also, the test must continue until the seeds stop germinating. The seedlings can then be planted in the vegetable garden. You can read where to find more information about seed testing in the reference chapter.



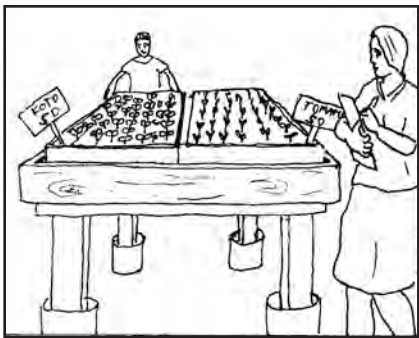


1. Counting Seed

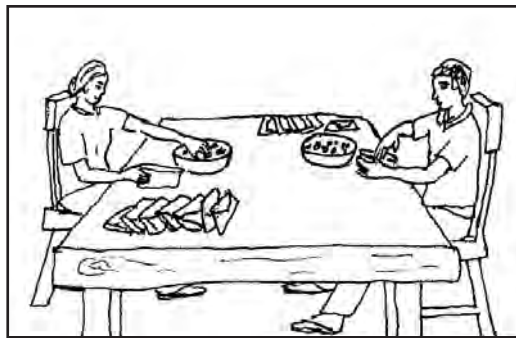


2. Planting Seed

Seed Testing
for trading
and selling
seed



3. Counting Seedlings



4. Packing and labelling seeds

10) Exchanging and Selling

- a. Seed can be packaged and exchanged or sold in the community or to other communities, towns and districts. Within communities seed can be exchanged, traded or sold as needed. Selling or trading to other communities or groups requires a continuous supply of seeds. A community group seed garden will help to increase seed supply. Seed must be tested first to make sure it is good quality before it is sold or exchanged.
- b. Planting materials can also be exchanged or sold. Crops from these plants can also be improved by selecting the best producing, most disease resistant plants to take new plants from.

11) Community Nursery

The next step is to make a community nursery where vegetables, fruit trees and other plants and trees can be grown.



Trading Bamboo



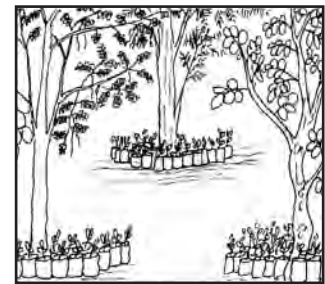
Plant Nursery

A plant nursery is an essential part of every farm and garden. It will provide the best environment for plants when they are small and fragile. The same as children need special attention when they are young, so do plants. Healthy, strong seedlings can grow into healthy, productive plants. The early stages of a plant's life determine how well it will grow in the future. This is the same for all plants and for seeds, cuttings, roots, and all methods of growing plants. A nursery can be as small or large as you need. It can be as small as a part of a garden bed with some coconut leaf cover or a large community nursery for reforestation. Small nurseries can be used to grow vegetable seedlings as well as plants, flowers, fruit trees, shade trees for animals and other trees that are planted near the house.

Important functions that nurseries provide are:

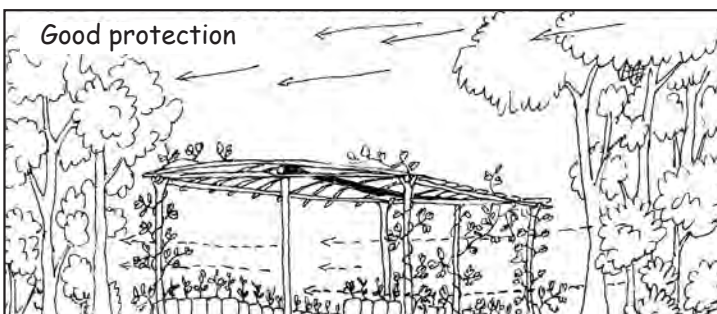
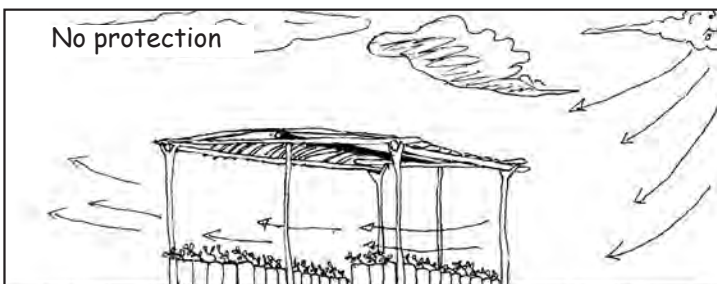
- Planting, watering and maintaining seedlings is easier because everything you need is in one place.
- Providing shade from the hot sun.
- Protection from heavy rains.
- Protection from strong winds.
- A controlled environment for young plants. Animals can be kept out and water and fertilizer can be easily applied and checked.
- Soil that allows for fast and strong root growth, good drainage and supplies enough nutrients.

In this section we will explain all of the steps necessary to create a good nursery.



Nursery Location

The nursery is the heart of the garden, and requires daily attention. It should be located close to the house and close to the garden. A nursery requires water on most days so it needs to be located close to a water supply.



Trees can be used for shade for the nursery. Too much shade though will cause problems later on as the seedlings will be weak. Good shade trees for nurseries, like Sesbania, Albizia and Eucalypts, will allow some sunlight through. Trees like Mango and Avocado give too much shade.

The best situation is to allow morning sun and provide shade during the middle of the day and mid afternoon. This is when the sun is hottest. Some gentle wind is good for the plants but exposure to strong winds will slow growth.

Windbreak protection from strong winds may be needed.

Nursery Design and Construction

Every nursery that is constructed will be different because of different needs, different land and different construction materials.

The examples that we show can be used or you can come up with your own design. Make it as long lasting as possible. Nurseries should have areas with different amounts of sunlight. It is good to have 3 different areas.

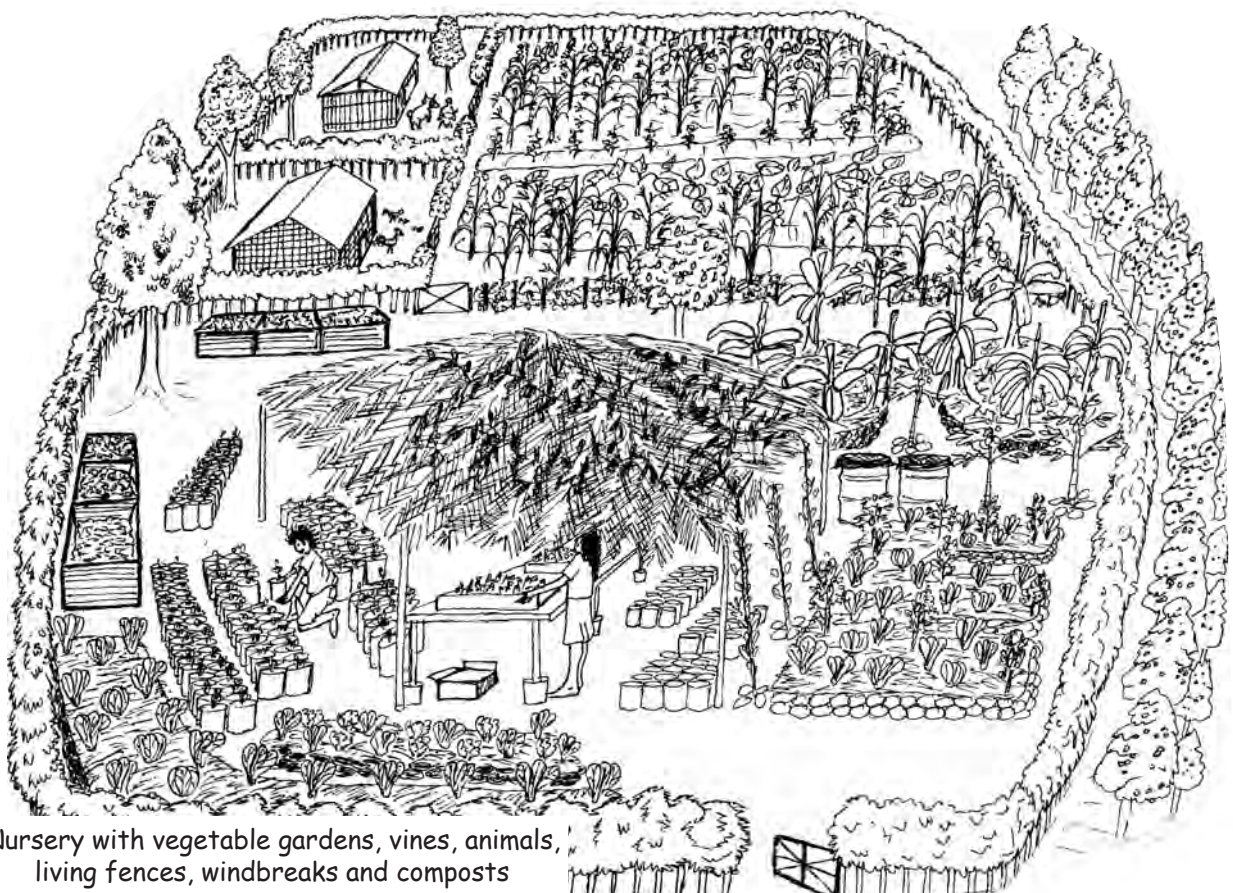
1. **Small seedlings and delicate plants** need good protection from the hot sun and from heavy rains.
2. **Larger seedlings** need less protection and benefit from more sunlight.
3. **An area that allows full sun.** This is for seedlings to “harden” before they are planted in the ground. To “harden” a plant is to prepare it for the conditions that it will grow in. Large tree seedlings need 3 - 4 weeks to harden and vegetable seedlings need 1 week to harden before planting.

When designing and building a nursery it is good to leave room for future nursery growth. All nurseries need to provide protection from animals. Nurseries that are waist high provide animal protection and protection from snails and other insects. Also, importantly, they are much easier to manage. Bending over all the time is no fun and puts stress on your body. Remember – think smart, not hard.

Larger nurseries are much easier to build and maintain if a group of people are involved. This could be family, neighbours, a community group, school or church. Everybody involved will benefit more from the work that they do and costs will be less. Different people can have different areas in the nursery if they want or everything can be grown together and then divided up when it is ready to plant. Or a combination of both.

Larger community nurseries are important for growing trees for reforestation work.
Nurseries can also be multifunctional

- Vines like luffa, cucumber, beans and gourds can be grown on the structure and the fences.
- The nursery area can also be the liquid compost/compost making area for the garden.
- It can be used for seed drying in the dry season.
- Excess water can be directed into vegetable gardens or small fruit trees and vines.



Nursery with vegetable gardens, vines, animals, living fences, windbreaks and composts

Good materials to use for construction

- **Eucalypt poles** are good to use for the main frame because they are long lasting.
- **Bamboo can be used for poles** but some types will go rotten in 1-2 years.

Some types of bamboo are borer resistant.

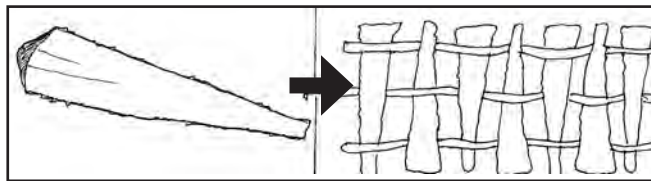
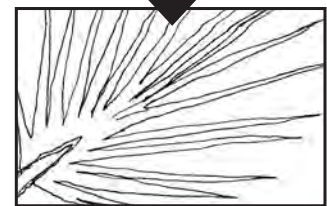
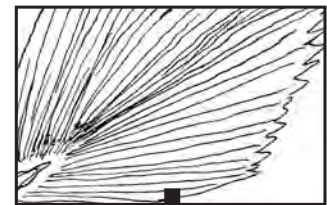
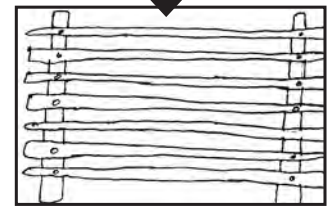
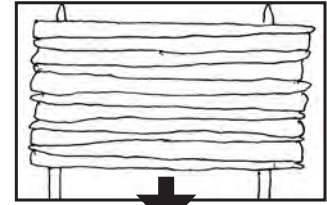
Correctly harvested and treated bamboo will last many years longer. (Read in the Bamboo Chapter (CH 8) of this book for details)

- **Roofing materials can be :**

- Bebak panels that are split.
- Split bamboo.
- Coconut leaves
- Grasses tied up in clumps (use only a thin cover so that a small amount of sun can come through)
- Split palm leaves

- **Fence materials can be :**

- Living fence
- Bamboo or wooden poles
- Palm leaf stakes
- Bebak panels
- Whatever you can find that will keep animals out!

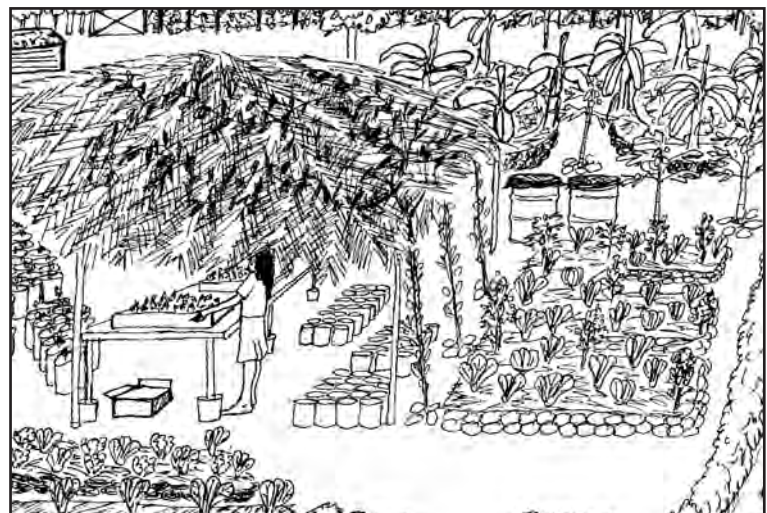


SMART IDEAS:

- In the mountain areas, seedlings will grow better if they are raised off the ground. Waist height is best. This is because at night the air temperature is coldest on the ground. Very cold temperatures can damage and even kill some seedlings. Other plants and trees nearby will also reduce cold temperature problems. A thick cover (10-15cm) of rice or coffee husks on the ground will also help. But a layer of rice or coffee husks could promote fungus problems in hot areas.

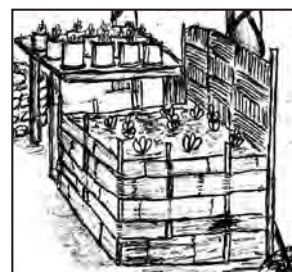


- The edge around the nursery is easily turned into a very productive garden plot. This is because of the excess water and nutrients that flow out from the nursery.

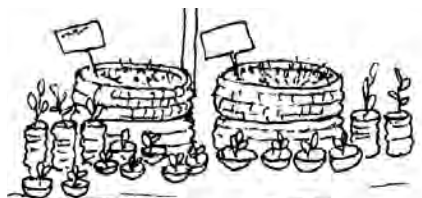
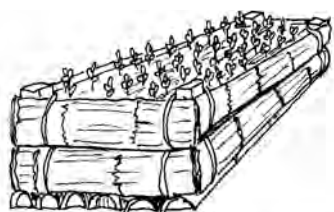


Seedling Boxes & Containers

Seedling boxes and containers need to be deep enough for roots to grow long and not grow around in circles. Seedling boxes are easy to make and they are good for growing many vegetable seedlings at once. They are also good for planting tree and plant seeds, which can then be planted into separate containers when they are about 1 month old or 4 sets of leaves old. Height and good drainage are important. Choose the size of the boxes to suit your needs and the materials you have. They can be made from any wood old or new including bamboo. If using bamboo place the bamboo outside up to give better water drainage.



Many different containers can be used for seedling and plant containers. Metal tins, buckets, old drink containers, food containers and old tyres are just some of the materials that can be used.



All seedling containers must have drainage holes at the bottom.

Plant and seedling containers can also be made from:

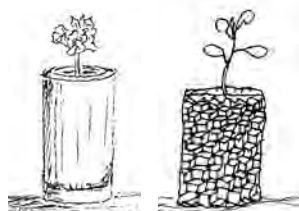
- Coconut shells



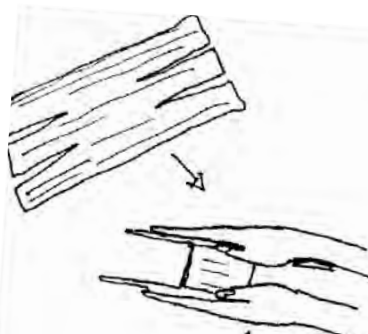
- Bamboo



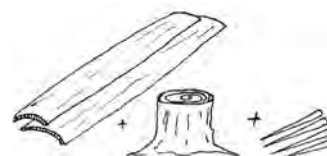
- Woven palm leaves
- Banana trunks
- Banana leaves (Should be 1 finger length wide at the base – better for water retention.)
- Poly bags are the easiest to use for large nurseries with a lot of trees. They cost money (About \$4 for 300) but they save a lot of time and work.



Banana leaf seedling container



Banana trunk seedling container



Soil Mixtures

Good soil mixtures for nurseries and containers are very different to the soil in the ground.

The most important part of making a good soil for seedlings is to make sure that the plant roots can grow easily and that water can drain easily.

It is also important to provide a small but steady supply of nutrients for seedlings. All plant seeds contain the food needed by the plant for the first few weeks of growth.

For the best results use different soil mixtures for specific needs.

Cuttings and Seeds

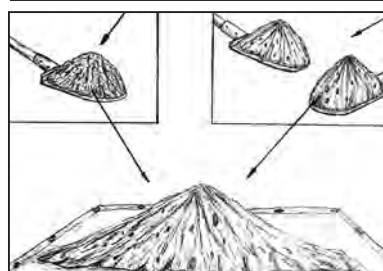
Plant cuttings and seeds only need a small amount of nutrient for the first month of growth. **Too much nutrients can cause problems.**

Some examples of soil mix for cuttings and seeds:

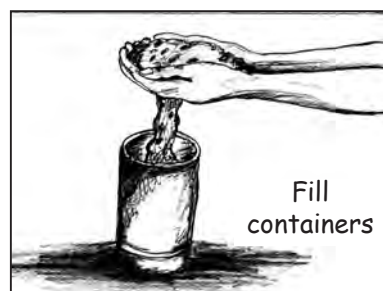
- 25% compost/dry manure
- 25% soil
- 25% sand
- 25% rice husks or composted coffee husks

Add a few handfuls of wood fire ash to a soil mix to improve the soil and help balance the soil PH.

- 50% sand or rice husks or composted coffee husks
- 25% compost/dry manure, 25% soil
- 25% compost
- 50% sand
- 25% rice/coffee husks



1 shovel compost to 2 shovels sand/soil



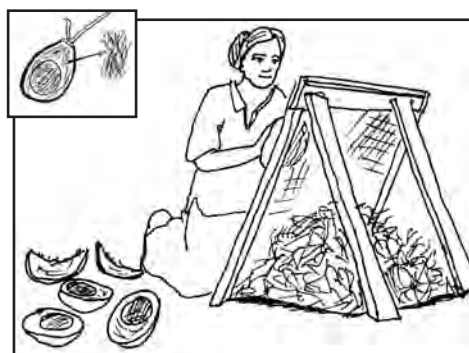
Long-term Trees and Plants

Trees and plants that have been planted into a container or polybag need more nutrients to grow well. More compost or dry manure can be added to the soil mix and liquid compost can be used. Some examples of soil mix for long-term trees and plants.

- 30% compost/dry manure, 30% soil, 30% sand, 10% ash/rice husks
- 50% composted manure/rice husks, 50% soil/sand.
- 50% sand, 50% dried manure/compost.

You can make your own mixes but remember what is important for good nursery soil.

- Soil from the ground does not make good soil for nurseries and needs to be mixed with other materials.
- Sand, rice husks and composted coffee husks provide good drainage and aeration for easy root growth.
- Ground coconut fibre is good to use. This can be made by scraping the coconut fibre against a wire frame.
- Compost and dry manure (cow, horse or pig manure) provide nutrients.
- Don't use chicken manure or fresh manure because it might burn the seedlings.
- Coffee husks can be used if it is composted first.
- Liquid fertilizer is good to use for seedlings more than 1 month old.



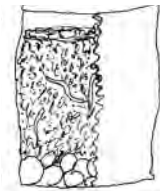
Ground coconut husk is great for soil mix



SMART IDEAS:

Put 3cm of small rocks at the bottom of seedling containers before you put the soil in. This will improve the water drainage.

- If seedlings are grown in vegetable plots, mix in rice husks, sand, and a small amount of compost and dry manure with the soil to help the seedlings to grow better.



Problems of too much nutrient and fungus

In the wet season, the seeds and seedlings may become affected by fungus in the soil.

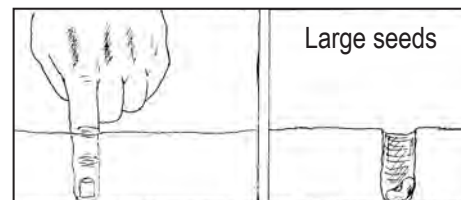
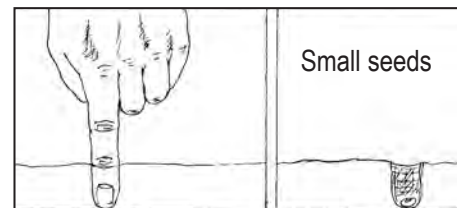
This is a common problem that will stop seeds from growing and make young seedlings rot.

If this happens to your seeds, there are 2 solutions you can use to stop this problem.

1. Use less manure and compost in the soil mixture. Manure and compost contain fungus and bacteria. For garden soil the fungus and bacteria are very beneficial. For nursery soil mixture too much fungus can cause problems.
2. Before you plant the seeds bring water to the boil and then pour onto the soil in the seedling containers. Use a lot of water. This will kill any fungus in the soil mixture. When the soil is cool again you can plant your seeds.

Planting Seeds

- **Small seeds should be planted about one finger knuckle deep in the soil**
- **Large seeds should be planted about two finger knuckles deep**
- **Vegetables that grow better when the seeds are planted in a nursery are** cabbage, tomatoes, green-leaf vegetables, spinach, eggplants, capsicum, onions, chilli, cucumbers, peas, okra, lettuce and mustard.
- **Vegetables that grow better if the seeds are planted straight into the ground are** pumpkins, corn, beans, peanuts, radish, sunflowers, luffas, squash, gourds and melons.



Most trees seeds need to be planted in a nursery and all will grow better if they are planted in a nursery. In some situations legume trees and papaya trees grow better if planted straight into the ground. Living terraces, living fences, pigeon peas, sesbanias and papayas in a mixed tree system.

Any time that seeds are directly planted the area should be protected from animals.

It is good to label each type of seed and plant. Write the name and date when planted. This is important for large nurseries and community nurseries.



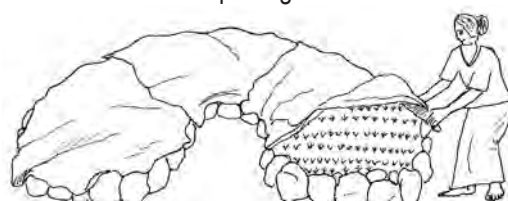
When to Plant

- Vegetables usually take about 3 – 4 weeks from seed to planting in the garden
- Fast growing trees take 2 – 3 months
- Slow growing trees take 3 – 5 months

Plant the tree seeds so that they are ready to plant in the beginning of the wet season.

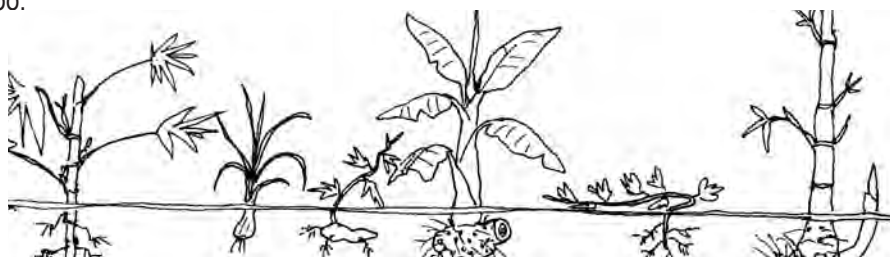
Carrots are a special case. They grow much better if planted straight into the ground but they need special attention to improve germination and growth.

1. Dig the soil very well before planting. Add some sand (if possible) if they soil is clay
2. Water the ground
3. Plant the seed very close to the surface and then spread a thin layer – 1/2cm – of sand or fine soil
4. Water again and then cover ground with old material or sacks for about 1 week to keep the ground moist
5. Water a little each day if no rain
6. Check for seedlings. When the first start to grow remove the cover and keep watering ever day or 2nd day for 2 weeks



All vegetables and plants that are grown from dividing roots or stems can be planted in a nursery but will grow better if planted straight into the ground.

Examples are sweet potatoes, potatoes, cassava kang kong, watercress, taro, garlic, onion bulbs, yam, ginger, bananas and bamboo.



Collecting young seedlings

Sometimes the easiest method for growing trees, and even for some vegetables and flowers, is to collect the young seedlings.

Young seedling trees can often be found under large parent trees.

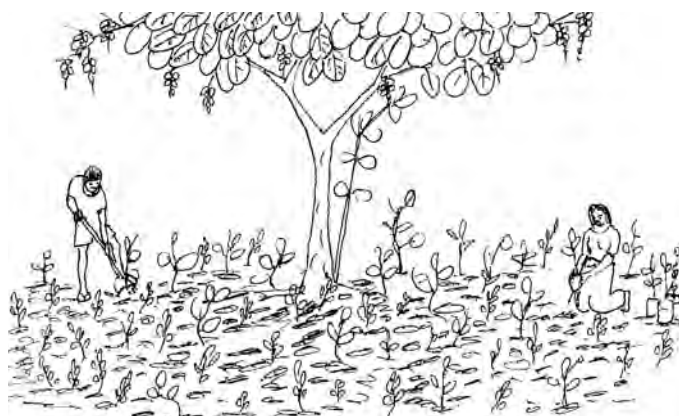
These seedlings need to be taken as small as possible – about 5 – 10cm is best. This will reduce the stress and root damage caused by removing them. Be careful and dig them up, don't just pull them out.

If the seedlings are bigger than 20cm, prune them back to 2 or 3 leaves high. Water the seedlings first or collect the seedlings after rain to reduce root damage and stress.

Replant into seedling containers, place them in a shaded area for a week then put into the nursery and treat them the same as the other tree seedlings.

If it is the beginning of the wet season and you want to plant them directly into the ground, give them shade for 1 week after planting.

For vegetable and flower seedlings, use to same technique, but plant straight into the ground and give them shade for 3 days.



Propagation Techniques

Cutting Propagation

There are many trees and plants in East Timor that can be easily propagated. Sometimes different plants need slightly different techniques but the following steps cover the basic method for good results.

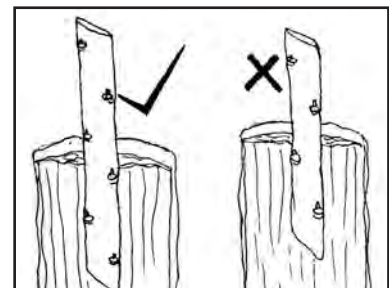
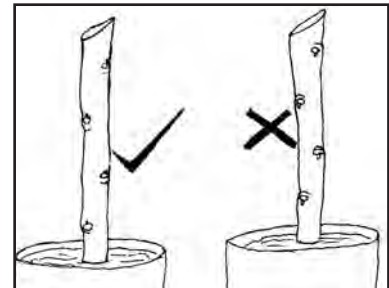
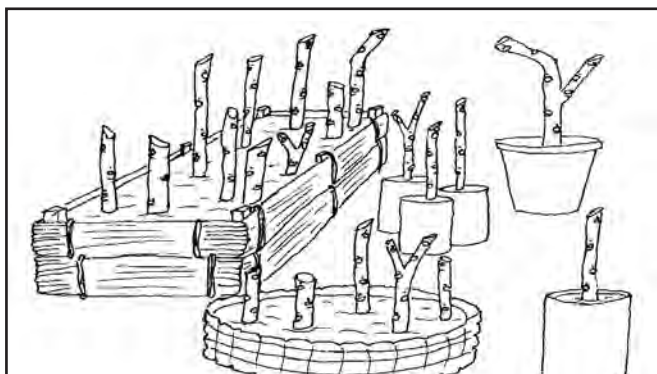
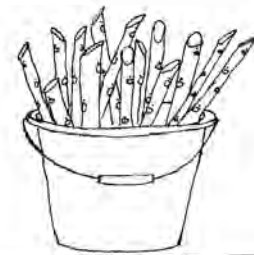
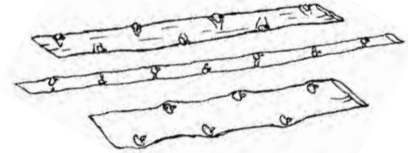
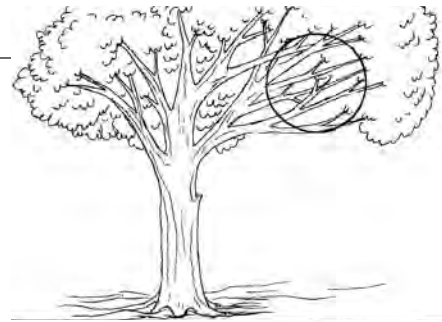
STEP 1: Select the appropriate branches for propagating. The best age of propagating branches is 1 or 2 years old. The wood needs to be hard and brown, but not tough and old.

STEP 2: Cut the ends of the sticks with a sharp knife to make a clean end. Make sure that there are at least 6 growing buds on each stick. The growing buds are where the new roots and new leaves will grow from. Cut off ALL of the leaves. Cut the TOP of the stick on an angle so that water doesn't sit on top and cause fungus and disease problems.

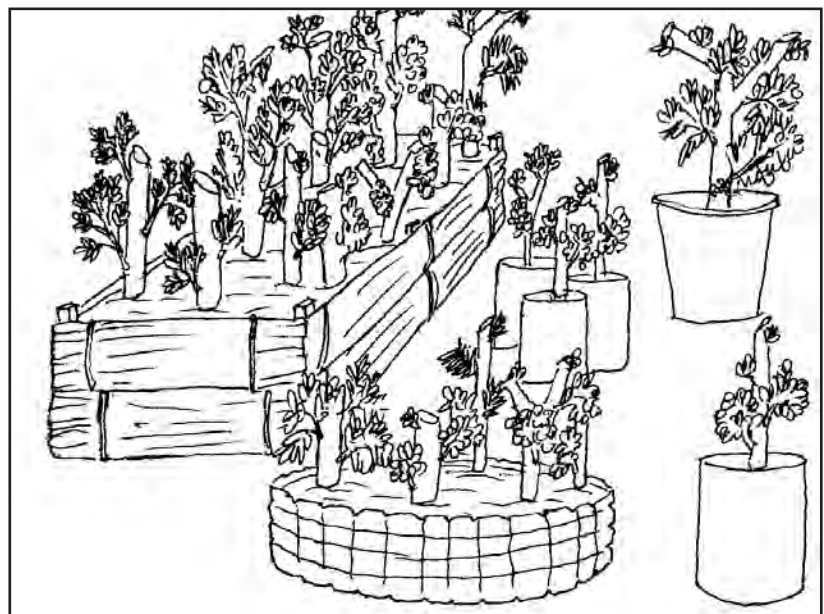
STEP 3: Put the sticks in a bucket of water until ready to plant.

STEP 4: Prepare the planting area. This can be plant boxes, containers, in a garden plot or straight out in the ground. If planting into a nursery use the same soil that you use for seedlings.

STEP 5: Plant the sticks. Make sure that the growing buds face upwards. Make sure that there are 3 growing buds in the soil, and 3 above the soil.



STEP 6: Water everyday or 2 days until the new leaves are growing. Then water twice a week. If you are planting out directly into the ground, water the cuttings every day if no rain and provide shade until new leaves are established. At the beginning of the wet season is the best time.



Root Propagation

For any plants that are propagated by root cuttings, the following steps will improve the results.

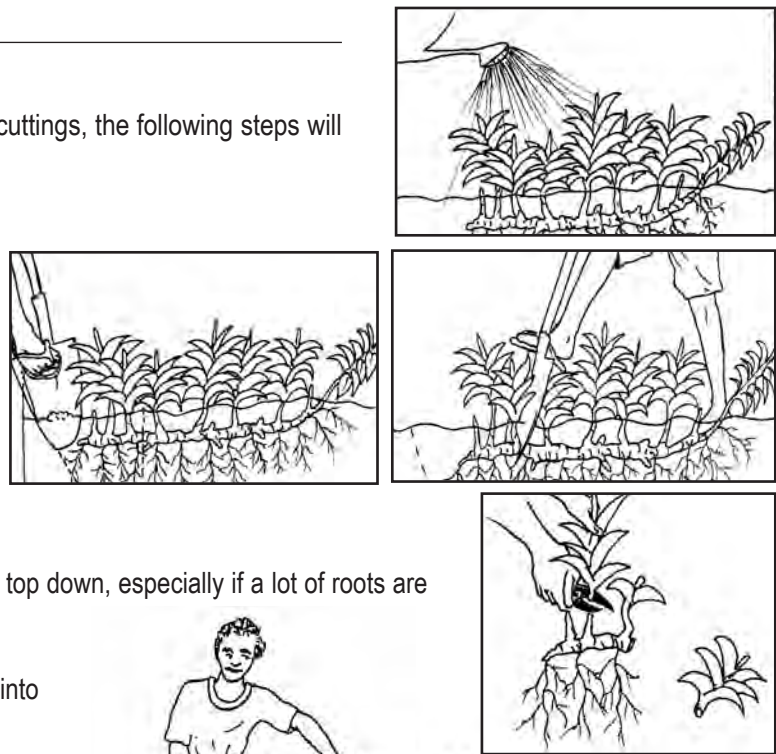
STEP 1: Water the plant very well.

STEP 2: Dig into the soil, first from the side under the plant, then second straight down through the plant to cut and separate the section of root that you want to take.

STEP 3: Remove the section, being VERY careful not to damage the roots.

STEP 4: Cut off most of the leaves, from the top down, especially if a lot of roots are damaged. Leave 2 or 3 on each stem.

STEP 5: Replant carefully into the ground or into a container and water well.



Marcotting - Aerial Roots

Growing trees from a tree branch by creating aerial roots is a common practice in East Timor. It is a good method to use because it creates new trees that would take 2 or 3 years to grow from seed. It is most useful for citrus trees but many other trees work as well.



STEP 1: Choose a strong, productive and disease/pest resistant tree to make the marcott. This is very important because the tree that you grow will have the same characteristics as the tree you make the marcott on.

STEP 2: Choose the branch, about 2cm thick, that you want to use with good healthy growth and where the marcott is mostly in the shade. Cut off the outside layer of bark from about 10cm (middle finger length) of the branch.

STEP 3: Cover the cut branch with good soil with a little manure, wrapped in a plastic bag. Tie both ends and the middle if needed as well. The soil needs to stay cool so use 2 plastic bags if needed.

STEP 4: Keep the soil wet and check regularly, while being careful not to disturb the soil. Leave for 3 months.

STEP 5: When there are a lot of roots growing you can cut the branch below the marcott. Use a saw if you can because a machete might damage the roots.

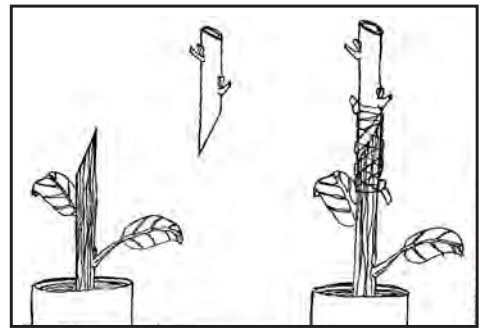
STEP 6: Plant the new tree straight away. Carefully remove the wrapping. Put the roots in water until planted. Remove about 1/3 of the branches and leaves. Plant into a pot and place in a nursery. Keep in the nursery until new growth commences. When the new tree is established, put out in the sun to harden. (read harden section later in chapter.) After hardening it can be planted out. (Look in Tree crops/Reforestation Chapter (CH 7) for some tree planting techniques.)



Grafting

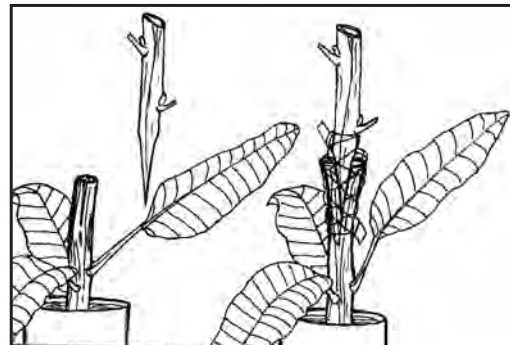
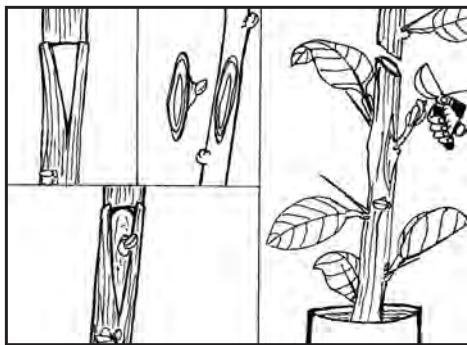
Grafting is a technique used for fruit and nut trees to improve the quality and productivity of the fruit tree and reduce the time from planting to fruiting. It is a difficult technique that requires a lot of practice.

A simple explanation is that a branch from a healthy, good quality fruit tree is “grafted” – attached - to the stem of a small fruit tree (about 2 years old) of the same type. E.g. Mango onto mango, orange onto orange.



A full explanation is too long to put in this manual. If you are interested in learning more you can read the references listed at the end of the book and ask the government agriculture department or the NGOs listed for more information.

Remember that grafting is NOT essential for producing good quality, highly productive fruit trees. Soil improvement, water storage, organic fertilizer, mulching and good maintenance are the first factors to improve for good production. Grafting is an important technique that will help increase quality and production in the future, but only if the first factors are addressed.

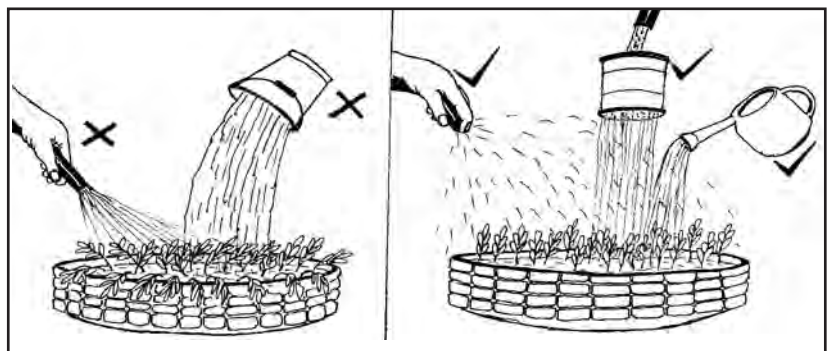


Nursery Maintenance

It is important to check the nursery everyday. The more attention you give to the young seedlings the better they will grow.

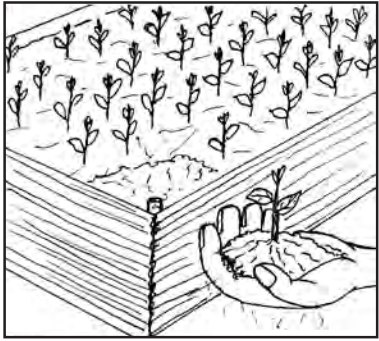
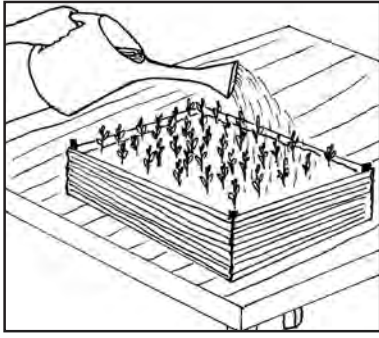
Watering

Plants in a nursery need water regularly. Seedlings and plants in small containers will need water every day or two. Plants in larger containers will need water once or twice a week. For larger containers if the soil is dry one knuckle depth beneath the surface then the plant needs water. Be very, very careful when watering young seedlings. Water them gently! Too much water at once can kill young seedlings because they are very fragile.



Fertilizing

Seedlings will grow stronger and faster if they have enough food (nutrients). This will lead to stronger and healthier plants later on. They do not need a lot. The BEST fertilizer to use is liquid compost because you can use it as often as is required and it has a wide variety of nutrients. (Refer to the Soil Chapter (CH 4) for details on making liquid compost) Dilute it with more water than you would for gardens, and use it once every 2 –3 weeks. Do not use on new seedlings until they are 1 month old. Plants in containers will suffer if too much manure is used in the soil mixture or too much liquid fertilizer is used. It is better to give the plants only a small amount of fertilizer in the nursery and then more when they are planted into the ground. This is especially true for trees that will be used for reforestation. Only use compost or dry manures (cow, pig, goat or horse manure is best) in the soil mixture.



Transplanting

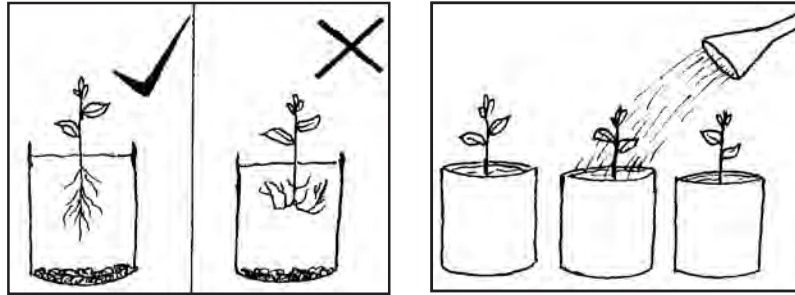
Sometimes young tree seedlings need to be transplanted into a larger container in the nursery.

STEP 1: Water the seedling well.

STEP 2: Dig up the seedling with a small shovel, digging bar or by hand. **DON'T** pull up the seedling by the stem!

STEP 3: If there are many seedlings together, separate the roots very carefully.

STEP 4: Immediately replant into the new container, with the roots pointing down, and water well.



Weed Control

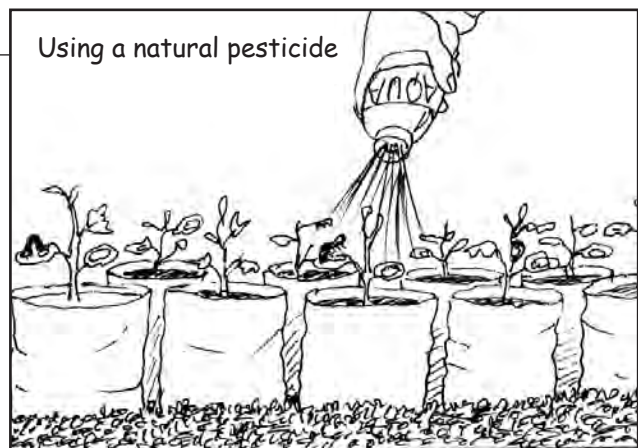
Weed control is very important in nurseries.

1. Continually remove any weeds that grow in the seedling containers. They compete with the seedlings and slow their growth, which decreases productivity, especially for vegetables.
2. On the ground in the nursery put a layer of newspapers, coffee husks, rice husks, sawdust or plastic to stop weeds from growing between the plants. A combination of materials is best.

Pest and Disease Control

Always look out for pests and diseases in a nursery because they can spread very easily. The best solution is to prevent problems before they occur by:

- Reducing plant stress as much as possible by stopping the hot sun and allowing gentle winds through the nursery.
- Good soil mixture.
- Enough water.
- Enough but not too much fertilizer.
- Raising the containers and boxes off the ground.
- Place the table legs in containers with water to stop ants, snails and slugs.



You can reduce the chances of pests or disease spreading from plant to plant by mixing the different varieties of plants together or putting them in small groups instead of large groups. If your plants are sick or attacked, you can:

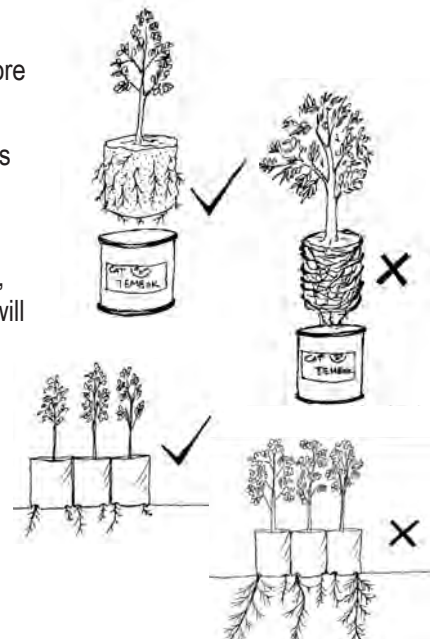
- Spray with a natural pesticide. (See the I.P.M Chapter (CH 10) for details)
- Changing the climate conditions. E.g. if a plant is suffering from fungus or mildew try giving it more sunlight and wind. This can help for some pest problems as well.
- If other solutions don't work then remove and burn diseased plants.



SMART IDEAS:

All trees that are grown should be planted out in the ground before the tree roots grow too large for the container.

- If the roots grow too large they will start growing around in circles and get tangled. This is called “root bound”. This will slow down plant growth a lot. It may even cause the plant to die later on.
- Plant roots are the MOST IMPORTANT part of a young plant. Healthy, happy roots will lead to a healthy and productive plant or tree. There will always be more roots than leaves when the plant is young.
- It is also important not to let plant roots grow out of the container into the ground. A small amount is not too bad. But if a lot of roots do grow into the ground and you have to break the roots before planting, the plant will be damaged and might die later on.
- Grow the plants so that the roots are only just starting to emerge from the containers at the beginning of the wet season. This is usually 2 – 3 months for fast growing trees and 3 – 5 months for slower growing trees.
- It will help if you put all trees boxes and containers above the ground, on old tin, wood, bamboo, etc. Then roots will not grow out of the container into the ground.
- If a plant does get root bound then you need to trim off the outside layer of roots to encourage new roots to grow. If you do have to cut roots then prune back some branches as well.



Good management for root bound plants

Hardening plants before planting

All plants that are grown in a nursery need to be “hardened” before they are planted in the ground.

This means to prepare them for where they will grow. Most plants need to be placed in the sun. Only plants that are to be planted in the shade, like Coffee and Vanilla, can be put in shade.

- Trees need 3-4 weeks to “harden” before they are planted out
- Vegetables need 1 week

“Hardening” plants is very important because it reduces the stress on the plant when planting. If a plant is not hardened it will stop growing for a few weeks, many leaves will fall and the plant even might die from the stress.

Another technique for reducing stress for a plant is to give it shade for about a week after it is planted.

The more that stress is reduced for a plant, the better it will grow. Same as people.







Home & Market Gardens

CHAPTER



The home garden plots and market garden plots are the basis for good health and self-sufficiency in East Timor.

Good Nutrition

Growing a wide range of vegetables, grains, fruit and nuts provides important nutritional needs for families, especially for children. The most important time period for good nutrition is when mothers are pregnant and for babies. Other family members need to help to make sure that they are eating as well as possible. This will reduce the chances of babies becoming sick and dying and will lead to a much healthier life later on. Good nutrition leads to:

- Fewer health problems.
- Faster recovery after sickness.
- Children grow up stronger and healthier and they have fewer health problems later.
- Longer lives.
- More energy for work and for play. Therefore more can be achieved in a day.
- The ability to learn and concentrate increases. This is very important for children at school. Better food leads to smarter people.



People need to eat a wide variety of foods to be healthy.

This means every day eating vegetables, fruit, eggs and meat as well as beans and grains. A wide range of healthy organic vegetables grown at home will provide many vitamins, minerals, proteins, energy and oils.



Good Sources of Nutrition from the Home Garden

Vitamin A (Good for eyes) - Taro leaves, sweet potato leaves, cassava leaves, pumpkin leaves, cabbage, green leaf vegetables, carrot, mango, banana, papaya, Moringa, sesbania.



Vitamin C (Healthy body, needed everyday) - green papaya, lemons, oranges, mandarins, pomelo, sweet peppers, tomato, pineapple, guava, mango, cashew fruit, tamarind.



Protein (Strong bones and muscles) - peanut, beans, peas, yam bean, pigeon pea, watermelon seed, banana tuber, cashew nut, candle nut, moringa seed pods, sesbania seed pods.



Energy (Fuel for people) - corn, sweet potato, cassava, taro, yam, potato, rice, pumpkin, avocado, ripe coconut, jackfruit, breadfruit, bananas, sugarcane.



Fats and Oils (keeps your insides healthy) - avocado, coconut, peanut, candle nut, cashew nut, soybean.



Iron (strength and stamina) - mustard, amaranth, green leaf vegetables, banana heart, cassava heart, sweet potato leaves, dried beans.

Other vegetables like eggplant, choko, kang kong, okra, pumpkins, cucumbers, watercress, bitter gourd, onions and radishes and fruit like watermelon, custard apple and passion fruit also provide many vitamins and minerals.



Some trees also provide very nutritional leaves and pods. **Sesbania and Moringa** grow in most areas in East Timor. Their leaves can be dried, ground and added to rice, soup, rice porridge and more. If they are mixed with small amounts of coconut oil, sea salt and sugar they will provide good basic nutrition

This is very important for pregnant mothers and when feeding babies and for babies and young children.

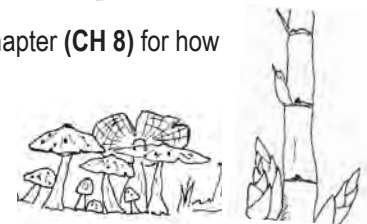
Look in the reference section for more information sources. The young pods of the Sesbania and Moringa trees can be cut up and cooked as well and are also very healthy.

Meat, fish and eggs provide lots of protein, iron and some oils and they are important to eat most days if possible. **Dry beans, tempe and tofu** also provide protein.



Bamboo Shoots provide many different vitamins and minerals. Read in the Bamboo Chapter (CH 8) for how to cook bamboo shoots.

Mushrooms are another excellent food for good health, providing protein and many vitamins and minerals. They can be collected wild, and by using manure, liquid compost and mulch they can be encouraged and grown in gardens and vegetable plots. This is because mushroom spores (seeds) live in and are spread by using manure, compost and mulch.



Traditional medicines, especially small medicine plants like Aloe Vera and mint can also be grown close to the house together with flowers and vegetables. Spices and herbs like chili, ginger, garlic, pepper, coriander and basil are also important to eat for healthy bodies, and are good to use to help fight some sicknesses.



Remember that many vitamins are lost if vegetables are cooked for too long or if cooking water is thrown away.

Remember that healthy soils are needed for the vegetables, fruit, grains and even animals to provide food that is full of vitamins, minerals and protein needed for healthy bodies.



With good techniques and maintenance vegetables, fruits, meat, eggs, herbs, spices, medicines can be produced at low cost.

Thus enough can be produced to sell AND eat at home. Excess produce can also be exchanged for other goods or food.

Women could use this information as a simple guide for nutrition. It could be used when preparing meals to help improve nutrition and for teaching to children. Something from each part of the list every day is a good goal. Use the food circle to help with how much of each food is good to eat.

This chapter looks at different techniques and ideas for home and market gardens. Later in the guidebook we will explain techniques for integrating small animals with garden systems.



Food nutrition circle

Step by Step Garden Design

There is a huge amount of knowledge about agriculture in East Timor and it is still growing. Improving food production relies on this knowledge being shared. This chapter uses a lot of these ideas and adds to it with techniques that use local materials and fit with local needs.

Garden Location

Sunlight

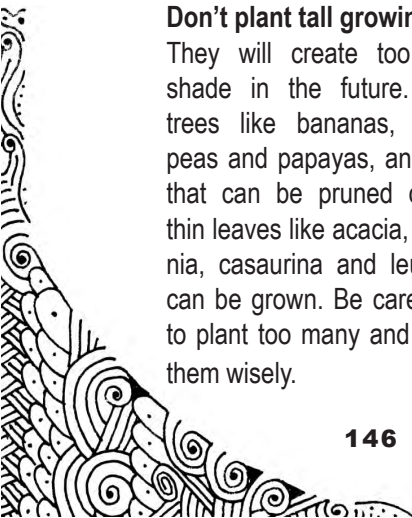
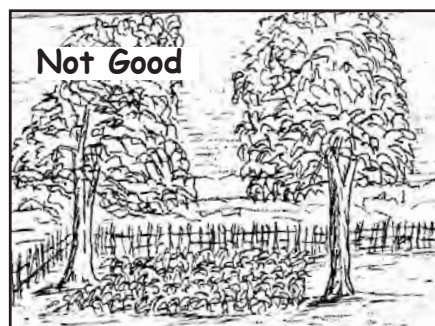
Plants need sunlight to grow and to produce large crops.

They use the sunlight and change it through "photosynthesis" into plant food. Some plants can still produce well with some shade but most plants prefer full sun.

Vegetables that can grow well in some shade are amaranth, beans, cabbage, cucumbers, lettuce, peas, potatoes, pumpkins and green leaf vegetables. Experiment for yourself. Some shade means not more than 1/3 of the day shade OR thin leaf trees providing 1/2 day shade.

Don't plant tall growing trees near vegetable beds, especially trees with thick leaves like mangoes or jackfruit.

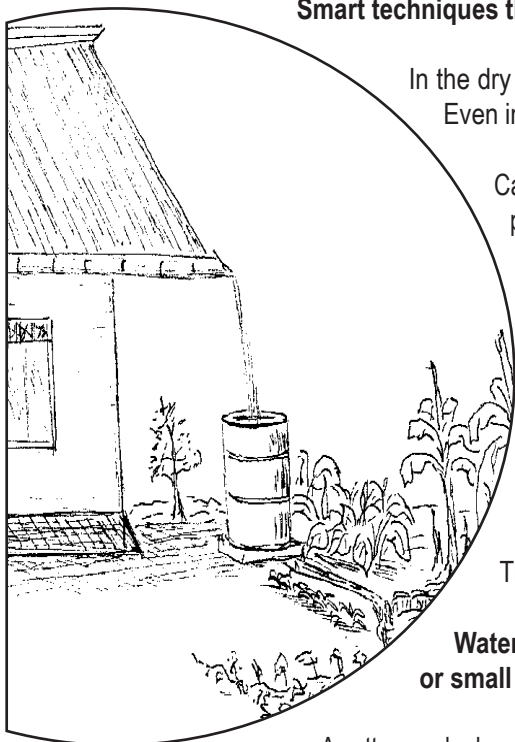
They will create too much shade in the future. Small trees like bananas, pigeon peas and papayas, and trees that can be pruned or with thin leaves like acacia, sesbania, casaurina and leuceana can be grown. Be careful not to plant too many and to use them wisely.



Water Supply

In many areas in East Timor water still has to be collected from far away from the house. Water supply is one of the most important problems to overcome to increase food production in East Timor.

Smart techniques that reduce water use are also very important.



In the dry season access to water is needed if any vegetables are to be grown. Even in the wet season in many areas in East Timor.

Cassava will survive through the dry season with no water but it doesn't produce very much. Therefore the plots must be close to a water supply OR bring the water supply to the plots.

Irrigation to the gardens can be made from bamboo, metal pipes or plastic hose, or can be run via water channels.

Storing irrigated water near the plots in water tanks or drums will help to provide a continuous water supply. Small or large holes can be dug as well and lined with concrete or clay.

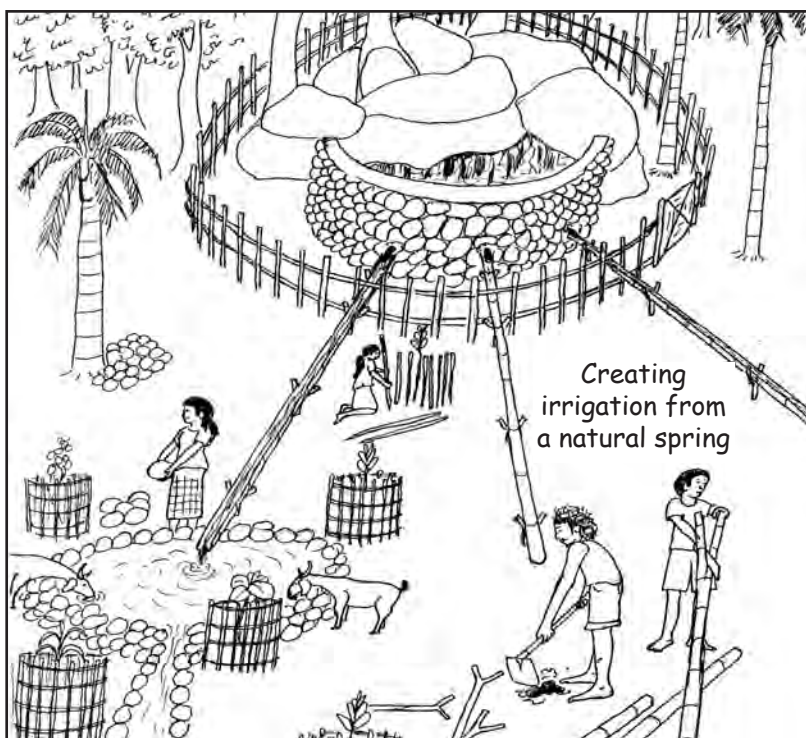
This will hold water for gardens and for animals.

Water can also be collected from your house roof or any building large or small that has a metal sheet roof.

A gutter can be bought or made out of bamboo. The water can be stored in a tank or tanks. This water can only be used for drinking if the roof is metal sheets and is not rusty.

Any stored water must be covered to reduce mosquito breeding and to decrease water loss from evaporation. A large handful of neem leaves can be added, once every 3 months to help prevent mosquitoes, but not for drinking water.

Use gravity (water running down hill) wherever possible to make irrigation easy and cheap. You can also use gravity to run water from storage tanks. If you can put the garden plots below the water supply it will make watering easier. Hand pumps and foot pumps are also good for bringing water up from underground. Read in the Alternative Technology Chapter (CH 14) about pumps.



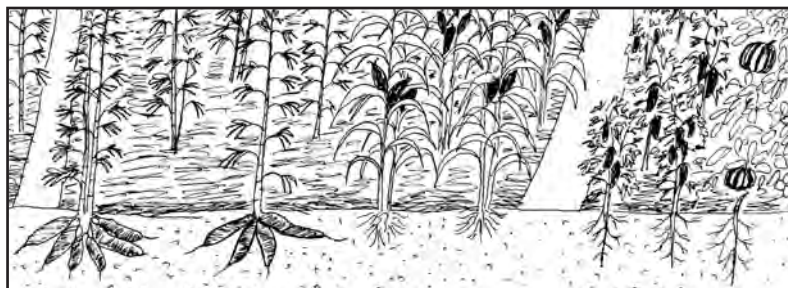
Any irrigation must be set up in cooperation with other water users!! If a community group is formed then tanks, pipes, and water pumps become cheaper to buy and easier to make and maintain. The extra water can then be shared and everyone in the group benefits.

Techniques for reducing water use, extending wet season growing time and getting maximum benefit from the water will be explained later in the chapter.

Soil

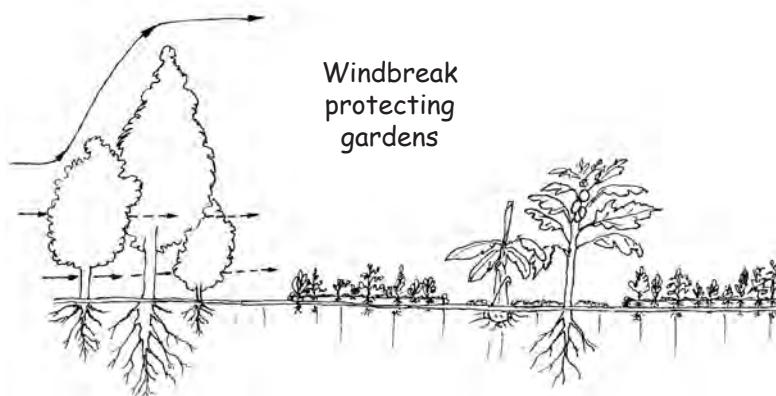
Finding a balance between quality of soil, and closeness to the house and water supply is important.

Loam soil will produce more vegetables and need less water, but most soils can be improved quickly with good techniques and continuous mulch and compost. Heavy clay and waterlogged soils need specific techniques and time to make them productive. It may be more productive to use these areas for something else, such as fish and water plants. Water is a more important factor to consider when locating a garden.



Wind

Vegetables, especially seedlings need to be protected from strong winds that will dry the soil and take moisture from the plants. Windbreaks and living fences will reduce water needs, and the plants that are protected will grow much faster.

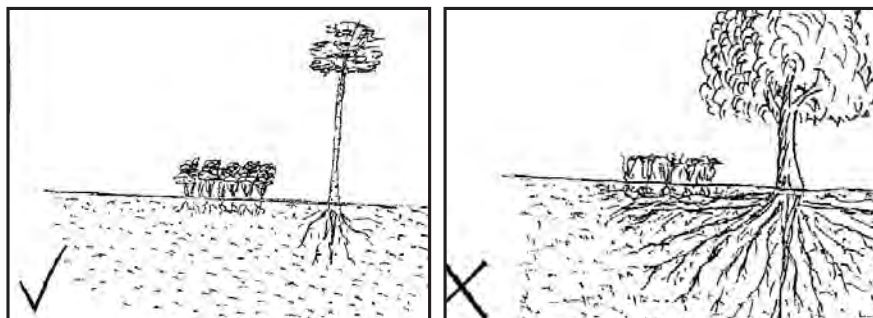


Other Factors

Tree Root competition.

Large trees have roots that spread out to 2/3 the height and the same width as the tree.

These roots compete for water and nutrients with vegetable crops. Some trees compete more than others. Eucalypt trees are very competitive and should either be removed from intensive crop and fruit tree areas or continuously pruned.



Pruning reduces the root size by the amount that the tree is pruned. Eucalypts also give out oils from their roots that most other plants don't like.

Thin leaf legumes (e.g. lequena, acacia, sesbania, pigeon pea) or small fruit trees (e.g. bananas, papaya, guava) are the best trees to plant with a garden.

Closeness to house.

The closer your vegetable production is to your house, the less time you need and the more energy you save. A garden close to the house can also make use of waste water from the house. Transporting resources and produce is easier.

This factor must be balanced with the other factors.

Garden Preparation

Garden Plot Design

The shape of the garden plots will vary according to the shape and slope of the land. Work with the land, not against it.

Plots don't have to be made in straight lines. The end of this chapter shows some pictures of different ideas and shapes for garden designs. Be creative, remember that beauty and natural patterns are also important.

On flat or gently sloped land raised plots work well in East Timor and are the most common form of plot. Raised plots should always have rocks, bamboo, wood etc around the edge:

- To hold the soil.
- To hold more water in the soil.
- To hold mulch.
- To allow soil to build up.



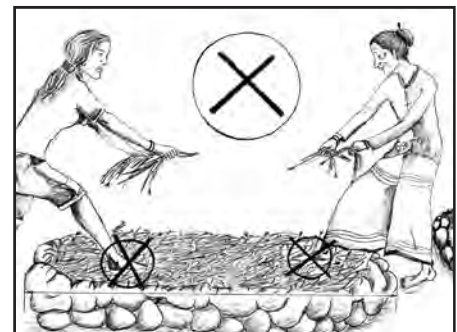
Good garden plot design will lead to soil improvement and for the amount of soil to increase each year.

This is a key to improving production, especially in the wet season.

Raised plots should be wide enough to be able to retain water, but small enough so that all of the plot can be reached **WITHOUT HAVING TO STEP ON THE PLOT!** Between 1/2 a metre and 1 metre wide is good or 1.5 metres wide if you have long arms. This will prevent compaction of the soil that happens when people stand and walk on the plots. Compaction of the soil causes many problems which all lead to reduced production. Garden plots should be designed with main pathways to use for bringing in compost, mulch and taking out produce, and smaller pathways for access and garden maintenance.



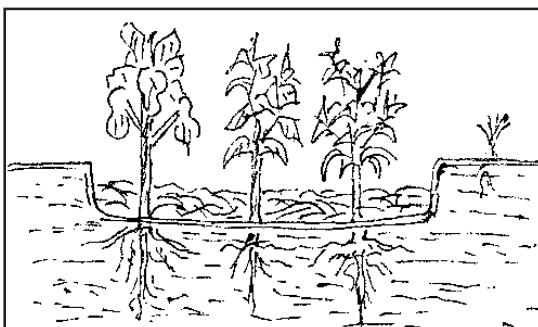
Remember that pathways make the land around them easy to maintain and more productive.



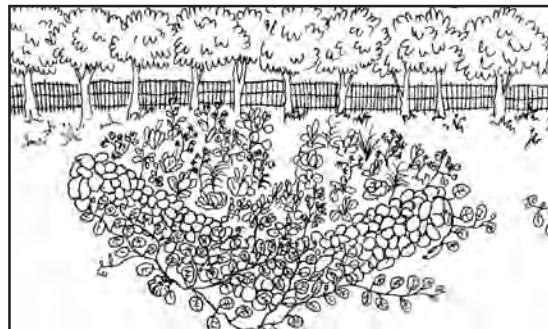
SMART IDEA:

- Pathways can be made so that wet season rains can be collected and used. Where does the water go? How can it be retained or collected and re-used in a different area?
- Banana pits/compost pits can be used to collect water. They are described in the compost section (**CH 4**). Banana pits are good for growing vegetables as well and are useful in any garden.

There are other garden plot designs that work very well in dry areas and make the most of water use.



Sunken Garden Plot

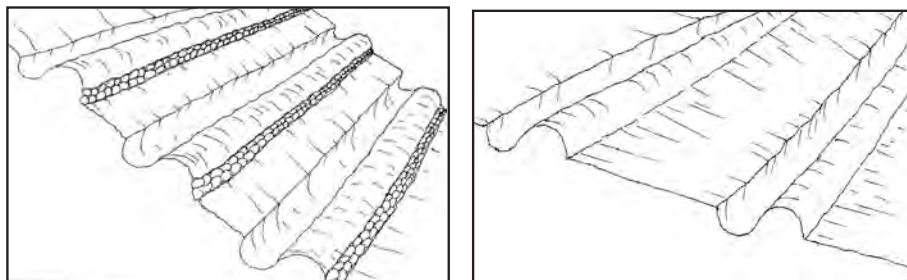


Boomerang Garden Plot

Swales

Most of East Timors land is sloped. Swales are an excellent way to make vegetable gardens on sloped land, even for small home gardens. Different patterns can also be used on gentle sloped land.

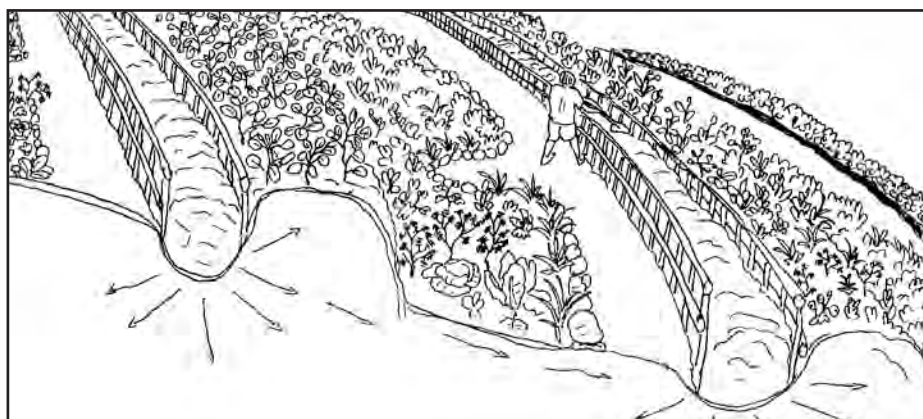
Swale garden designs for steep and gentle slopes



On steep slopes swales will prevent erosion and hold all water and nutrients in the ground. The swales and terraces need to follow the shape of the land so that heavy rains do not create problems. For vegetable gardens smaller swales are usually better. On steep slopes make small swales about 1 metre apart. For gentle slopes make bigger swales about 2 metres apart. On gentle slopes the swales can be made into terraces. Look at the Reforestation Chapter (CH 7) for instructions on how to make swales and terracing.

On slopes the pathways can be the trenches of the swale system. This will reduce erosion. Or the trenches can be used to make compost.

Using swale trenches to make compost



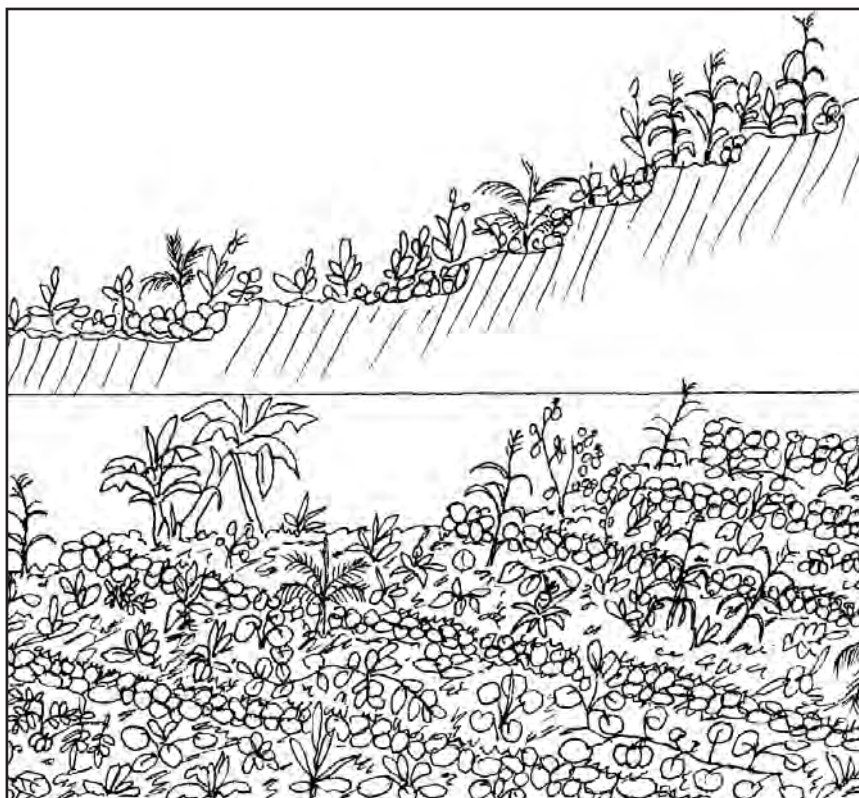
Terraces

Terraces are like swales because they also follow the contour of the land. They are cut into the land and usually stone or clay walls are made to hold the land in place.

The land between the walls is flat.

Terraces take a lot more time, effort and sometimes money to make but create very productive land. Terraces are used in many countries and there is a lot of information on building and using them.

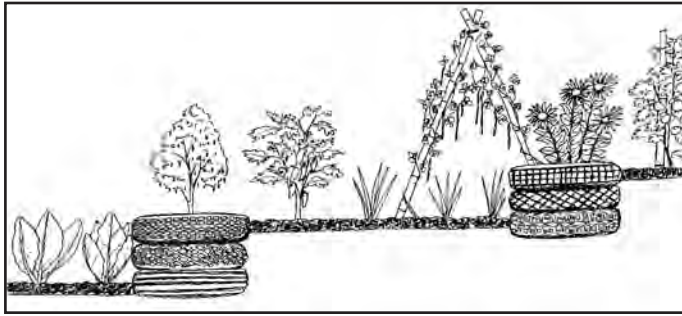
Look in the reference section for books and internet sites.





SMART IDEAS FOR SWALES AND TERRACES:

- Always build up the edge of the terrace higher with rocks etc. This will prevent erosion and allow for soil to increase. It also provides room for putting mulch and compost and helps to hold more water.



- On steep slopes care needs to be taken to make sure that heavy rains don't cause erosion or land slides. Because of the limestone rock base in some areas in East Timor and the potential land slide problems, some deep rooted trees need to be planted to help to hold the soil. Use legumes that don't give too much shade and that can be cut back for mulch and animal food.
- There are many ways to integrate vegetable crops with fruit trees and animals. Read in the reforestation Chapter (CH 7) for more examples of swale and terrace production.



Integrating vegetables, trees and fishponds

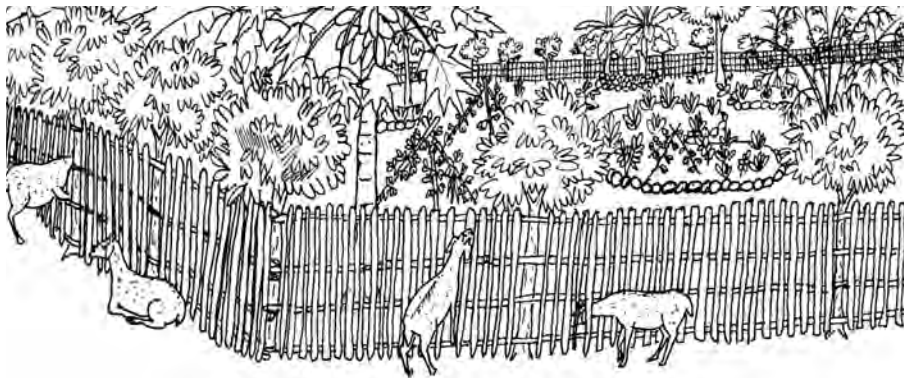
Fences

A fence is important to prevent animals from eating your precious vegetables.

Remember that fences are multifunctional.

If you use one fence for two areas, you are saving time, labour and resources.

The quickest and easiest way to make a fence is to plant a living fence. Living fences can be made from many different plants and trees, and can provide many products.



Fence materials

Living Fences: Leuceana, Flame tree, cactus, sesbania, Moringa, tall grasses and many more.....

Other materials: Stone, wood, bamboo, old fishing net, old tin roofing.

Fence Products

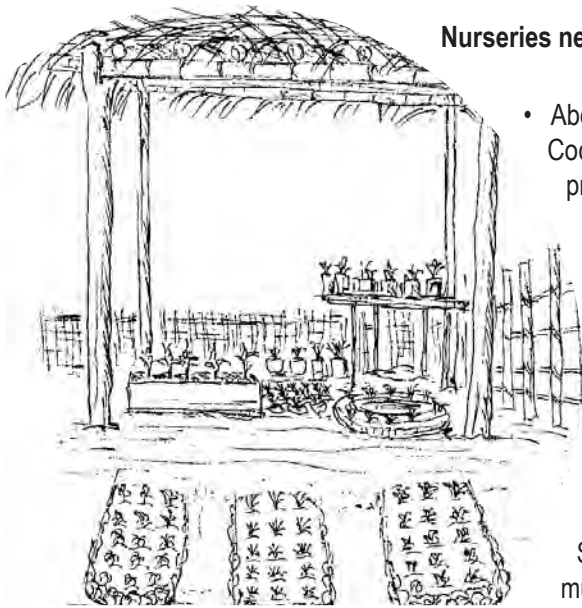
Human Food; Animal Food; Mulch; Compost Material; Medicine; Wood; Weaving Material; Nitrogen Fixing Legume; Natural Insecticide.

Fence Functions

Windbreak; Trellising for vines; Shade; Animal Habitat; Erosion Control.

Small nurseries

It is very easy to make a small nursery out of cheap and natural materials. You can even make small moveable nurseries. A nursery is important because plants need more care when they are young. If seedlings are looked after, size and quality of vegetables will increase.



Nurseries need to provide:

- About 30-50% shade, especially shade in the middle of the day. Coconut palm leaves or other palm leaves that have been split will provide the right amount of shade.
- Protection for seedlings from animals.
- Soil that will provide nutrients and easy root growth.

Different examples of soil mixes:

1. 30% compost/dry manure, 30% soil, 30% sand, 10% ash/ rice waste
2. 50% composted manure/rice waste, 50% soil/sand.

Soil from the ground does not make good soil for nurseries and must be mixed with other materials.

Sand and rice waste provides good drainage and aeration for easy root growth.

Compost and dry manure provide nutrients.

If seedlings are grown in vegetable plots, mix in rice waste, sand, compost and dry manure to help the seedlings to grow better. Also make temporary shade for the first 3-4 weeks.

What you can use for pots in a nursery is up to your imagination.

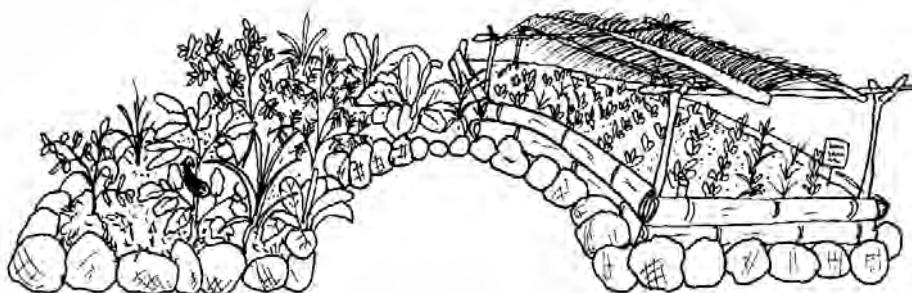
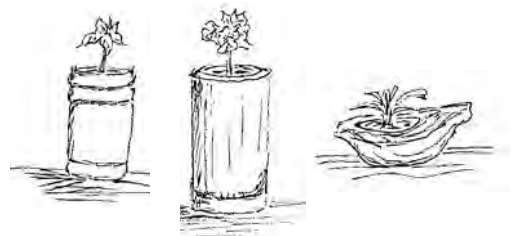
Many different old drink containers, food containers, old metal tins and containers, old tyres, coconut shells and much more can be used.

Banana leaves make excellent small containers. They are easy to make and free.

Grow 1 seedling in each banana leaf container.

When it is time to plant the seedlings simply place the whole container in the ground and the roots will grow through the banana leaves. Easy!

Look up "Seed saving and Nurseries" chapter (CH 6) for more information and techniques for small and large nurseries.



Growing seedlings in a garden bed

Garden Additions

Other than a fence, gardens can be surrounded with small fruit trees, perennial plants and small trees, legumes and flowers.

These provide wind shelter for the garden, food for humans and animals, mulch and compost materials.

Pollinators and pest predators such as birds, wasps, bees, spiders, and other helpful insects will also be attracted into your garden. Increased pollination of fruit and vegetable flowers will lead to more fruit or vegetables per plant. Pest predators eat pest insects in your garden and will help to reduce pest numbers.

Flowers and herbs are especially important to include because they also add beauty and fragrant smells to the garden as well as their many other benefits.



Ponds

Ponds are beneficial in many ways.

You can use them to grow fish and prawns or vegetables like taro, watercress and kang kong.

By placing a pond or ponds near the garden they also provide homes for frogs, small lizards and insects that will eat many pest insects in the garden. Birds will be attracted as well. Mulch and compost material can be produced quickly and easily. Ducks also love ponds but must be fenced from the gardens.

The ponds can be part of an irrigation supply, or can be fed from an irrigation supply or from a spring.

Dry season ponds can be made to use in the wet season to grow water vegetables, compost material and mulch but left to dry out in the dry season.



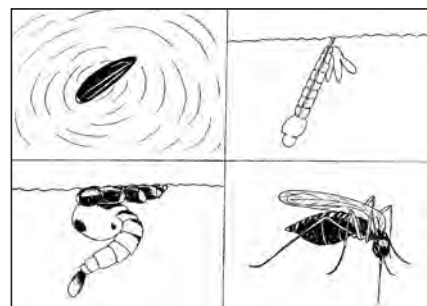
SMART IDEA:

- Extra water in the wet season can be collected into ponds using trenches and swales. This prevents water from lying on the ground. Mosquitoes will only be able to lay eggs in the pond.
- The fish, frogs, small lizards and other pest predators that live in and around the pond will eat Mosquito eggs and larvae in the water.
- Add some large handfuls of neem leaves to the pond, once every 3 months. Neem leaves will help stop the mosquitoes breeding but won't harm other insects or animals.
- Therefore mosquito numbers will be reduced and diseases from mosquitoes will be reduced. Everyone's health will benefit.

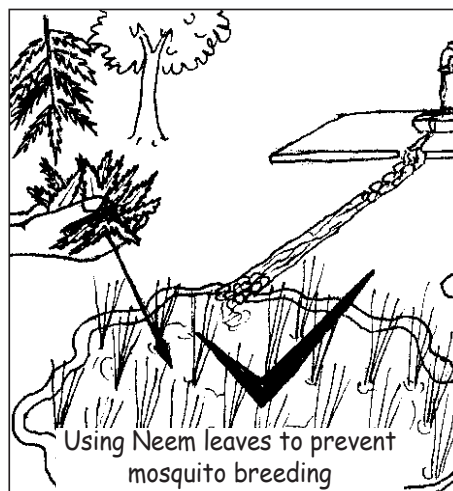


Beware:

Chemicals from pesticides and herbicides can kill a lot of plant and animal life in ponds and aquaculture systems.



Mosquito Breeding Cycle

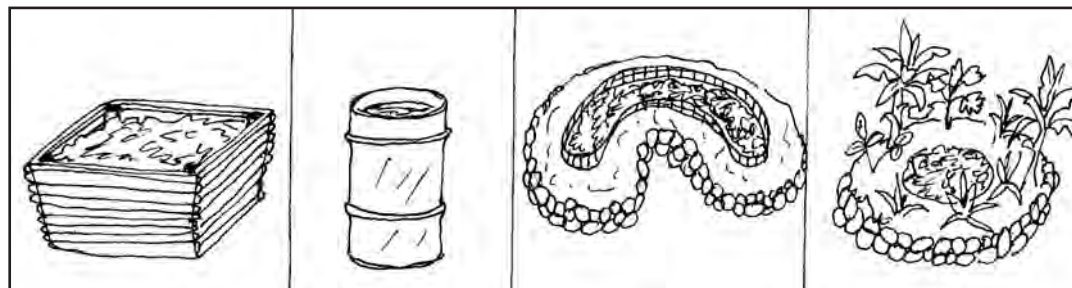


Garden Maintenance

Adding Plant Food

Garden plots should be covered with compost 2 weeks before planting with seeds or seedlings.

The compost can be lightly turned in to the soil if nothing has been planted, or just left on top. When vegetables or trees are already planted more compost can be added, one week or more after planting, but put on top of the soil. Disturb plant roots as little as possible.



After composting it is good to add a thick layer of mulch on top of the soil and compost. Mulching the garden provides many benefits and is ESSENTIAL for long term soil improvement.

Liquid compost can be added every 2 weeks to 1 month, but be sure to mix it properly with water.

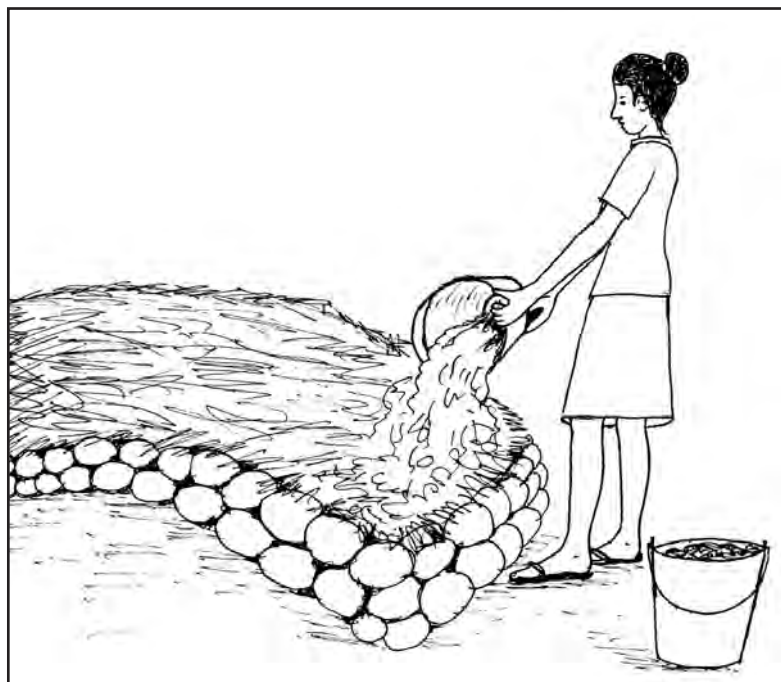
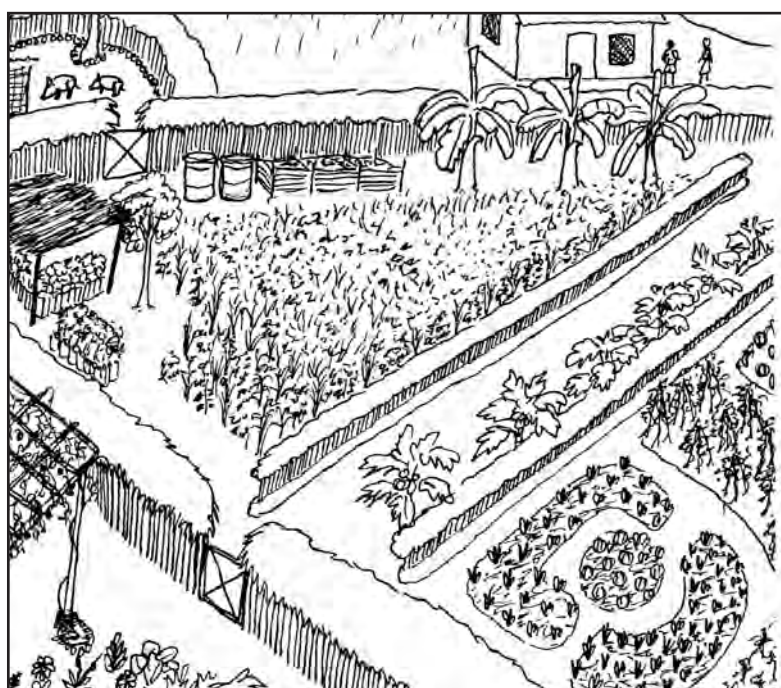
There are many different ways to make and use compost and liquid compost. It is up to you to decide which method is best for your situation.

Use EM – Effective Microorganisms to augment other soil improvement techniques. It will improve soil quality, soil structure and nutrient availability.

Integrating composts with garden design.

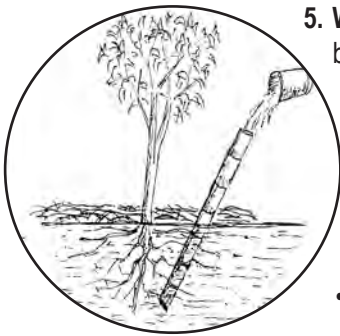
Banana pits, trench and basket composting and direct composting and are all ways of integrating composts with garden plots. These ideas increase production, improve soil quality and save water.

Look in the soil Chapter (CH 4) for explanations and pictures of compost and liquid compost making, compost integration and mulching.



Water Saving Techniques

1. **First and most importantly always water very early in the morning or late afternoon.** Early morning is better because watering in late afternoon and especially at night can sometimes promote fungus problems. In the middle of the day the sun will evaporate a lot of water into the air before the water can enter the soil. Therefore the plants can't use it and it is wasted. This technique alone will greatly reduce water use for each plot.
2. **Garden borders** help a lot to hold more water in the soil. Use rocks, bamboo, wood etc.
3. **Mulching** has many benefits. One of the most important benefits is that it protects the soil from the sun and prevents evaporation. This reduces the soil temperature and the amount of water needed for the garden plots.
4. **Windbreaks** around the garden plots will save a lot of water. Wind makes plant leaves dry out and lose water so plants use more water from the ground. Less wind means plants need less water. This is most important for young plants and trees.



5. **Watering pipes.** Water bottles are everywhere in East Timor and burning them causes bad health problems and pollution. A good way to re-use them is to make watering containers that slowly water deep in the soil. Bamboo can also be used and is more effective, especially for fruit trees. Benefits of deep watering are :

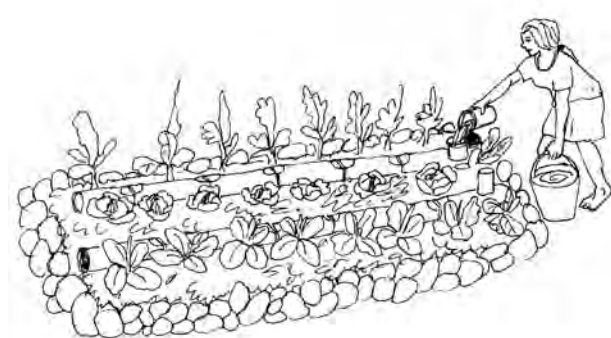
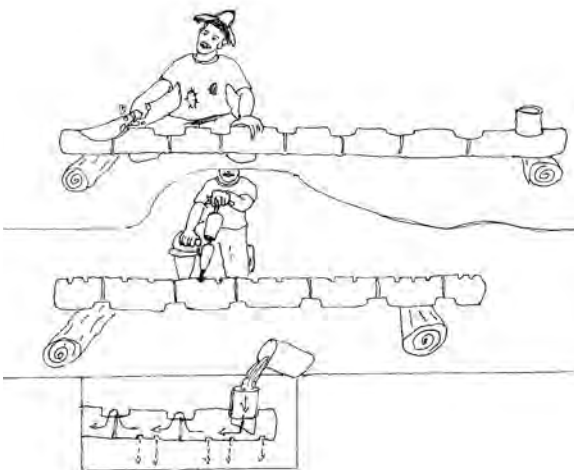
- Less evaporation because water is released in the soil not on top of the soil
- Water can be concentrated at the roots of each plant
- A lot less water is used
- The containers can also be used to feed liquid compost to plants.



Use aqua bottles and bamboo for irrigation

6. **Garden plots dug out rather than raised** will save a lot of water especially in very dry areas.

7. **Bamboo irrigation.** Another good water saving idea is to make bamboo irrigation pipes for the garden plots. They will save time and effort too. Lay them on the ground about 1/2 metre apart. Make 3 small holes in each section and be careful not to split the bamboo when making the holes. Use a hand drill if possible.



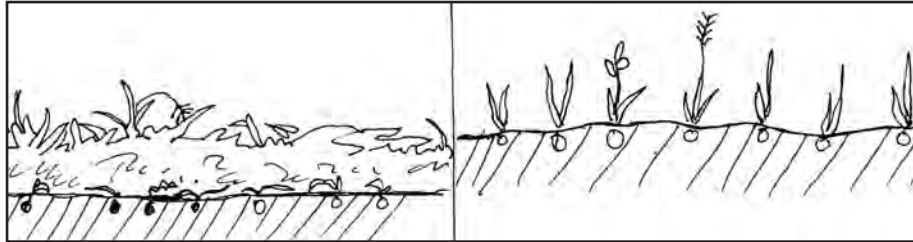
Bamboo watering system saves time and water

Weed Control

Weeds are a great source of mulch, food for chickens and compost material. They should be understood as a benefit rather than a problem. Reusing the weeds reduces the need to bring in compost materials and helps to keep the soil healthy. However removing weeds can take a lot of time if there are many weeds and some types of weeds can create problems if they are not controlled.

The following are some natural methods for controlling the weeds in your garden.

1. Mulching the vegetable gardens continuously will greatly reduce the amount of weeds. This is because when the ground is mulched the light that reaches the soil surface is stopped. When the weed seeds grow they need to reach the light quickly to keep growing because they need the sunlight to produce food. Most weeds die before they reach the light. Try not to use mulch that contains a lot of weed seeds because this can spread weeds. If using running grasses as mulch, make sure that they are dry first to stop them from growing again.



Mulch stops weeds from growing

2. Plant ground covering vegetables like pumpkin, beans, luffa, sweet potato and yam under cassava, corn and other large crops to reduce weeds. The same technique can be used under fruit tree or other tree crops. Plant the pumpkins, yams, luffa and sweet potato in mounds on flat land or in swales on sloped land.



Ground cover plants reduce weed problems

3. Make a "weed barrier" around the outside of the vegetable plots to stop running grasses from growing into the garden plots. The weed barrier can be:

- A path around the edge that is kept free of weeds.
- A small but thick living fence that will prevent running grasses from entering the garden. Lemon grass, Vetiver grass, pigeon peas, other small legumes and cassava can all be used as well as any plant that can make a thick fence and has a large root system.



4. Every time that soil is turned over weed seeds will be disturbed and are more likely to grow. Therefore if you turn over the soil less, then fewer weeds will grow.

5. Look in the animal systems section about how to make and use an animal tractor. This is a good way to remove weeds and weed seeds and fertilize the ground at the same time.

6. Any weeds that do grow should be removed before they produce seeds. By doing this you will slowly reduce the number of weeds that will grow. If weeds are removed when they are young the roots of vegetables will not be damaged by weed removal. Steps 1, 2, 3, 4 and 5 will all reduce the amount of hand weeding needed.



Weeds like running grasses or weeds that have already seeded need to be removed to stop them from creating more weeds and should not be used as mulch. By putting these weeds in banana pits, into liquid compost or into a chicken house you will stop future weed problems and produce natural fertilizer and chicken food at the same time.

Grow Your Own Weeds

Continuously collecting and spreading seeds and cuttings of useful plants that grow easily will create a new weed problem. The difference is that it is useful plants that become weeds! Some types of vegetables, fruit, animal food, legume cover crops grow quickly and spread easily. This method helps to provide more food, especially for animals, and is an effective way of controlling problem weeds. The plants that can be used will change from district to district and in each place people will know what grows fastest and spreads most easily.

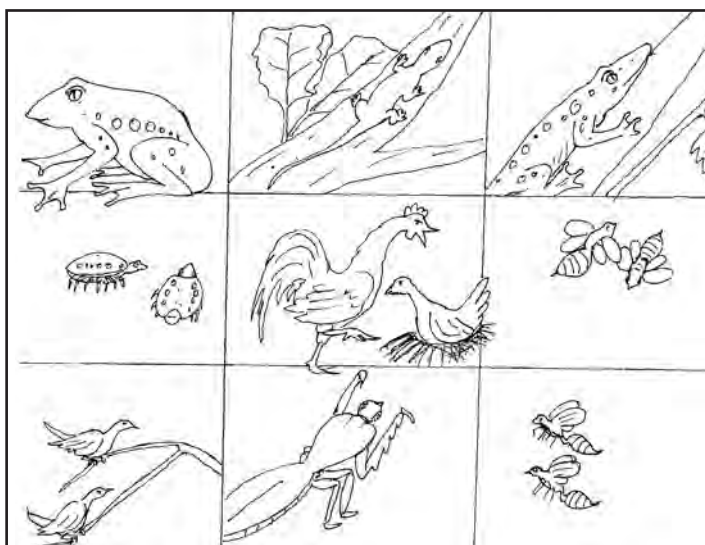


Pest Control

Pest Control in the garden is not just about removing pests.

To control pests in a sustainable method involves using many different techniques that result in rarely having to use pesticides at all. Techniques like improving soil quality, encouraging pest predators and preventing pests.

Examples of Pest predators



And then, if pesticides are needed, natural pesticides should be used, not chemical pesticides.

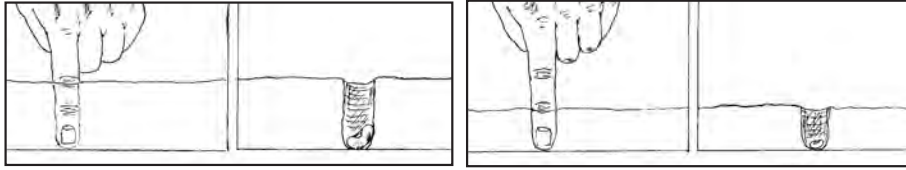
The Integrated Pest Management (IPM) Chapter (CH 10) in this guidebook gives a step by step method for naturally controlling pests, and different recipes for natural pesticides.

Now we have looked at where to put your garden, how to make garden plots, fences for keeping animals out, small nurseries, natural fertilizers and mulch, water use, weeding, pest control and the need for growing a wide variety of food. **It is now time to add the plants!!**

Planting Methods & Planting Times

Seed and Seedling Planting Ideas

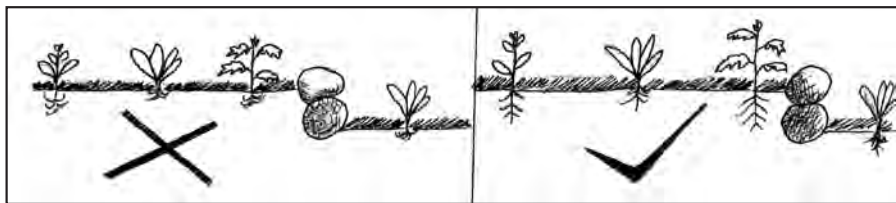
- Plant small seeds about 2cm deep. The soil needs to be watered everyday. Large seeds (any seed bigger than a pea) should be planted 3-4cm deep.



- If planting large seeds into pots, soak them overnight to increase plant numbers and make seedling growth faster.
- Don't put too many seeds in each pot. When the seedlings grow they need room for roots to grow. If they are planted too close together plants will compete too much. Many roots will break as they are separated and this will slow plant growth.

The following ideas will reduce damage caused to plants and plant roots when planting. Plants are alive and will react to damage or mistreatment in the same way as humans!!! Any damage caused will slow plant growth and reduce the final harvest.

- Increase the sunlight for seedling pots for 1 week before planting to help the seedlings to get used to the extra sunlight in the garden. This technique is called "hardening up" the seedlings and it will reduce leaf burning from the sun when they are planted.
- Always water before and after planting seedlings into the ground.
- Be very careful when handling plant roots. Don't expose roots to sunlight and try not to break any.
- Make sure that the plant roots are always pointing down. This is very important.



- Plant seedlings in the late afternoon to avoid the hot sun during the day.
- In the hottest times of the year cover seedlings with banana skins or coconut leaves for 2-3 days to protect from the sun.



Succession Plantings

Don't plant out all your garden plots at once. By planting 3 crops of the same vegetable at different times you will get 3 harvests. Therefore harvests will be smaller but they will be extended and provide food continually for families and for sale at markets. Less food will be wasted or go rotten.

Plan ahead: First plant seeds 2 weeks to 1 month apart, then prepare the garden plots when needed. Different types of the same vegetable can take different lengths of time to grow. If you plant different types then you can have harvests at different times.

Food Calendar

A good technique for planning for continuous food supply is to make a food calendar.

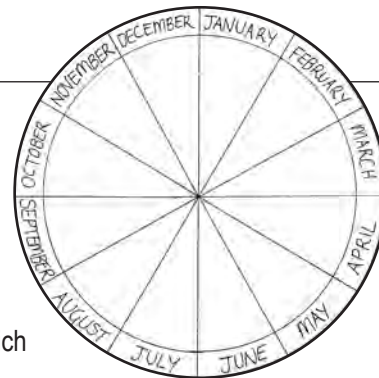
Step 1: Make a list of all the vegetables and grains you want to grow. You can represent the foods with drawings too if you want. Fruits like jackfruit and avocado can be included as well.

Step 2: write down: when you plant each vegetable and grain. Write down: which month(s) you harvest each vegetable and grain.

Step 3: Draw the calendar and write on each month of the calendar what is planted and what is harvested.

Step 4: Look at the months that are empty for harvesting.

- What else can you grow to be harvested in that month?
- Can planting of some vegetables at different times help to add more harvest times?
- Are there other types of the some vegetables that can be grown at different times of the year?
- Can different gardening and water saving techniques make the harvest time for vegetables longer?
- Are there vegetables that can be harvested for most or all of the year?
- Can your community bring in irrigation or pumped water to increase growing time?



Step 5: Try to have at least 4 vegetables or grains harvested each month of the year.

Step 6: You can also make a food calendar for fruit and nuts.

Remember that to plant continuous crops, a sufficient water supply is needed. If you have a water supply or live where there is a second wet season then planting can be extended to most or all of the year. Mulch, compost and good garden design will help hold water in the soil for longer time. This reduces water use and will help to maximize rain storage for plants. It also will extend the production period for vegetables. This is very important in dry areas.

example food
harvesting calendar

Use Different Plant Growth Lengths

Each vegetable has a different length of time to grow and to produce its crop.

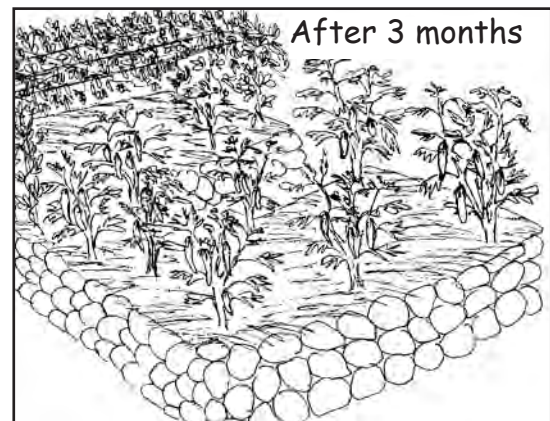
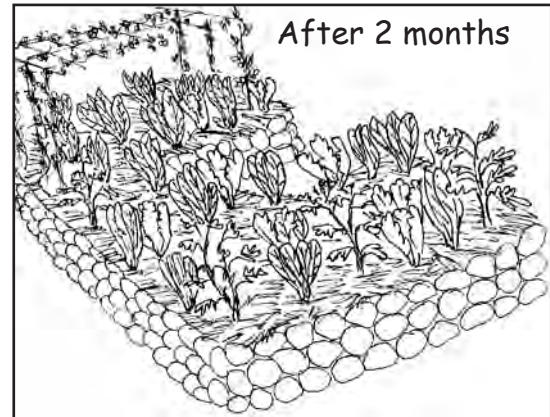
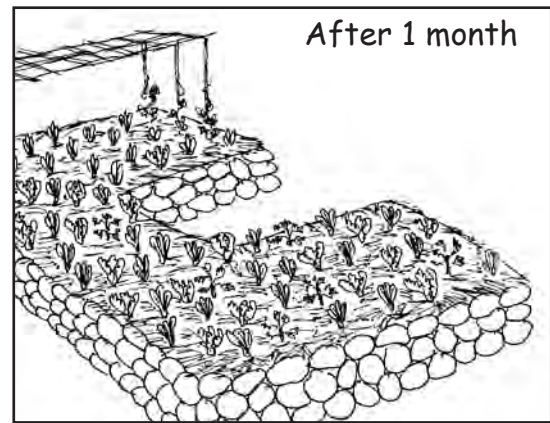
You can use this knowledge to increase production in each garden plot.

- Lettuce and green leaf vegetables grow fast and produce their crops in 1 to 2 months.
- Eggplants, chilies, cabbages, capsicums, tomatoes, beans and other vegetables take 3 months or more to produce their crops.

If these crops are planted together at the same time, the lettuce and green vegetables will be harvested first before the other vegetables have grown large.

Afterwards the long-term vegetables will grow to their full size and start producing their crops.

Be very careful not to disturb the roots of the long-term crop when harvesting the short-term crop.



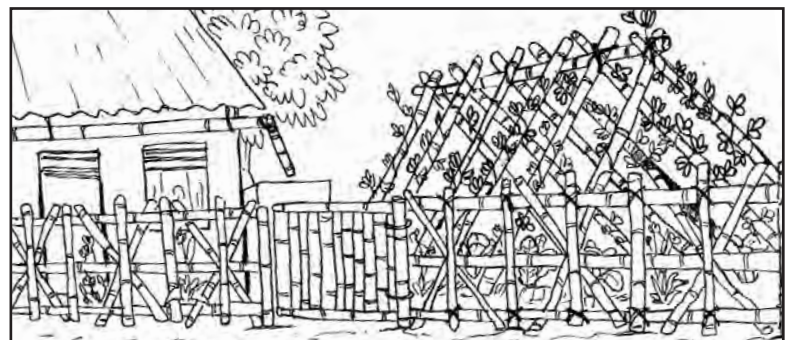
Use Different Plant Heights

Plants that grow to different heights can be grown together to increase the amount of production from each garden plot. Care needs to be taken not to shade smaller plants too much. Observe the sun direction.

Trellising can also be used to increase production. Living fences, fruit trees and even corn stalks can be used for trellising.



Trellising examples



Changing Garden Plot Heights

Changing the height of a garden plot can increase the production and planting area. Different heights allow for more root growth and better access to sunlight.

On sloped land swales will give more planting area and also provide different microclimates. The bottoms of the swales are wet and sometimes full of water in the wet season so water-loving plants like kang kong and taro can be grown. The top and behind the swale is drier so other vegetables and plants can be grown.



Crop rotation

Crop rotation helps to balance the amount of nutrients taken from a garden plot. Different plants take different amounts of nutrients. Crop rotation also helps to reduce pest and disease problems. A good method is to never grow the same vegetable in the same bed twice in a row.

All beans can be considered as 1 type of vegetable. Tomato, eggplant, capsicum, potato and chilli can all be considered as 1 type of vegetable because they are all from the same family – (Solanaceae). It is good to give each garden plot a rest for a few months, once every 2 years, to help it regain its stock of nutrients.

During this time add lots of compost and mulch.

Integrating crops together

We have already shown how to integrate crops with different harvest times and different heights, but there are many other reasons to grow several vegetables, fruits, spices and even flowers together in the same garden plots.



- Growing different crops together will reduce the size of pest problems because it takes more time for insects to move from plant to plant. Also there is less of each type of vegetable to attack. Therefore pest problems are easier to control.
- Some plants benefit from having other plants grow near them. For example garlic helps to repel aphids. (A very small pest that in large numbers can cause a lot of damage to tomatoes, cabbages, green vegetable and other crops) Therefore any plants that could be attacked by aphids will benefit from garlic growing nearby. Garlic will not stop all aphids but it will discourage them and reduce their numbers. Look in the Integrated Pest Management Chapter (CH 10) for more ideas.

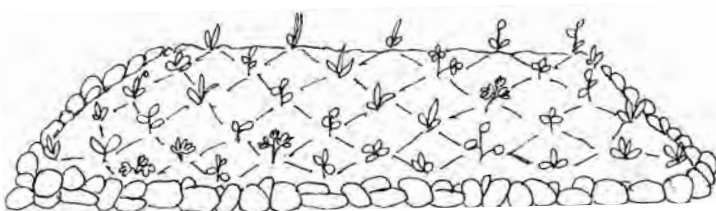


- Planting flowers and herbs in garden beds will attract insects that will increase pollination rate of vegetables. Insects that feed on pest insects will also increase in number and help to reduce pest problems.
- Beauty is important in any garden and integrating different plants together makes a much more beautiful garden.



SMART IDEAS:

- You don't have to plant vegetables and other plants in straight lines. Different patterns can increase number of plants in a garden plot.



Use zig-zag pattern to maximize production space

- Place long-term vegetables and plants that need low maintenance and one harvest at the back of the plot. If the plot has paths on both sides, place in the middle. Put short-term, high maintenance, vegetables at the front of the plots. This makes gardening easier and importantly reduces soil compaction.

Vegetable combinations

The most common combination here is corn, pumpkins and beans together

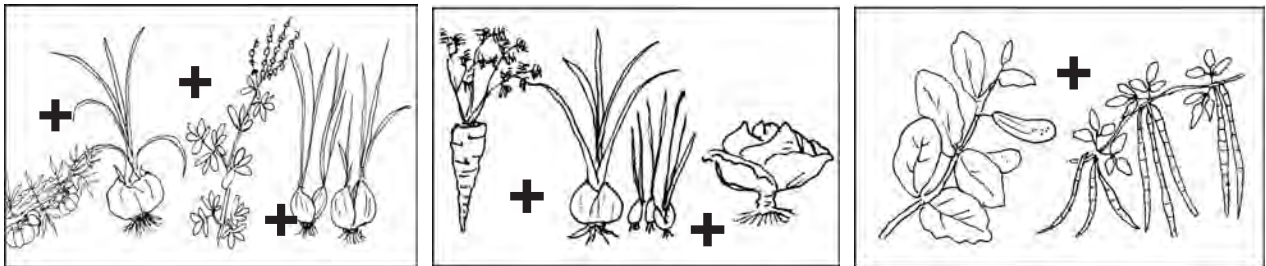
On a smaller scale, tomatoes, garlic and basil grow well together and help to protect each other from pests.

Chilli plants are also good for tomatoes, but potatoes are not.

Sunflowers are good to grow around corn to help to reduce pest problems.

Cabbages like onions growing with them to help repel insects and tomatoes are good too. Carrots grow well with onions, cabbages and lettuce.

Cucumbers like beans and peas grown next to them.



Sweet potato and taro

Another combination is sweet potato and taro, but not because they deter insects.

This method is particularly good for ground with a lot of rocks.

Start by making a rock pile. The pile should be about 2 metres x 2 metres when it is finished. Use large rocks, hand size or bigger so that there is lots of gaps.

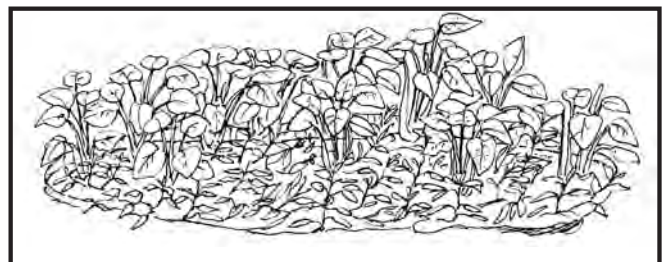
Next to the rock pile start digging a shallow pit, about 1 adult hand length deep. Use the rocks that you dig up to help make the pile. Use the soil that you dig up to fill in the gaps in the rock pile.

Add sweet potato cuttings as the rock pile grows. Keep adding soil, rocks and sweet potatoes until the pile is 1 metre high or more.

Use more rocks near the outside and more soil on the inside. The result will be a pit that can be used to grow taro and the sweet potatoes will grow out from the pile. The rocks will protect the sweet potatoes from rats. Don't forget to add some compost or dry manure as well and some liquid fertilizer is also good. In the taro pit place cut banana stalks as mulch. They help to keep the moisture in the pit.



Making a sweet potato pile and taro pit

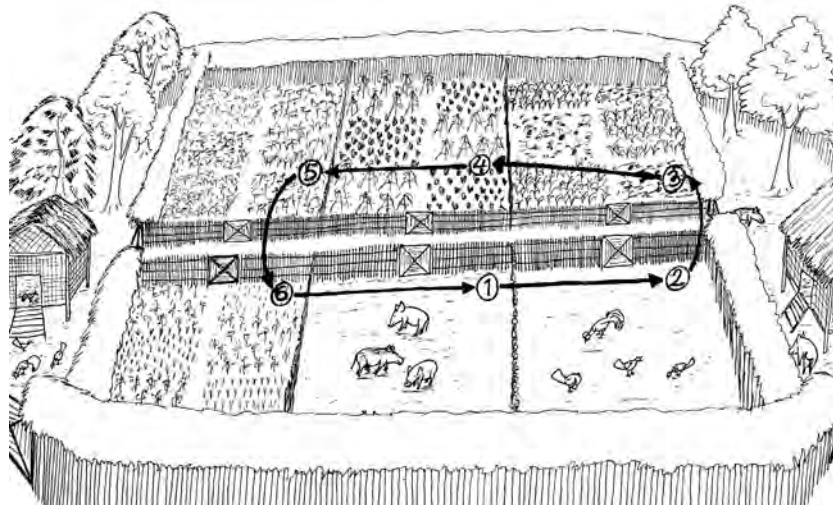


Sweet potato and Taro after 3 months.

Integration with Animals

The manure from animals is food for your vegetables. And the weed and vegetable stalks are food for your animals. But integration can go much further. Chickens, ducks, pigs and fish can all be raised together with vegetables.

- Areas of land can be rotated between vegetables and animals.
- Animals can be used to clean weeds and insects after crops, and fertilize as they clean.
- For small gardens, chickens and pigs can be put in small movable houses each day to clean and fertilize the soil.
- Vegetables can be grown in the bottom of fishponds in the dry season. (Clay ponds, not cement ponds)
- Vegetables can be grown around the edge of fishponds.



Look in the Aquaculture (CH 11) and Animal Systems (CH 12) Chapters for how to make and use these ideas and for many more ideas on animal and vegetable integration.

Vegetable plot and paddy integration

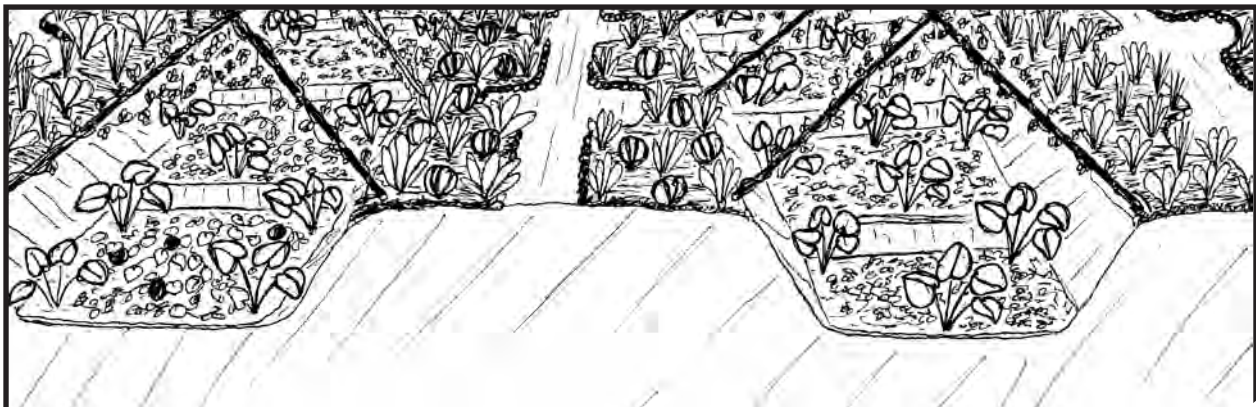
Garden plots can also be integrated with small rice/vegetable paddies.

The plots are raised from soil dug out to make the paddies. The paddies will collect the run-off water and water plants can be grown. The water that goes through the paddies can be collected in a pond at the end.

This system works best with a gentle slope. It can be used all year with the paddies becoming vegetable beds in the dry season. Trellises for annual vegetables such as beans, luffas, cucumbers and squash can be made over the paddies.

These designs for garden systems are examples. You can use them or take different parts of each system to make your own, or create a completely new system.

Every system can be different. Your systems can be as big or small as you want. Importantly, the system should fit with the natural pattern of the land and with your needs. If this happens then every system WILL be different.



Vegetable plot and vegetable paddy integration

Storing, drying & preserving vegetables

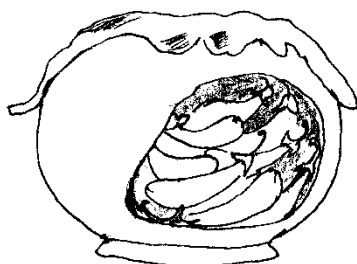
This chapter has given many different ideas for growing vegetables, but storing and using the vegetables properly is also important. Good storage means that the vegetables last much longer and keep more vitamins. Less vegetables go rotten and there is more chance of selling them. For most root vegetables the best option is to store them in the ground until needed. But for other vegetables a good storage method is essential.

After harvest, clean and remove any rotten leaves. Store the vegetables in a cool place that is out of the sun and protected from insects and animals.

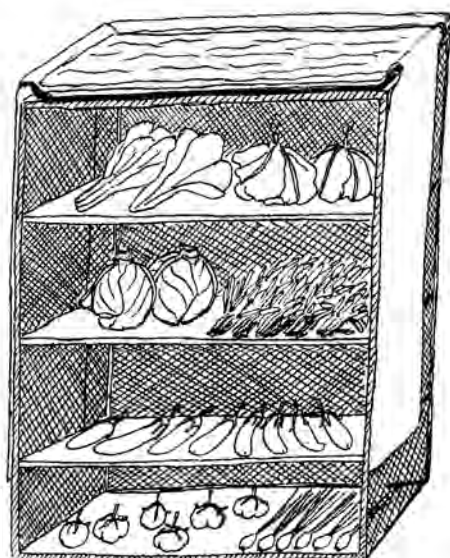
Three good types of containers are:

1. **Clay pots** are excellent for small vegetables and green leaf vegetables. Cover the top with a damp cloth and use string or rubber bands to tie it on. Keep away from the sun. The vegetables will stay fresh for many days longer.
2. **In Africa some people use two clay pots**, a smaller pot within a larger pot. Wet sand is placed between them. Cover and keep out of the sun. This technique works even better than 1 clay pot.
3. **Coolgardie Safe**. This is a large box that is covered in wire and uses water and wind to keep vegetables cool. It can also be used for meat and other food.

Look in the Alternative Technology Chapter (**CH 14**) for how to make a Coolgardie Safe. They are cheap and easy to make and will make vegetables and food last many days longer.



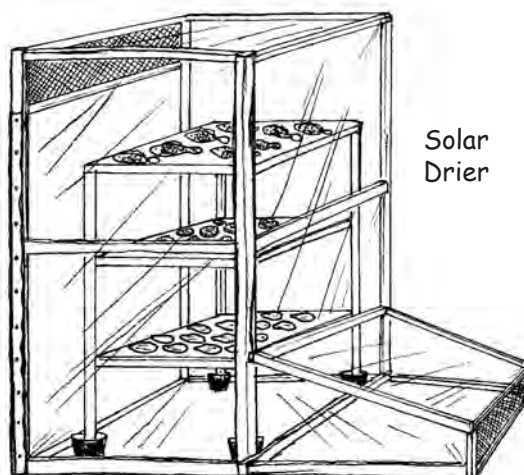
Clay pot



Coolgardie safe

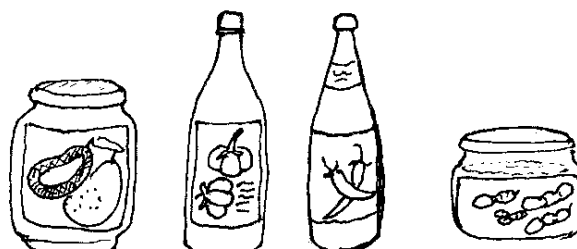
If many vegetables are picked at once or can't be sold or eaten there are methods to use and store the vegetables for later.

1. A Solar Drier can be used to dry vegetables. There are many different types and they can also be used for drying fish, meat and fruit. Read in the Alternative Technology Chapter (**CH 14**) for how to make and use solar driers.
2. Vegetables and fruit can be preserved as sauces, pastes, pickles and jams. Some examples:
 - Sauces: tomato, chilli, tamarind.
 - Paste: peanut, candlenut, cashew.
 - Pickles: cucumber, onions, capsicum, cabbage, mango, limes, bamboo.
 - Jams: All fruit except watermelon
3. Some vegetables can be dried and stored in oil for later use: eggplant, capsicum, chilli, tomato.



Solar Drier

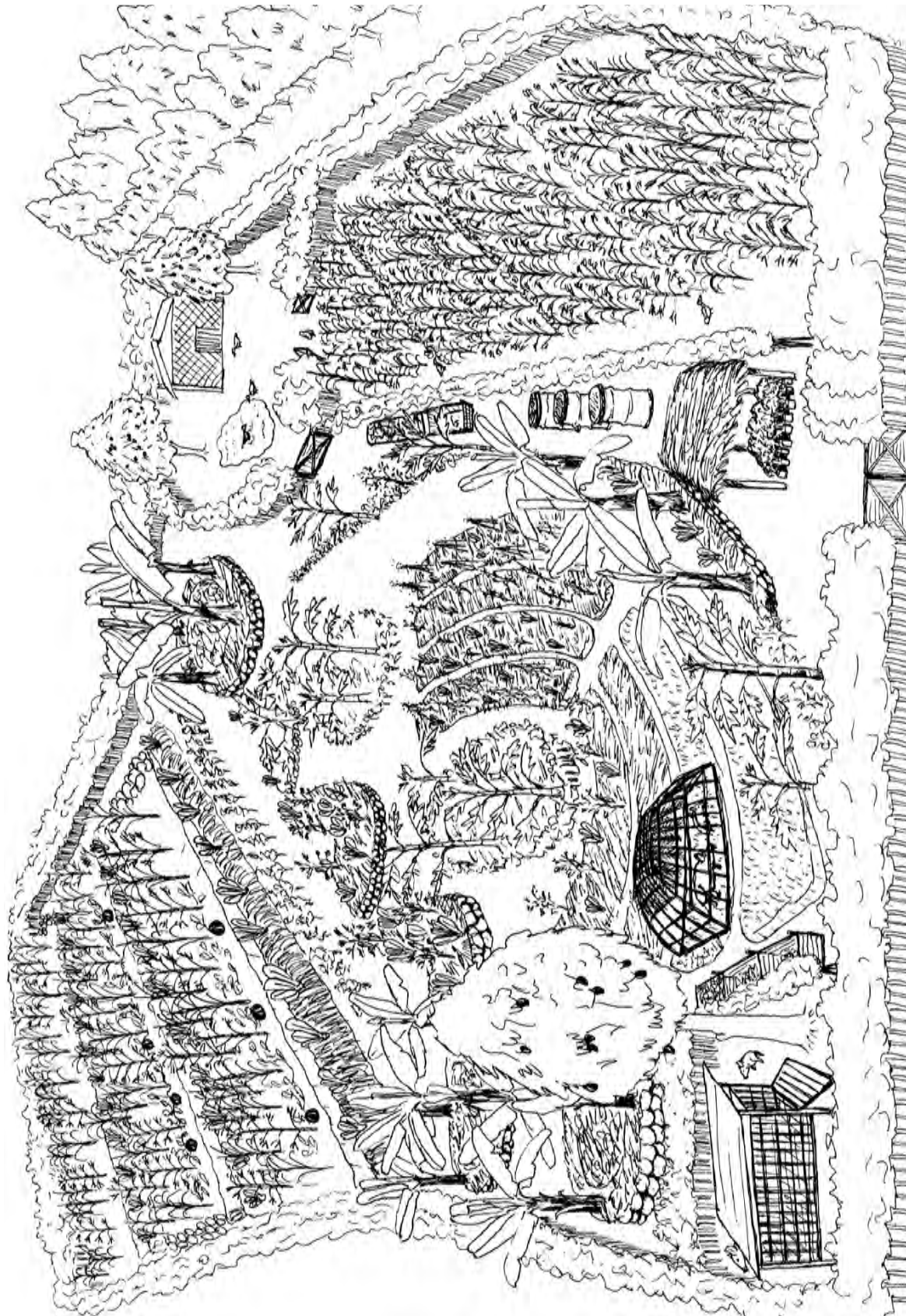
Look in the reference section for where find recipes.



Everyone in East Timor needs a wide variety of vegetables to be strong and healthy. Gardens can provide vegetables, and also fruit, spices and medicines for very small cost.

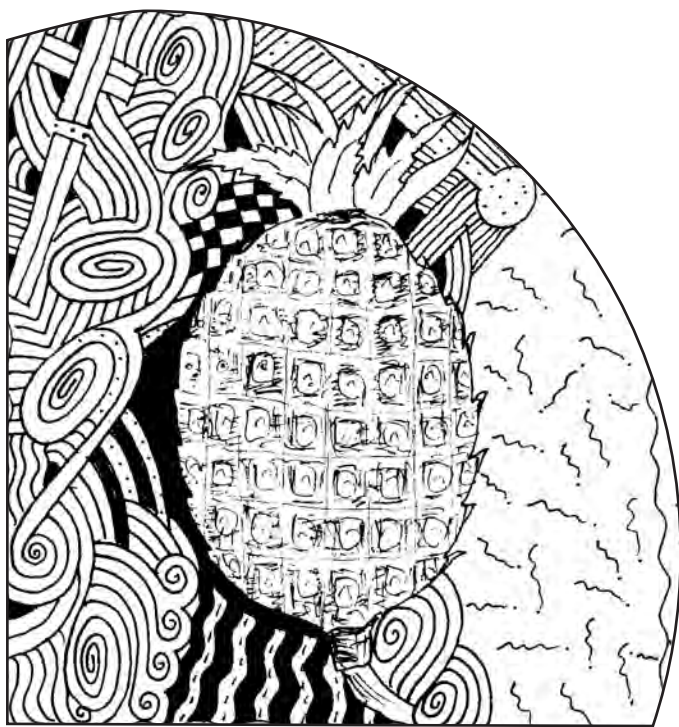
Remember to start small and make a garden that works well and is protected from animals. Then expand your garden, as you need. Remember to re-use all the water from the kitchen and washroom. This is a valuable resource. Remember to work smart, not hard.

A lot of food can be grown in a very small garden.



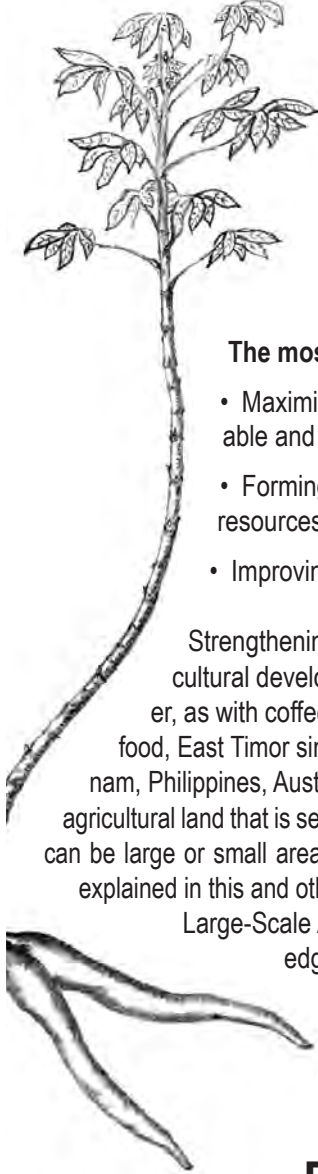
Vegetable and fruit crop system with pigs, ducks, swales, nursery, composts, banana pits, living fences and windbreak

Large Scale Agriculture



CHAPTER





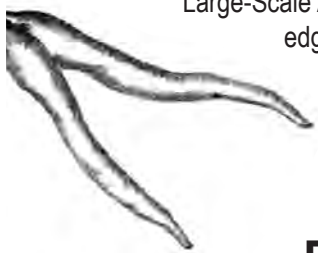
This chapter is about larger crops grown to eat, sell or trade. For example: rice, corn, cassava, beans, pumpkins, potatoes, sweet potatoes, lettuce, tomatoes and so on. Large-scale agriculture in East Timor is small compared to large-scale agriculture in many parts of the world. This is because East Timor is a small country! It is also because of the mountainous land, traditional agricultural practice and the family and community based land ownership. There are no reasons for big changes to this situation, especially when looking at long-term sustainability and improving food security and income for as many people as possible.

The most important issues to deal with are:

- Maximizing production on agricultural land already in use, in a sustainable and affordable way.
- Forming community co-operatives and farmers' groups that can share resources, costs, share techniques and knowledge.
- Improving storing, marketing and transporting of produce.



Strengthening and improving communities should be the main focus of any agricultural development. Export opportunities exist, as East Timor's export coffee market shows. However, as with coffee, the best potential with exporting crops is to produce ORGANIC food. With non-organic food, East Timor simply cannot compete for price and quantity with much larger countries like Indonesia, Vietnam, Philippines, Australia and China. The techniques and ideas in this chapter can be used for market gardens, agricultural land that is separate from the house, community agricultural land and all grain and vegetable crops. These can be large or small areas of land, and flat or sloped land. Integration techniques with tree crops and animals are explained in this and other chapters.



Large-Scale Agriculture is a very large subject. The people of East Timor already have a lot of knowledge and tradition with agriculture. Therefore in this chapter we aim to augment this knowledge and give many ideas and techniques that will improve large-scale agriculture and help to make it more sustainable for you and for the land. One specific technique, the System of Rice Intensification (SRI) is explained because it is a new technique that uses simple, cheap methods to greatly increase rice production.

Environment, Land and People

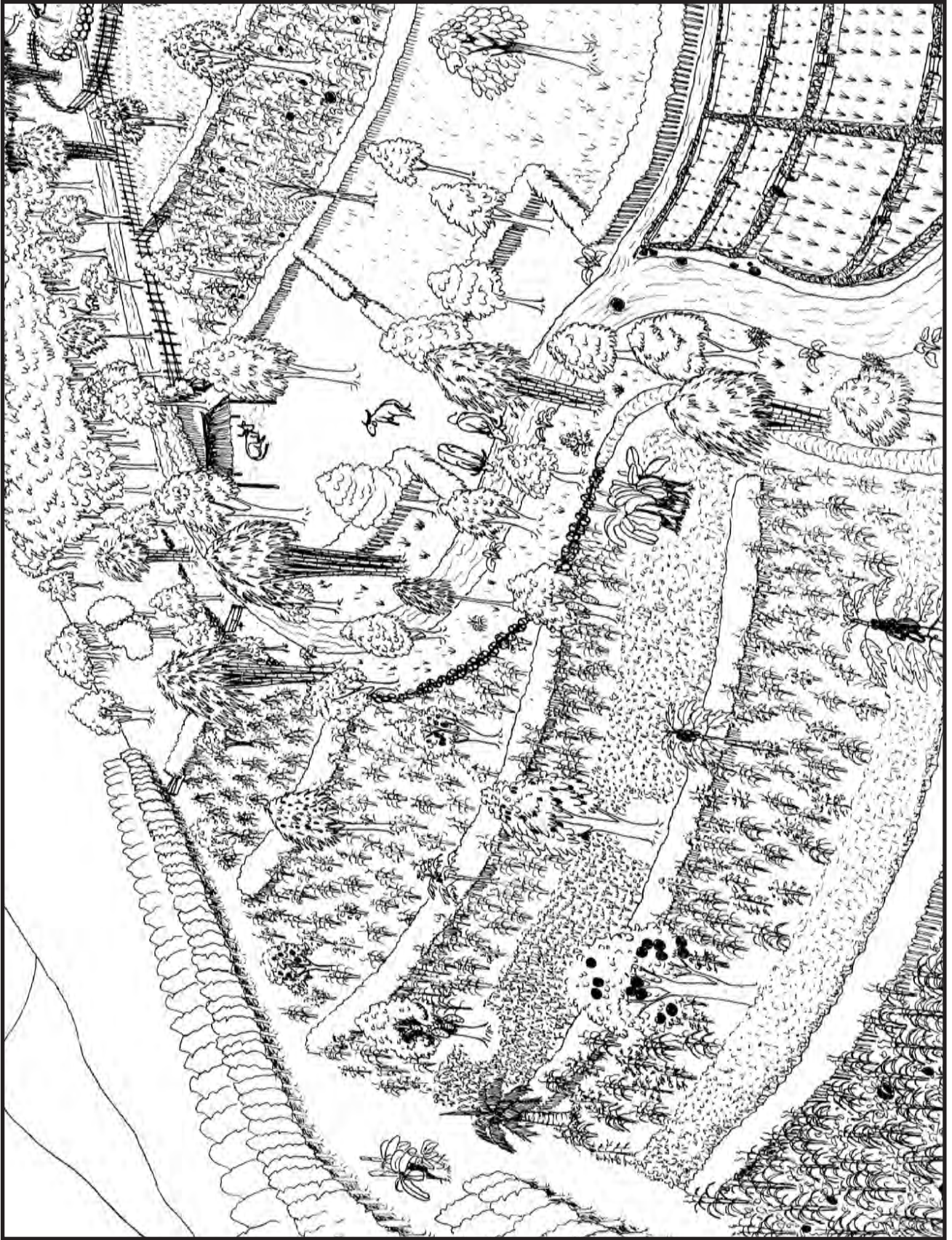
Large-scale agriculture is part of the land and environment around it. Wherever large-scale agriculture is practiced it affects and is affected by the land, the environment and the people. Large-scale agriculture is affected by:

- Climate – sun, rain, wind.
- Surrounding land and land use.
- Surrounding vegetation, animal and bird life.
- Water supply and water quality.
- Soil type and quality.
- Erosion and landslides.
- Closeness to houses or towns.
- Transport and marketing of produce.
- Resources available to farmers and workers. E.g. seeds, tools, fertilizers, harvesting and storage equipment and so on.

If you understand how your land and crops are affected, then you can use simple techniques and solutions that will benefit and improve your crops and your land. Large-scale agriculture affects the land, environment and people around it:

- Using terracing and swales to protect soil and stopping burning will help prevent erosion and even landslides.
- Pesticides and herbicides and overuse of chemical fertilizers can cause water pollution in rivers, fishponds and wells.
- This then will also damage the health of people, animals and birds.
- Soil quality will be damaged by burning and by using pesticides, herbicides and chemical fertilizers. This can also lead to erosion.

If you understand how your crops and land management affects your surrounding environment you can help to maintain and improve the health of the people and the environment. Problems occur as a result of bad agricultural techniques, if you recognize it or not. It is the same for agriculture all over the world. If you ignore it, it will still occur, and will cause problems now and worse problems in the future.

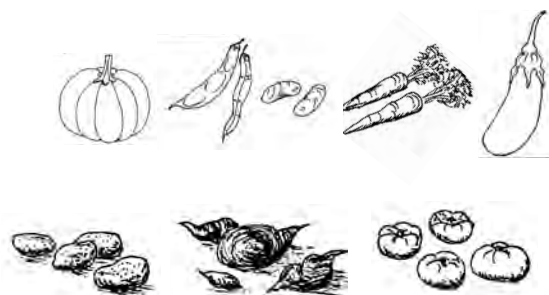


Community large
scale agriculture
system including
legume tree ter-
races, mixed crops,
animal integration,
spring protection,
river protection,
windbreaks and
natural forest on
mountain tops

Improving Large-Scale Agriculture

These Techniques come in 5 sections:

- Improving the Conditions
- Improving the Land
- System of Rice Intensification (SRI)
- Working with the People
- Working With Nature



Improving the Conditions

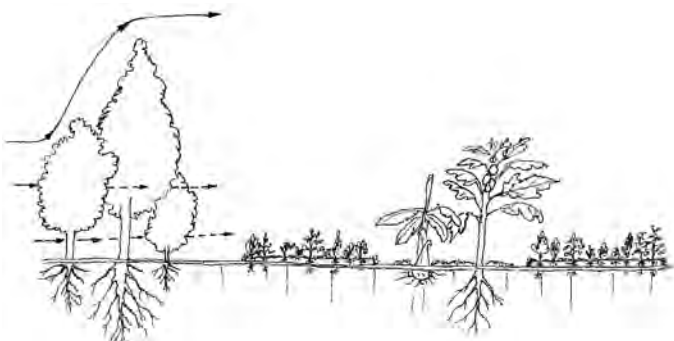
The following ideas and techniques will help you to use the land around your croplands to improve your crops and protect your land for the future.

1. Windbreaks

Light winds are good for agriculture and life generally. Strong winds however can cause a lot of damage to plants and trees, slow growth and make life difficult for people and animals. A windbreak is 3 or 4 rows of trees planted together that will slow and redirect strong winds while still allowing light winds to flow. Windbreaks are especially important for flat lands and for areas like Los Palos, Maliana and Bobonaro where strong winds continually blow many months of the year. **Even a small windbreak can improve production for a large area of land.** Windbreaks are important for improving large-scale agriculture. They will also benefit tree crops, market and home gardens, animal production, aquaculture and house and living areas.

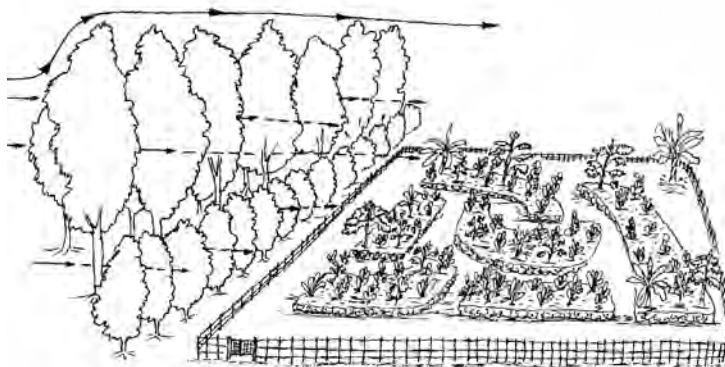
Direct benefits for agriculture:

- Reduce stress on plants therefore increasing growth rate.
- Reduce wind damage to plants.
- Erosion is greatly reduced.
- Water evaporation from plants and the soil is much reduced, and plants use available water more efficiently.
- Soil temperature won't change as much – the soil won't get as hot or cold.
- This creates a better temperature for healthy plant roots and soil biota.



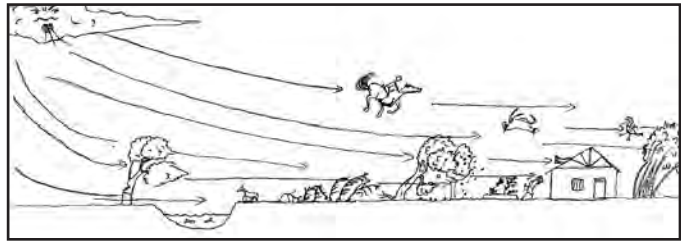
Other benefits:

- Pollination rate will increase because the number of birds and insects will increase. This will increase the number of grains, vegetables or fruit on each plant.
- If you use a lot of legume trees then nitrogen in the soil will increase around the windbreaks and below them.
- Windbreak trees also can provide animal food, nuts, oils, firewood, timber, mulch, fibre, medicines and much more.
- Water evaporation from rice paddies, ponds and aquaculture will be much less.
- Animals will be healthier and less stressed. This will increase the amount and the quality of meat and reduce animal sickness.
- House areas will be much better and more comfortable to live in.

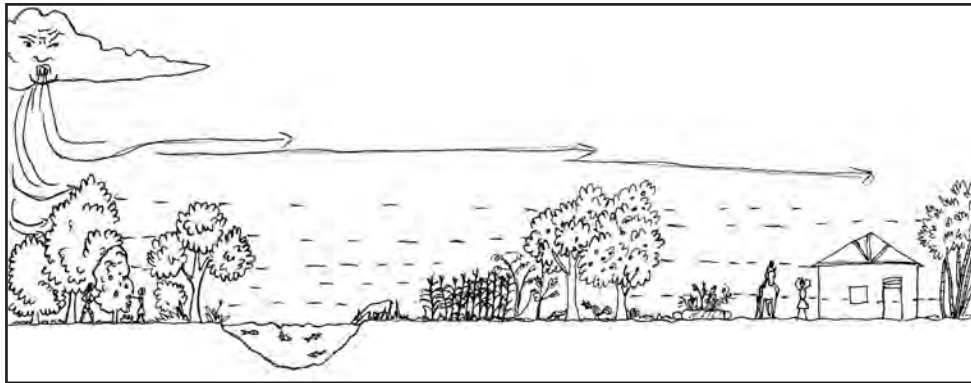


Windbreak Location

- Where do strong winds come from?
- Where do the winds come from most often?
- What do you need to protect from strong winds?
E.g. house, animals, crops, fruit trees and so on.



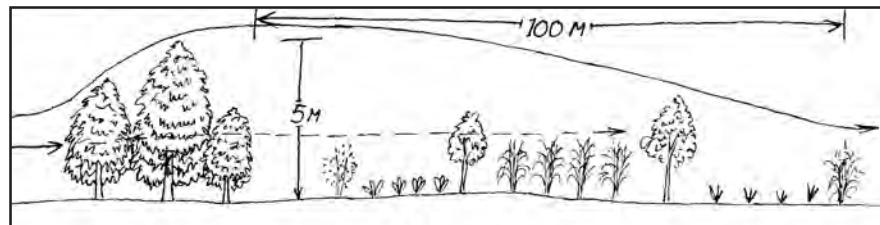
By answering these questions you can work out the best locations for windbreaks.



Factors for location

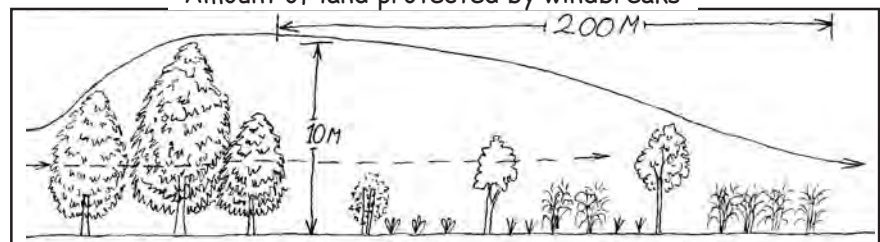
The area of land that is improved by windbreaks depends on how high the windbreak is.

A 5 metre high windbreak slows the wind for more than 100 metres of land behind the windbreak.

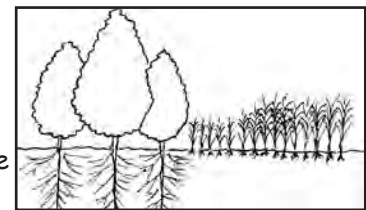


Amount of land protected by windbreaks

A 10 metre high windbreak slows the wind for more than 200 metres of land.



Roots of windbreak trees will reduce productivity of any crops grown next to the trees. Shade from large trees when they are fully grown can affect crops. However very tall trees are not usually needed for windbreaks.



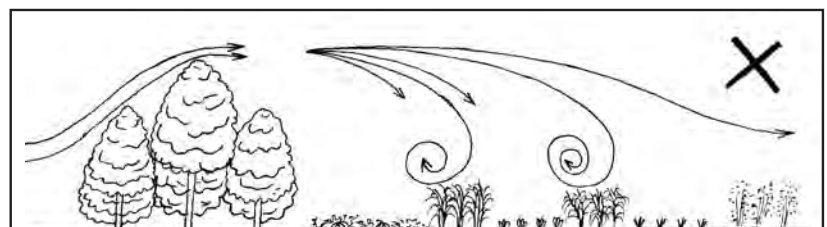
Planting too close to windbreak

Windbreak Construction

A windbreak needs to be 3 or 4 rows wide to work properly. This is thick enough to reduce the strength the wind and will allow it to gently rise and fall.



It is also important to use trees that allow some wind to pass through the windbreak. E.g. casuarina, leuceana, sesbania, tamarind, sleeping tree, acacia, eucalypts, bamboo, gliricidia, and many more. Trees with many thick leaves like Jackfruit, avocado and mango don't work as well.





Mix the tree types together when planting and use a zigzag planting technique to maximize the effect of the windbreak. Fast growing legumes and bamboo are good to use because they provide protection quickly. The length and shape of the windbreak will depend on what you need it for. The wind will flow around the sides so always make the windbreak longer than the area that needs protecting.

Windbreaks can be:

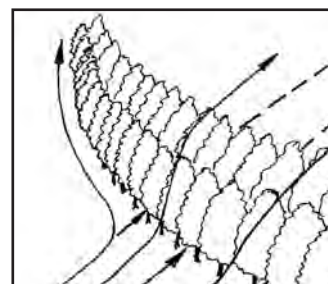
- Straight lines.
- Made in sections – Wind will be concentrated and stronger where there is a gap.
- Curved lines – Always make the outside edges curve away from the wind.



Zig-zag pattern for windbreak planting

The windbreak shape depends on the size of the windbreak, the shape of the land, the wind characteristics and what it is needed for.

Windbreak Maintenance



Protection from animals must be provided while the trees are young. Replant where any trees die, especially when the trees are small. It is very important to have an even windbreak. Don't cut all the bottom branches for firewood or let animals eat too much from the bottom. This will allow the wind to flow under the windbreak. Try to keep the tree shape even to provide the best results.



SMART IDEAS:

- Use taller windbreaks for protecting tree crops. 10 – 15 metres high is best.
- Use some fire resistant trees if possible to reduce potential fire problems.

2. Tree Terraces, Swales and Water Storage

Erosion and flooding from land above agricultural areas can cause a lot of damage and destroy crops, animals and even houses.

Erosion can take away large amounts of soil, but it can also enter irrigation canals and rice paddies causing more problems. The most recent widespread flooding occurred in East Timor in 2003.

Sometimes flooding can be prevented, sometimes it cannot, but the affects and amount of flooding can always be minimized. Tree terraces, swales and other water storage techniques can be used to catch and store water and prevent erosion.

- * Water will be stopped from building up and flowing in large amounts.
- * Start from where the water starts building up as high up the mountains as possible.
- * Always plant out with trees immediately. Loss of trees increases erosion dramatically.

To be most effective, all solutions must be made on a community and district level. Community groups can work together to implement solutions. If swales are made on a families' land, they will improve productivity and reduce erosion on that piece of land.

The swales and tree terraces will reduce flood potential for the land below them.

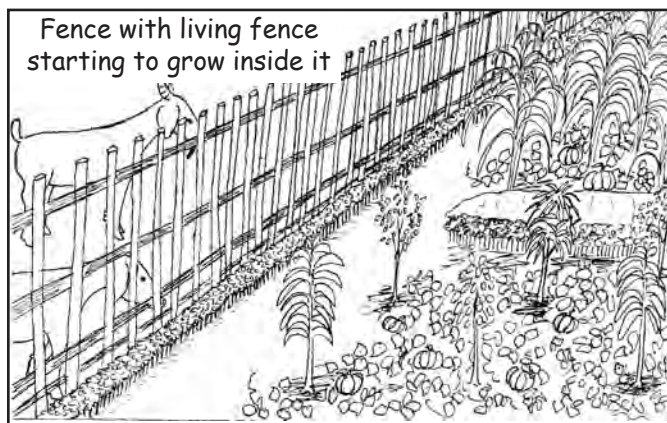
Look in the Reafforestation and Tree crops Chapter (CH 7) for how to plan and build tree terraces, swales and other water storage techniques.



Legume tree terraces and river protection

3. Fences

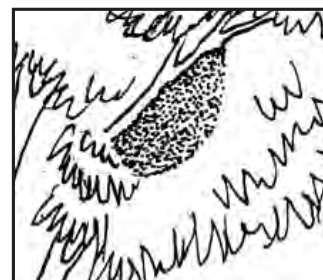
Fences are very important for protecting your crops. Living fences provide mulch and animal food. Fences can also provide some wind protection.



4. Stop Burning

Why Stop Burning?

- Burning the land causes and increases erosion
- Burning destroys all organic matter and soil biota that is necessary to improve and replenish the soil
- Burning removes plant material that can be used for mulch on your cropland
- Fire can spread quickly, especially when there is a lot of wind, and can damage dry season crops
- If the land is burnt each year then you cannot plant windbreaks that will protect and improve your crops
- If the land is burnt each year there will be a lot less birds and insects that provide natural pest control



5. Increase the number and types of trees

More trees and more types of trees surrounding your croplands will provide many benefits. Most importantly, trees protect soil and reduce erosion. They will attract birds and helpful insects like bees, wasps, ladybirds, beetles and spiders. The birds and insects will help to control pest insects, therefore reducing problems for crops. They will also increase pollination, which will increase yields. The trees also make a barrier that will slow the spread of pest problems.

Trees also provide many different products.

Remember to think **MULTIFUNCTIONAL**.



6. Natural patterns

Straight lines and squares do not exist in nature. Follow the natural patterns of the land. If you observe the natural shape of the land, the water flows, soil quality, sun direction and so on, the land will TELL YOU the best uses for the land and the best shapes for your croplands.

Terracing and swales are good examples of using the natural pattern to create productive land. Working with nature and natural patterns will:

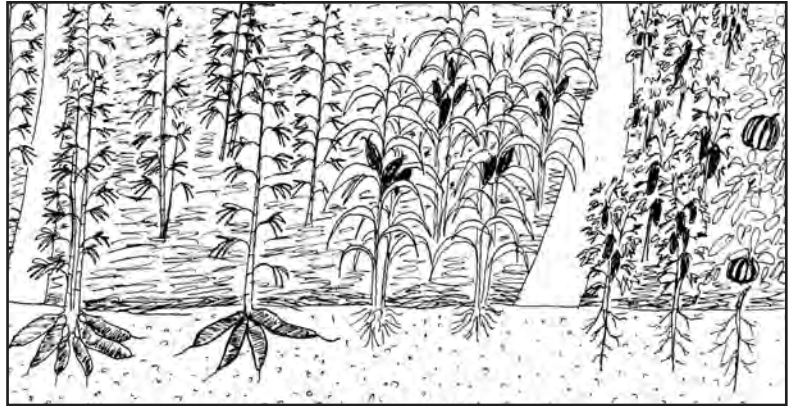
- Reduce labour and resources needed.
- Maximize the productivity of sloping land.
- Greatly improve the long-term sustainability of your land.



Improving the Land

Healthy, living soil is the basis for good agriculture. Agriculture practice must be focused on building up and improving the soil year after year.

Other important techniques for improving agricultural sustainability, such as irrigation, crop rotation and integration are also explained.



1. Natural fertilizers and Mulch

There are many ways to provide natural fertilizers to your croplands.

Mulch

Mulch provides many, many benefits for your cropland.

Use the crop waste and leaves for mulch instead of burning it, because this will provide nutrients for future crops. As well as supplying nutrients, the soil is greatly improved because the mulch provides organic material and food for soil biota (animals).

Water will stay in the soil for much longer and erosion will be decreased. Apply the mulch continuously and as thickly (5-10cm) as possible. Read more about Mulch in the Soil Chapter (CH 4).

Many legumes trees, like leuceana, acacia, albizia, sesbania, moringa, sleeping tree and more can be grown around croplands or in rows to provide mulch. When the mulch is cut the legume trees will also provide nitrogen from their roots. They will also act as a windbreak. Read in the Tree Crops Chapter (CH 7) for more about using legume trees.

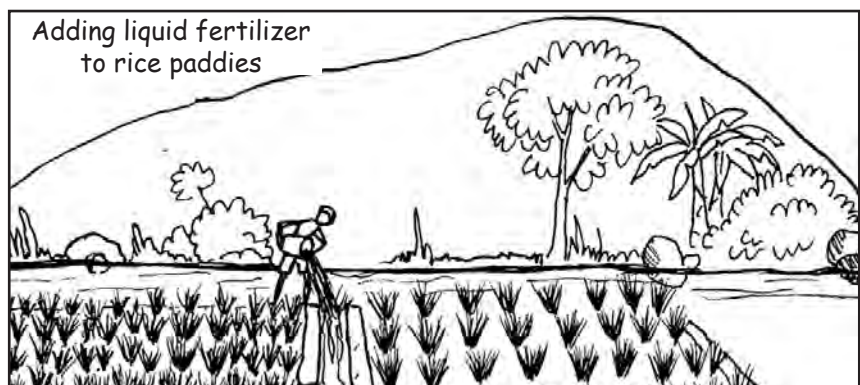
Liquid Fertilizer

Liquid fertilizer is a good way to use natural fertilizer because it is concentrated compost. Read the Soils Chapter (CH 4) for how to make and use liquid compost.

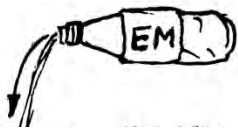


SMART IDEAS:

- When used on large areas liquid compost can be made even more concentrated so that you can use it over a larger area. To do this use chicken, duck, bat or pigeon manure, add more seaweed and double the amount of wood fire ash. If you make it stronger make sure that you dilute it with more water, at 30 parts water to 1part liquid fertilizer.
- Liquid compost can be added to rice paddies. Use before planting, during growing and after harvest for best results. Use approximately 1 bucket of fertilizer per paddy, mix it with 1or 2 buckets of water and spread it evenly.
- If your croplands are flood irrigated add the liquid fertilizer straight into the irrigation water. Use about 1 bucket per 10 x 10metres, and apply once or twice a month.



E.M. – Effective Microorganisms



E.M. is a liquid that will increase the amount of microorganisms in the soil. This improves soil quality and increases production. It is especially good for large scale production because:

- It can be easily used on a large area of land.
- It can be combined with any type of organic fertilizer, liquid fertilizer and mulch.
- With good land management it will naturally multiply in the soil. Read in the Soils Chapter (CH 4) for how to make and use EM.

Compost and Manure



Compost and manures are excellent for supplying nutrients and improving soil quality. On large-scale land they can be used in small amounts to augment the mulch and liquid fertilizer. It is much easier to collect and use large amounts of manure and compost if animals are housed at night.

Animals can also be fenced or tethered on the cropland in the dry season or in between crops to provide manure.

Green Manure crops

Green Manure crops can be grown to provide nutrients, organic matter and mulch. Read the legume section in Soils Chapter (CH 4) for how to grow a green manure crop. Green Manure crops on Large-scale agriculture land can be grown in rotation with other crops or intercropped. They can also be used in rotation with animals.

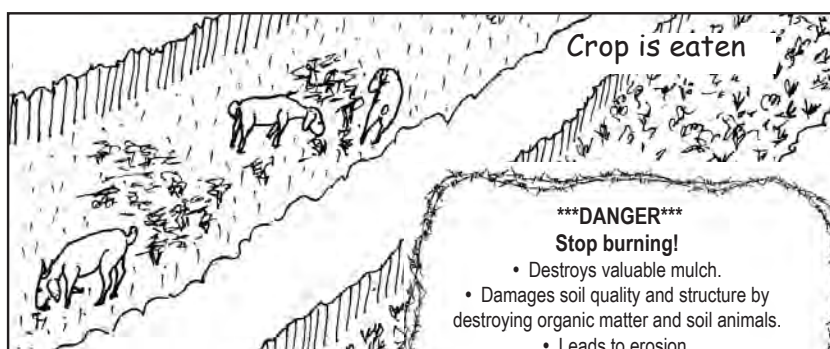
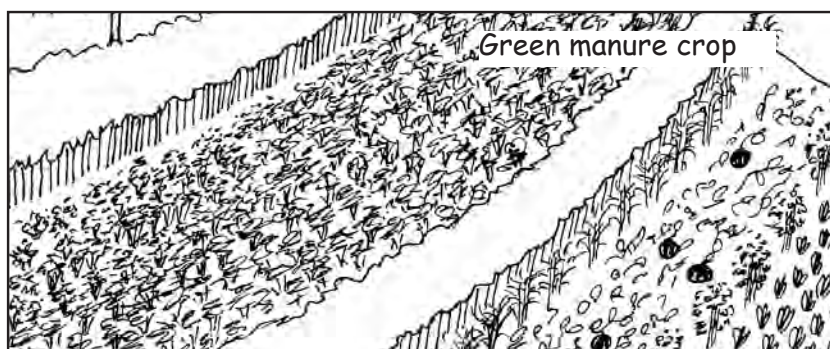
- a. After the main crop (E.g. rice or corn), a green manure crop is planted.
- b. The animals are brought in just before the green manure crop starts to flower.
- c. The animals eat most of the green manure crop. The crop still provides nitrogen and some organic matter for the soil and the animals will provide manure for the soil.

This technique will work better if the land is fenced, especially if a living fence is made.

Cover Crops

Cover crops are crops which grow along the ground, thus “covering” the ground. They provide 2 important functions:

1. Nutrients and organic matter for the soil.
2. Weed control because they prevent many weed from growing due to lack of light. E.g. The “Slash and Mulch” System, introduced and trialled by agriculture lecturers at UNTL. Beans planted 1/2 way through the corn growing cycle will cover the ground in between the corn. The beans don’t compete with the corn because of when they are planted and they provide good weed control and food for the soil. The beans are also cut back for mulch, as is the corn stalks. In the trials Sword bean, Velvet bean (Macona bean) and Jack bean have been used, with promising results. Contact the Agriculture Department at UNTL for more details.



2. Water storage and irrigation

For most farmers in East Timor, large crops are dependant on rains. Therefore most of the large-scale vegetable and grain crops are only grown in the wet season.



Two important ways to improve crop production and extend the growing season are:

a. Store and protect water in the soil

All farmers can store and protect the water in the soil.

For mountains and sloped land swales and tree terraces will catch and store water. Even gently sloped land will hold a lot more water if swales and tree terraces are used. Read Tree Crops and Reafforestation Chapter (CH 7) for how to make and use tree terraces and swales.



Mulch will protect the water in the soil and stop the soil from drying up. Healthy, living soil is also important for water storage because it will hold A LOT more water than unhealthy soil.

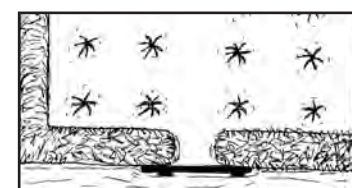
b. Irrigation

Irrigation can be used in many ways:

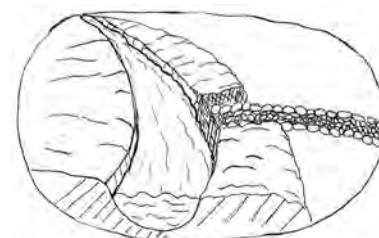
- To add to the wet season rains.
- Extend the wet season
- To channel the wet season rains where you want the water to go.
- To provide a separate irrigation system from a pump or water source that can irrigate cropland even in the dry season.



Irrigation of large crops can take a long time to set up, and can be expensive so it is important to MAKE A PLAN. It is always good to start small but think about what you will want in the future. Observe where water flows through your land. Plan for where you will want irrigation on your land and plan for future needs as well. Try to combine different crops and areas and plan for how to use excess water from one area to irrigate another area. Work together with neighbours and your community. This will make irrigation cheaper and easier to maintain. A community water users group is a good way to manage irrigation and water use.



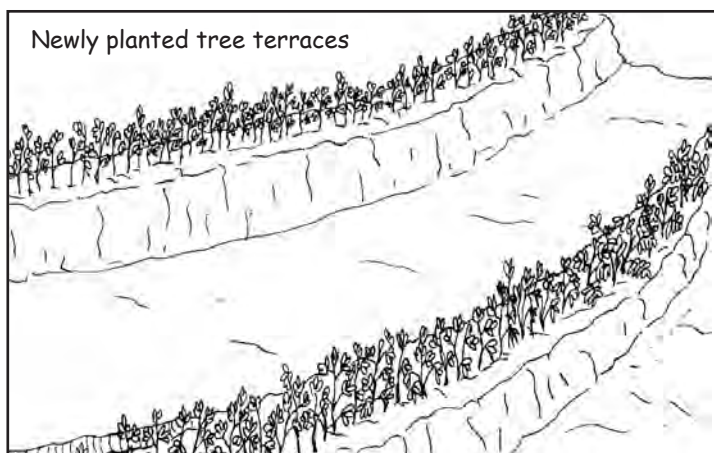
Paddy irrigation and trench flooding irrigation are the most common types of irrigation in East Timor. They are good for the wet season but use too much water to be used in many places in the dry season. Water gates can reduce the amount of water needed. This means that not all paddies or trenches get flooded at once. The gates can be on the irrigation channel or from paddy to paddy.



The water is directed where it is needed. It still requires a constant source of water. Swales can be used for irrigation and can be used to run water down a slope evenly. Swales can be combined easily with aquaculture ponds and can run water into rice paddies, croplands, market gardens etc. If you use swales for irrigation make sure that the overflow point is well made to stop erosion. Rocks or a simple gate can be used to regulate the flow of water.

3. Tree and Grass Terracing

Tree Terracing (or Living Terracing) has recently been introduced in East Timor. It is an excellent method for improving production, improving soil quality, storing water and stopping erosion.



The process involves:

- Marking out contour lines, approximately 5 metres apart on gentle slopes and 2 –3 metres apart on steep slopes.
- Digging small swales on the contour lines.
- When the wet season begins, plant out legume seeds on top of the swales, very close together. (3 – 5cm). Gliricidia or Lueceana are best.

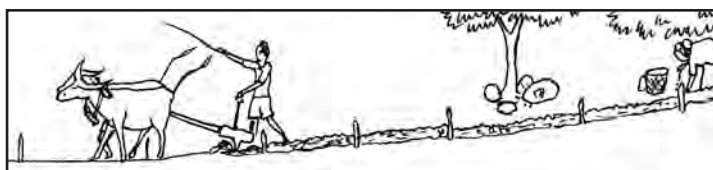
The legumes will grow into a thick fence which will eventually create a terrace.

They can be cut back for mulch, every 1 - 2 months in the wet season, and 1 – 2 times in the dry season.

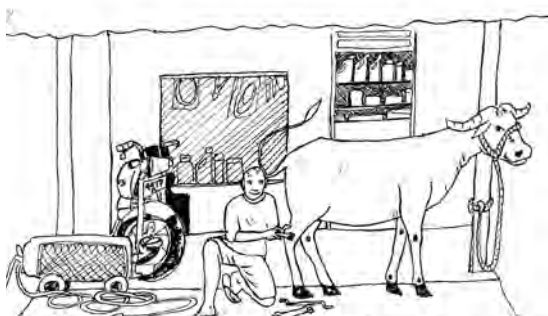
Vegetable and grain crops are grown between the rows. Read CH 7 for much more information and for integration ideas. Vetiver grass can be instead of legumes on some rows. It is very deep rooted, holds the soil together and produces a lot of mulch. It is especially good for steep slopes.

4. Use buffalo ploughs

Buffalos can be used to prepare croplands and rice paddies for planting. This will improve production and reduce preparation time. They can also be used for ploughing contour lines on slopes and helping to prepare sloped land for planting trees.



Cost - Buffalo are not cheap but they will be able to work for many years. A young buffalo costs about \$200. A mature buffalo costs about \$250. Once a family, farmer group or community group has a male and female buffalo then their numbers will slowly grow.



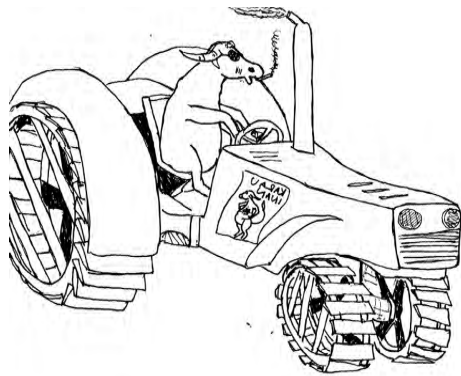
Maintenance - Buffalo need to be healthy to be able to work well. Food, water and shelter are needed, and medical care when required. Buffalo maintenance requires time but not a lot of money.

Training - Buffalos have not commonly been used for ploughing in East Timor, but there are many groups now giving training. Almost anyone can learn how to train buffalo and how to use buffalo ploughs. Read the Buffalo section in the Animal Systems Chapter (CH12) for ideas about training and using Buffalos for ploughing.

Soil structure - Good soil structure is very important for healthy soils and in turn healthy crops. It is better to plough a line through the soil. This makes it easy for the plants to grow but doesn't damage soil structure. Buffalo ploughs work in this way. Turning the soil right over damages soil structure.

Lack of flat land and road access - Most of East Timor has sloped land. Buffalos can be used on slopes as well as on flat lands. Buffalos can be kept anywhere in East Timor as long as you have water.

Other benefits from buffalo - Buffalo also provide income, meat, leather, manure and more buffaloes.



About Tractors

Tractors take a lot less time to prepare land for planting and can be good for large areas of flat land. However, there are many other factors that also must be looked at when deciding if a tractor is beneficial or not.

Cost - Tractors cost a lot of money to buy, too much for most people, even farmers groups. It is much better to rent a tractor.

Maintenance - Tractors cost a lot of money to maintain every year. Petrol, oil, tyres, engine and hydraulic maintenance are only a start. Tractors also need people who have a lot of knowledge of machines to maintain them. Spare parts can be very hard to find and sometimes need to be imported from overseas. Tractors also need a storage house to keep them out of the rain.

Training - Tractors are much harder than cars to drive and require a lot of training.

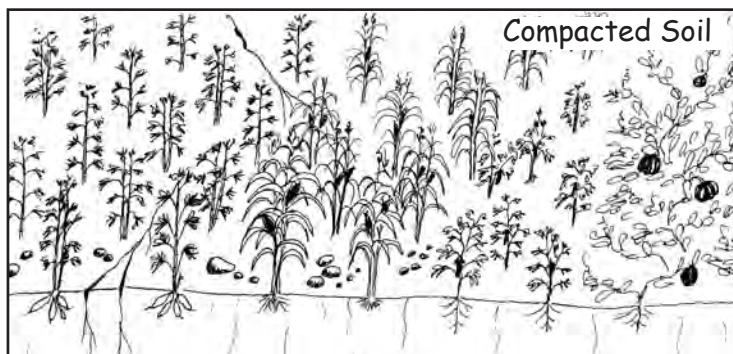
Soil Structure - Most tractor ploughs turn the soil over. This helps crops to grow but damages soil structure. Therefore soil quality gets worse over time, not better. Tractor ploughs that cut through the soil rather than turn it over are much better.

Lack of flat land and road access - There are not many areas in East Timor where there is a lot of flat land to use a tractor. There are also many places in East Timor where it is impossible to get a tractor to because the roads are too narrow or become blocked in the wet season. Many areas have no road access.

5. Reduce Soil Compaction

Soil compaction causes many problems for large-scale agriculture:

- The soil will hold a lot less water.
- Soil biota that are necessary for healthy soil can only live in small numbers.
- The soil will contain a lot less air.
- Plant roots find it much harder to grow and therefore are smaller and grow close to the surface.

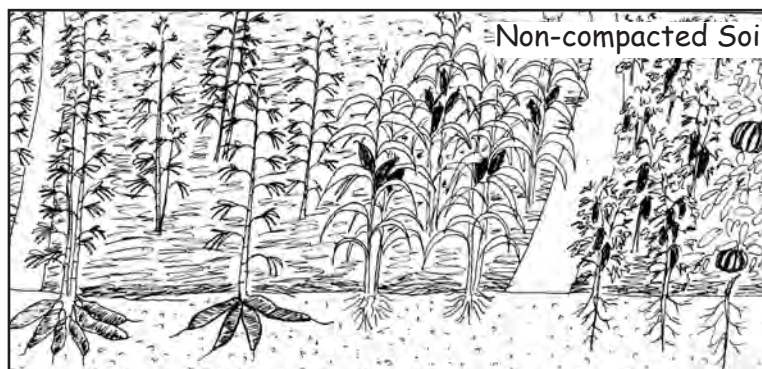


Compacted Soil

All these problems cause smaller crops and higher water use.

To reduce soil compaction

- Poor soil becomes compact as it dries. Healthy soil with organic matter and mulch will dry a lot slower and become less compact when it does dry. Use tree terraces, swales, rock terraces etc to build up the soil.
- Buffalo ploughs cause a lot less compaction than tractors.
- Don't graze too many heavy animals (buffalo, cows) on your cropland between crops.



Non-compacted Soil

Even people cause compaction. Use a few paths for walking so that only the paths are compacted. This is very important on sloped land.

6. Intercropping vegetables, grains & small trees

Intercropping means to mix different types of grains, vegetables and even small trees together. There are many benefits that intercropping gives and many different combinations.

Combinations

- Legume trees, small fruit trees, grain and vegetable crops:
- The legume trees provide shelter, mulch, nitrogen, and food and even can be a living fence and a trellis for beans. E.g. Moringa, pigeon pea, sesbania, leuceana, Albizia, etc.
- Small fruit trees can also be grown. E.g. papaya, banana, citrus.
- Trees also slow and reduce pest problems.
- The grain and vegetable crops can be grown in between the trees. The different grains and vegetable can also be mixed together, and so can the legumes and fruit trees.
- The combinations you choose and the way of combining them is up to you.

Corn, pumpkins and beans

A traditional combination in many countries that provides 3 different crops in the same space.



Corn and peanut rows

The corn shelters the peanuts and the peanuts provide nitrogen for the corn. Recent trials in East Timor show an improvement of both corn and peanut production from growing them together.



Cassava

Cassava can be grown with small trees. Papaya, sesbania, moringa, pineapples and bananas can all be grown together. As well as growing more crops the cassava will benefit from the shade and from the nitrogen from the legumes. This combination is common in parts of East Timor, especially the Bobonaro district.



Mound and trench combinations:

Mound rows with trenches dug in between are good for holding wet season rains and for irrigation. The mounds can be used for different grains, vegetables and even some legumes and small fruit trees, and in the trenches you can grow kang kong, watercress and taro. And remember that the mound rows don't have to be straight.

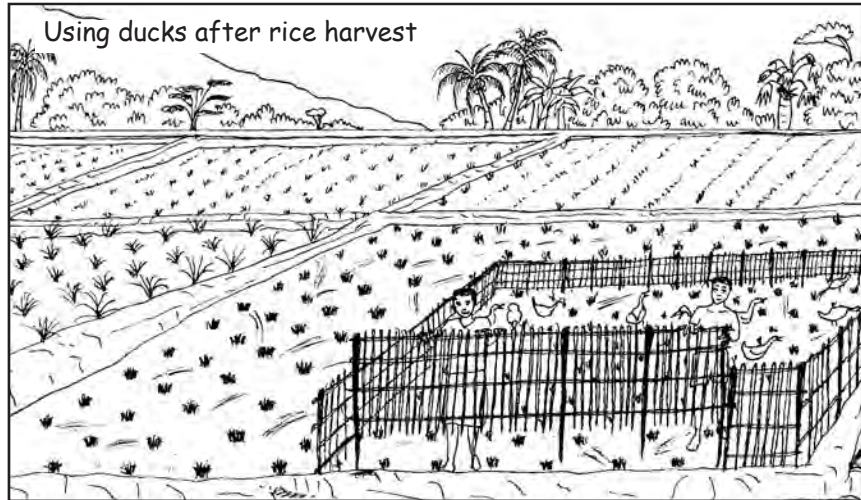
7. Integration with other systems

Different systems can work better if they are integrated together into one system. Maintenance can be cheaper and easier because the waste from one part can be used as a resource in another part of the system.

Overall production from the land can be increased.

Rice paddies with ducks

Ducks can be used to clean up after rice harvest and fertilize the soil. They can also be rotated from one paddy to another using a moveable fence. The ducks will fertilize the paddy and prepare it for the next crop. They can be continually rotated for short or long periods in each paddy. This depends on how many ducks, how many paddies and how many crops per year.



Tree and annual crops

Small fruit trees and legume trees can be grown with grains and vegetables. The trees can be harvested as well and can help to increase production of the grains and vegetables. They can be grown in rows, around the cropland or in groups. Read the tree crop chapter and earlier this chapter for explanation and many different examples.

Animal grazing and crop production: rows and plot rotation

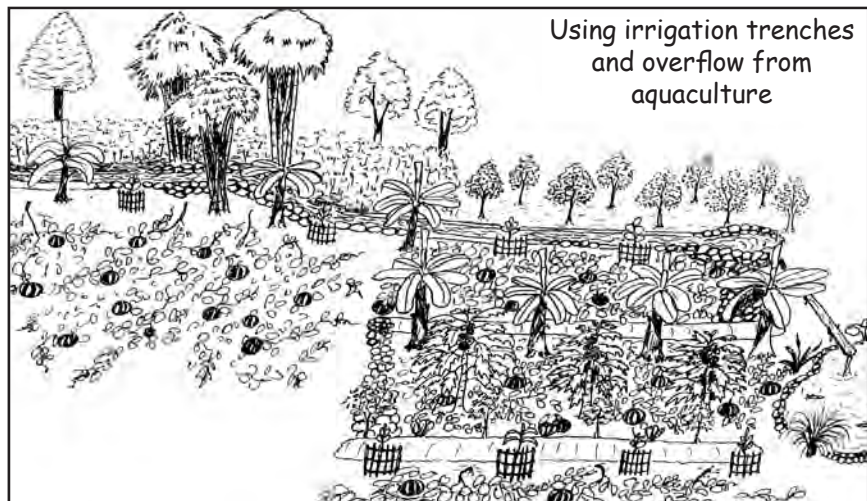
Animals can be grazed on the cropland after harvest, and will fertilize the soil. Be careful not to leave buffalo and cows in one spot too long or the soil will become compacted. Legume trees grown in rows, or dividing cropland into sections can be used as living fences for animal grazing.

Rice paddies with Fish

With careful management fish can be raised in paddy systems at certain times of the year. The fish provide manure for the rice plants. Look in the Aquaculture Chapter (CH 11) for more ideas.

Aquaculture run-off

Water from aquaculture ponds is rich in nutrient and should not be wasted. Swales, terraces and paddies can be used to catch and store the run-off water and use it to grow vegetables and trees.



8. Natural Pest Management

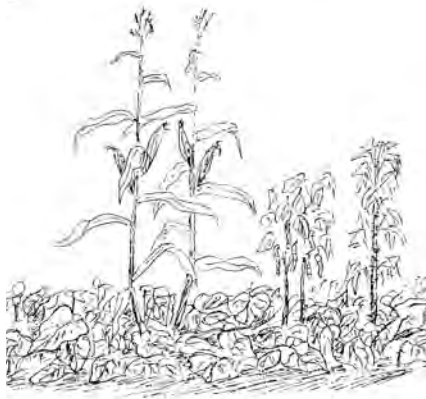
There are many different parts to natural pest management. It is best to prevent problems before they occur. A healthy system with healthy, nutrient rich soil will have a lot less pest and disease problems. There are also many different natural pesticides to use if problems do occur.

The next chapter explains about a system called Integrated Pest Management, which is used in many countries to naturally prevent and treat pest and disease problems.

9. Weed maintenance

Weeds are a big problem affecting agriculture in East Timor. Crop production is very poor if weeds are not controlled. They use nutrients and water and compete with the agricultural crops. However, if they are put back onto the ground as mulch then some nutrients and water is returned. They also greatly reduce future weed growth. If they are burned then the benefits are lost. More weed removal equals better production; more plants and larger crop size. If possible, remove weeds once a month. Always use the weeds as mulch for the crops.

Ground covers
reduce weed
growth



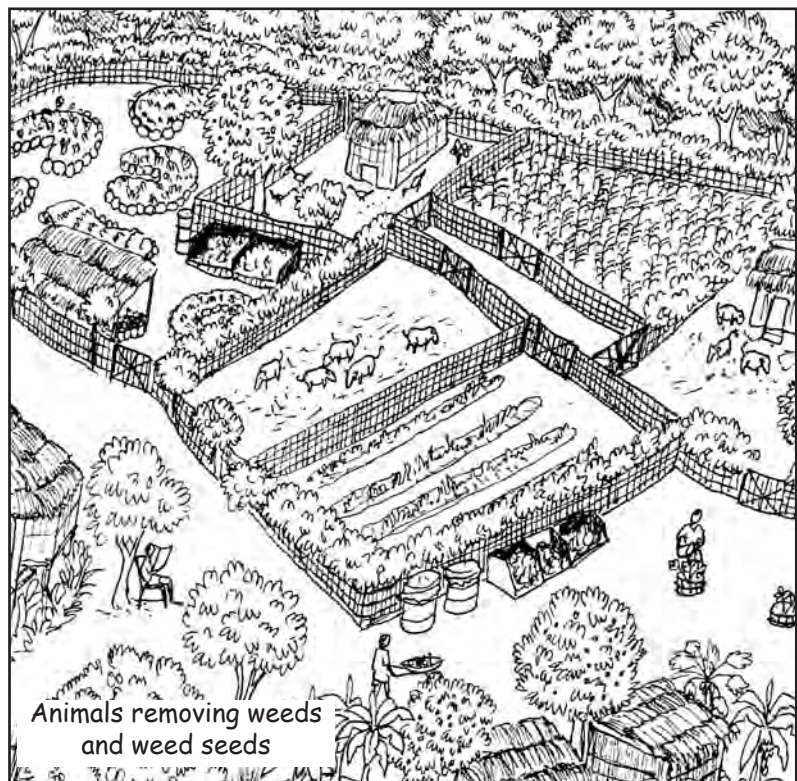
Watering pipes
reduce weed
growth



Techniques

- Mulch is very important to reduce the number of weeds. It covers the ground and many weeds die before they can break through the mulch layer. The thicker the mulch layer, the lower the number of weeds.
- Cover Crops are plants that cover the ground. They reduce weed growth by blocking sunlight, essential for seed germination. They also improve the soil, improve production of other crops and provide food. E.g. pumpkin, velvet bean, sword bean.
- Plough the ground before planting. Most weeds get turned back into the soil and the rest become easy to remove.
- Different techniques for different weeds. Annual weeds can be slashed but perennial weeds should be pulled out before they become too old and too hard to remove.
- Remove the weeds before the weeds form seeds. Then each year the number of weeds is reduced. This is especially important for problem weeds.
- Observation of weed growth and weed types. Are new weeds growing? What weed control technique is best for each type of weed? Which weeds reduce crop production the most?
- Animal labour. Controlled use of animals can remove a lot of weeds before and after crop production. They also provide manure.
- For irrigated vegetable crops in dry season, especially tomatoes, beans, eggplants, etc: more specific irrigation means less weed problems. Flood irrigation means that many weeds can grow over the whole vegetable plot. Bamboo irrigation for crops means that water is only given to the vegetables. A lot less weeds grow. Maintenance is MUCH easier.

DANGER: Burning is a quick method for removing weeds but it causes many problems and reduces soil quality each year. There are many better alternatives.



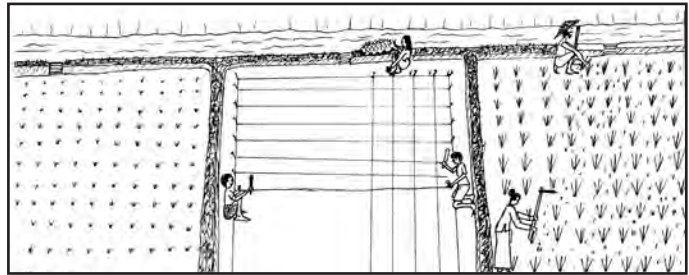
Animals removing weeds
and weed seeds

System of Rice Intensification (SRI)

SRI is a method for increasing rice production. It has been tried in many countries, including Indonesia, with successful results.

In many of the experiments the size of rice yields has doubled! SRI increases production while:

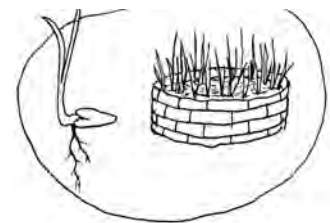
- * Using much less water
- * Using much less seed
- * Improving sustainability and the environment
- * Using fewer or no external inputs



SRI can be used on small farms or large farms. All farmers and communities can use it because the methods do not need new machinery, new tools or special fertilizers and pesticides. It has been shown to work well with traditional and non-traditional varieties of rice. Because of the climate and conditions in East Timor, the introduction of SRI is very important. The limited amount of water available means that SRI can be used in many places where the flooded rice paddy technique cannot. It may also extend the growing season. It also means that more water is available for other crops.

SRI works best when it is combined with organic fertilizers, such as compost, and Integrated Pest Management (IPM).

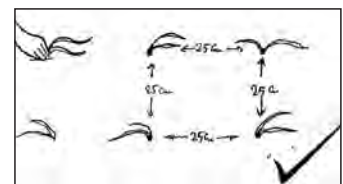
However, the method of irrigation is different and good water control is necessary, so irrigation improvement may be needed. Also, training and practice in the new techniques is needed. This leads to an increase in time and labour at first. But when farmers become skilled the labour time decreases and eventually a similar amount of time and labour is needed to regular rice production methods.



SRI Techniques

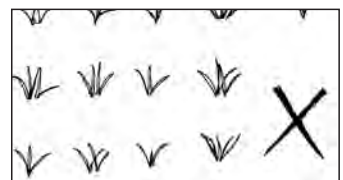
1. Early Transplanting

Plant the seedlings when they have just 2 small leaves and with the seed sac still attached. This is usually between 8 – 12 days, sometimes up to 15 days. In colder areas this may be later, 16- 18 days. Early transplanting gives rice the maximum time for root, leaf and tiller growth. Every day delayed reduces the growth potential, especially after 15 days.



2. Careful Transplanting

Lay the seedlings in muddy soil, NOT in standing water, with the roots 1-2 cm deep and the root tips pointing across or down. If the seedling is pushed into the soil the root tips will point upwards. If the root tips point upwards then growth is slowed or stopped for up to 1 week while the plant recovers. Careful transplanting reduces root loss and stress to the plant and reduces delays in plant growth after transplanting. This has a big effect on how big the plant can grow later on.



3. Wide Spacing

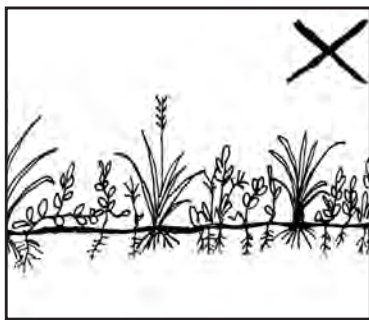
Plant the seedlings 1 at a time, not 2, 3 or 4 together. Seedlings are planted in a square pattern, not in lines. Plant the seedlings in squares of 25cm x 25cm. As soil quality improves, the square size can be increased up to 50cm x 50cm for the highest yields. Spacing can be marked out with rope or string, but a better method is to use a special rake to mark out the squares. Wide spacing promotes better root and leaf growth.



4. Well-drained soil

While the plant is growing leaves, only give enough water to keep the soil moist but with no continuously standing water. When flowering and grain development starts maintain a thin layer (1 – 2cm) of water in each paddy. Drain before harvest as is usually done. Well-drained soil promotes a much larger root system.

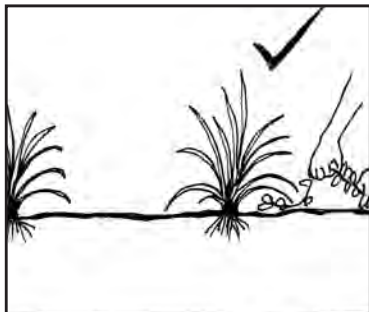




5. Early & Frequent weeding

Start weeding 10-12 days after the seedlings are transplanted. Use a digging bar or hoe. Weed every 10 – 12 days until the rice plants grow large enough to shade all the ground (form a canopy).

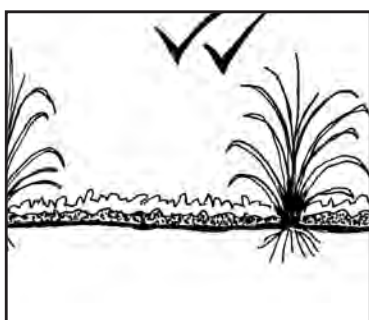
In experiments, each weeding adds to the yield of rice by up to 1tonne per hectare! Use mulch to help prevent weeds from growing. Early and frequent weeding adds air to the soil, improving root growth, and removes weed competition. Mulch provides weed control.



6. Apply Compost & Mulch

SRI works without compost or fertilizer, but compost will improve growth, improve the soil and increase yields. Experiments have shown that compost and organic fertilizer have usually given better results than chemical fertilizer, especially over many years.

This is mostly because of improvement of soil quality and microbe activity in the soil, which increases nutrient availability and uptake. Mulch is also very important for providing nutrients and increasing soil biota (bacteria, fungus, microorganisms). The use of EM – Effective microorganisms will help as well.



The reasons that these techniques work is because the rice plants have:

- Greater root growth, which leads to more leaves and tillers.
- Greater leaf growth, which leads to even more root growth.
- Greater leaf and tiller growth and greater root growth leads to larger grains.

Using SRI

Farmers and groups interested in SRI need to have training in SRI techniques so that they have the knowledge and skills to practice SRI. The training can be combined with small experiments on 1 or 2 rice paddies to test the results and compare them to regular techniques.

One of the main problems with using SRI in East Timor will be controlling the irrigation water. Flood irrigation and irrigation from one paddy to the next doesn't give good water control. Therefore, irrigation channels and water gates will be needed, as well as training about irrigation control.

Some solutions for this problem are:

- Start by changing the irrigation for 1 or 2 paddies and slowly change the irrigation system as time and money allows. The extra yields can provide the money needed to improve the irrigation.
- Community groups and farmers groups can work with the government, NGOs, churches or micro finance groups (even better, a combination of these) to arrange training and to improve the irrigation system.

The results of SRI trials in many other countries in Asia, Africa and Latin America have shown that SRI should be tested in East Timor.

Many NGOs have more information on the SRI and there are internet sites as well. Look in the reference chapter at the back of the book.



Working with the People

Large-scale agriculture depends on the land around it and also affects the land around it. Therefore it is important for people and communities to work together to be able to improve cropland and production. Often many different farms need to share resources like water, harvesting and processing equipment, transport, tools and labour.

There are many different levels of working together:

- Family
- Neighbours and community
- Sub district
- District
- National
- International

All levels are important and different problems require solutions on different levels and often many levels.

1. Community Consultation

Almost everyone in East Timor has a lot of Agricultural knowledge.

Sharing and gathering information will help to improve Timor's agricultural crops. All the men and women who participate or have participated in agricultural production must be a part of this process because the best knowledge comes from experience.

Women, who do a lot of the planting, weeding and harvesting of crops, especially rice, need to be included more in the planning process to make use of their knowledge and observations.

This can include information about:

- What is the best age and time to plant seedlings?
- What insects are attacking crops?
- * Are there predators that are eating the pests?
- * Are there areas where the crops are doing better than other areas? And why? Different soils, competing trees, different amounts of water or sun, etc.

All this information will lead to better management and better crops.

2. Community participation and understanding

If many people in a community understand and participate in agricultural development, then the development will be more productive and more sustainable.

Issues that require community understanding and participation include:

- Water management
- Burning
- Crop maintenance
- Harvest and marketing
- Use of chemicals
- Waste management
- Fences



Teaching children about pest control

Example: Water management

Issues:

- If water source is a river or spring, the land above it affects it, and it affects the land below.
- How to protect the water source.
- How to collect the water – E.g. river, spring, well, pump.
- How to distribute the water – E.g. pipes, channels, bamboo.
- How to share the water evenly between users.
- Who pays?
- What happens if water is wasted?
- How is irrigation maintained and repaired?

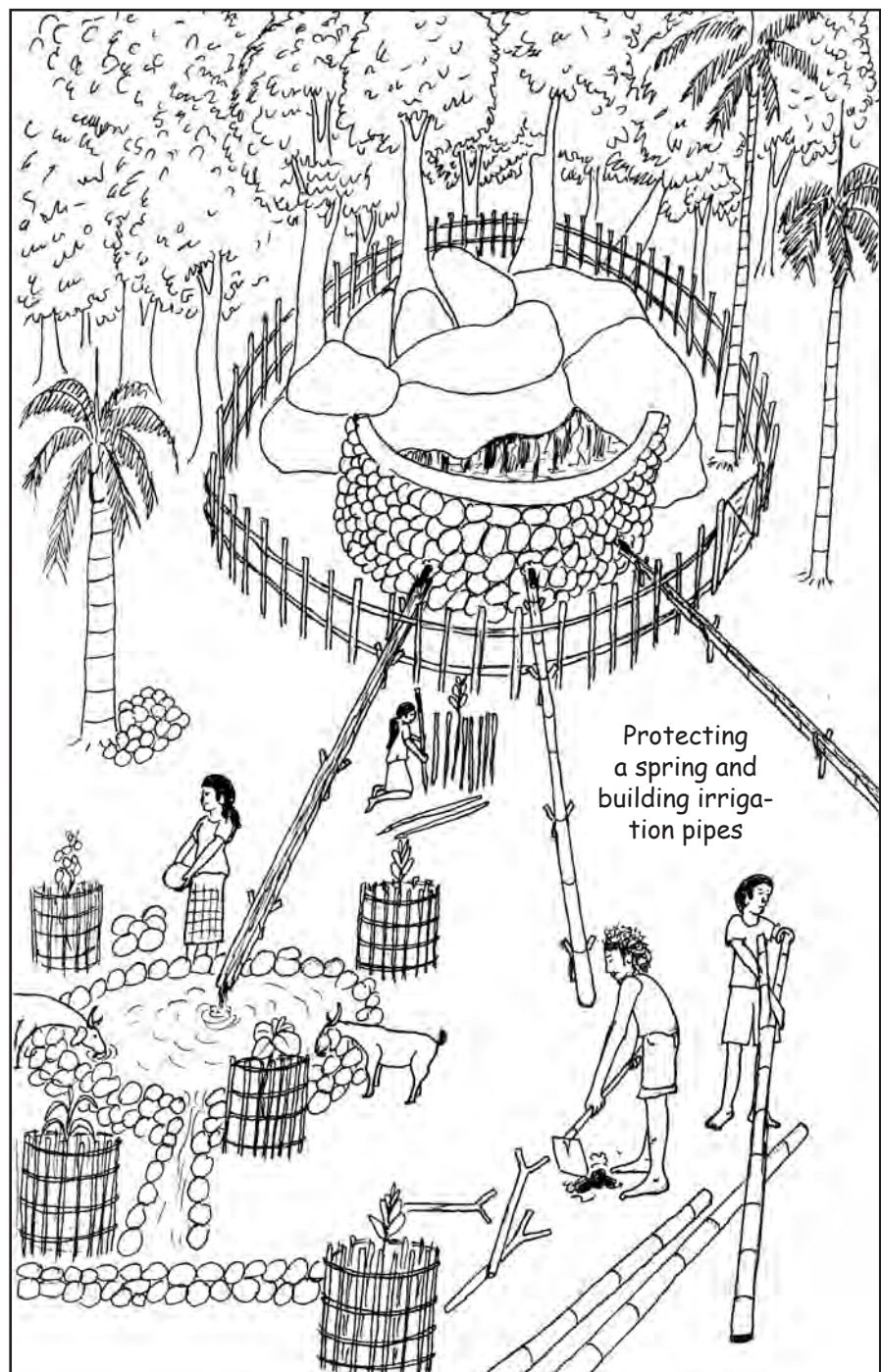


Treadle pump for irrigation water

If farmers and the community address these issues together, it is possible to find solutions beneficial to, and understood by the whole community.

As a result:

- Guidelines for water use can be applied
- Costs are reduced
- Management and maintenance are easier
- All factors upriver and downriver are considered
- The environment and water quality are improved



3. Neighbours working together

If people work together in communities, the whole community will benefit.

The range of food and products that people can sell, buy and trade will increase.

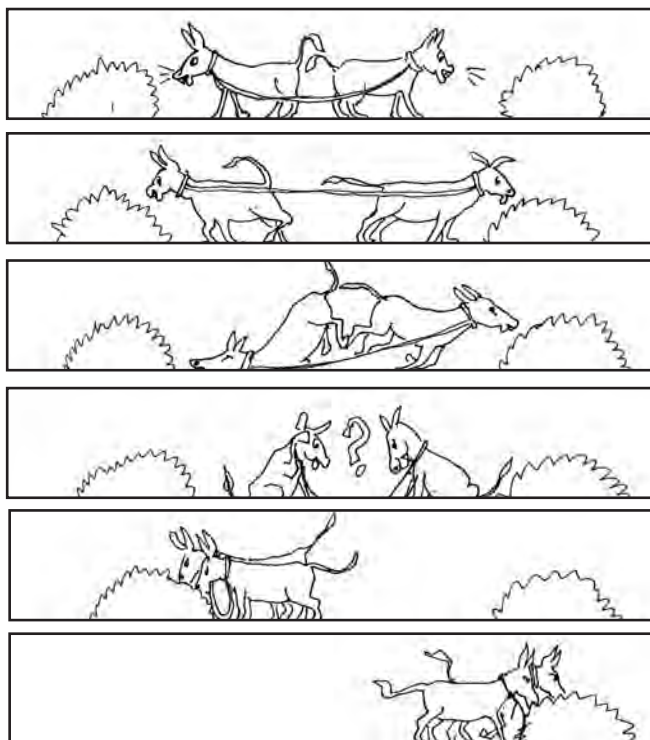
In particular, children will benefit because the community will have a stronger base for their future.

4. Community cooperatives & farmers groups

These are the best way to be able to put ideas into practice. Resources can be bought more cheaply. Harvesting, storage and marketing are easier and more efficient. Sharing and trading of knowledge, labour, seed, tools and products are easier to achieve on a district, national and even international level.

Importantly, it is a way to ensure that resources are owned by the people in the community. And remember: governments and large organizations are much more likely to listen to a group than an individual.

Read Chapter 15 about how to set up and manage a community cooperative or farmers' group. It is also good to read about ideas for increasing the value of your produce.



Working With Nature

Many of the techniques explained so far help to work with nature and natural patterns to improve crops. There are 2 more important points that will also help.

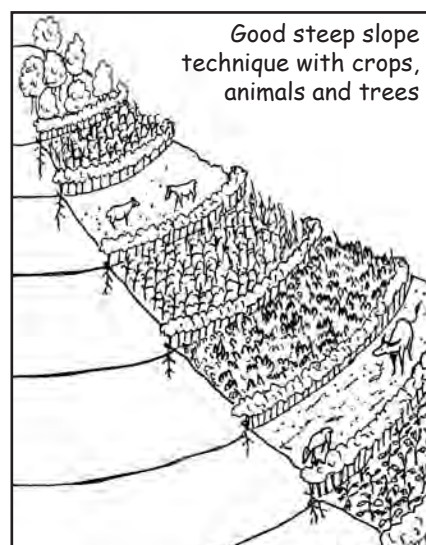
1. Planting times in the Wet Season

Crops are often planted after the 1st good rain or 2nd good rain. This can sometimes lead to crop failure or smaller crop size if there is a break before continuous rains start. The best time is to wait until the 3rd or 4th good rain or until it starts raining every day. This will give a much better chance of success. January and February is generally a time when food resources are lower. Perhaps planting a small crop after the 2nd rains and then a bigger crop after 3rd or 4th rains can relieve the food shortage time and give better crop security.

2. Using land for its BEST use

Sometimes crops are planted on land that is too steep. This leads to erosion, it is not sustainable and it is very hard work. Some solutions are:

- Use tree terraces or small swales to hold the soil so that crops can be grown without causing erosion. Trees need to be planted to hold the soil in place and stop mudslides. These trees may be legume trees that are cut for animal food and mulch.
- Using the land for raising animals. Plant legume trees and other trees for animal food and shade. Animal production may be worth more money too.
- Growing tree crops. Small swales will help the trees to grow and the trees will hold the soil. After a few years when the trees are tall animals can be raised on the land as well.



Post-Harvest Storage & Use



This is a time when a lot of food and income can be lost. There are steps that can be taken to reduce this problem. For rice, dry beans, corn and other dry produce:

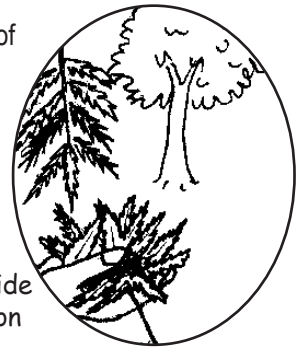
- Harvest at the right time.
- Remove plant material from seeds quickly. Removal of the plant material will reduce insect problems. This is especially important when drying and storing seeds.
- Dry produce properly. If seeds are stored when they haven't dried properly they may go rotten.
- Store properly.

Try to store the produce in containers. Containers should be dry and have a secure lid. Rice sacks won't keep rats and mice out. Traditional storing techniques keep animals away but aren't as effective at keeping insects, rats and mice away. For trees and storage rooms on poles: a flat sheet of metal attached to the pole will protect corn from rats and mice.

Natural protection from insects

Natural materials can be added to the grains or beans to provide protection from insects.

- **Ash:** Ashes from plants will help to reduce pest attack. DO NOT use ash from rubbish fires. For large amounts of seed use 2% by weight of grain. (E.g. for 100kg of grain/beans used 2kg of ash) For small containers a 1cm layer at the top and bottom is good. Ashes from Casuarina, Eucalypt, Mango, Tamarind and rice husks work best.
- **Tobacco leaf:** Be very careful because tobacco is very strong. Only use old, dry leaves. Only use in large storage silos. Place a layer of leaves approximately 2cm thick on top of the stored grain.
- **Neem leaves:** Leaves can be used fresh or dried. Use a layer approximately 2cm thick of leaves on top of the grains/beans. For small containers use about 1cm thick of leaves.
- **Peels:** The peel (skin) from lemon, grapefruit, limes, orange and mandarin are effective for repelling pests from stored produce.
- **Eucalypt:** Use 10 to 20 leaves that are fresh or dried and crushed. Add to the stored grain to repel pests.



Neem leaves provide storage protection

Storage Containers

Grain/Bean storage silos, made from metal sheets, are now being made in East Timor. They will reduce insect and animal problems with stored grains and beans and protect your valuable produce. Storage time will also be lengthened.

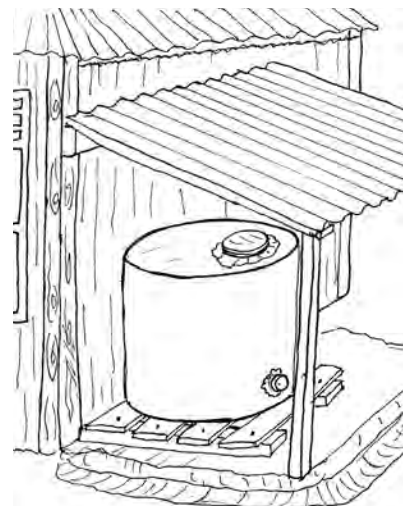
Trainings for local blacksmiths in making silos have been conducted in Los Palos, Laivai, Baucau - W'ainiki, Viqueque, Watulari and Manututu -Kribas, Natabora, Same - Fatuberlihu, Aileu, Ermera, Liquica, Maliana, Balibo, Suai – Zumalai and Tilomar, Oecussi – Pantai Makasar.

Farmers, community groups, etc can buy silos but only have to pay for labour costs, so that the silos are affordable. People can pay with money, part money/part trade or trade. This is up to the buyer and the seller.

Instructions given with silos:

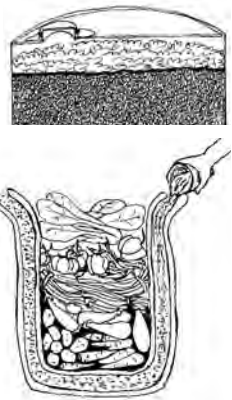
- First, clean the grain
- Put the silo on a stand
- Put the silo under roof to protect it from rain
- Use tyre tubes to close the silo openings

Pest control methods are also needed to protect the grains and beans. Use dry, old tobacco leaf or neem leaf to cover the top of the grain/beans in the silos for 2cm thick.



For fresh produce like tomatoes, lettuces, snake beans, snow peas, cabbages:

- Harvest at the right time.
- Produce that stays fresh must be stored in a cool, dry place, free from insect and animals if possible, until eaten, sold or transported. Spray with clean water occasionally to keep the moisture in the vegetables.
- Transport goods carefully, away from the sun and as cool as possible and prevent bruising. This will make the food last many days longer.
- For home storage of vegetables, and storage for local markets, use clay pots with a damp cloth on top. Produce will stay good for many days longer.



For root vegetables like potatoes, sweet potatoes, cassava, yams, taro:

- For eating they can be stored in the ground until ready to eat.
- For selling, harvest as carefully as possible. Any cuts or bruises will make them rot much faster.
- When they are harvested they must be stored in a dry, cool place out of the sun and protected from animals and insects. Wood fire ash can be used for insect and animal protection, simply wash it off before selling or eating.
- Carrots are different because they will turn hard and bitter if they are left in the ground too long. Store in sand to make them last longer.
- Sand can also be used to store other root vegetables.

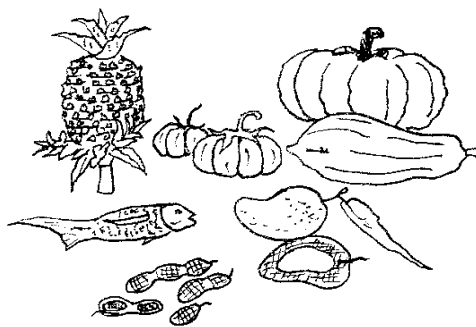


Ash provides storage protection

Using excess produce

Sometimes produce can't be eaten, sold or traded and goes rotten. But this produce doesn't have to be wasted.

- Solar driers can be used to dry vegetables or fruit so that it can be stored to use later. Look in the Alternative Technology Chapter (CH 14) for how to make and use solar driers.



Solar Drier

- Sauces, preserves, jams, and more can be made from vegetables and fruit.



- Excess food can also be used to make pig food, chicken food or turned into compost.



Healthy Large Scale Agriculture

Large Scale Agriculture changes the environment around it. It is very important to be aware of how it affects the land, water and people. Therefore you can prevent negative impacts and make your land sustainable for you and for future generations.

Protect the surrounding environment

An important part of large-scale agriculture is to protect the environment around it. Small and large rivers especially need protection. Clean water and healthy rivers are essential for East Timor's future. A healthy environment will help the cropland as well. Cleaner water leads to less maintenance for irrigation. More birds, small animals and insects leads to better pollination and fewer pest problems.

Prevent soil erosion from croplands

Soil erosion from croplands will deplete your croplands. It also can create large problems on the land below. This will then create problems in the rivers and then in the ocean. There are 2 main ways to prevent soil erosion:

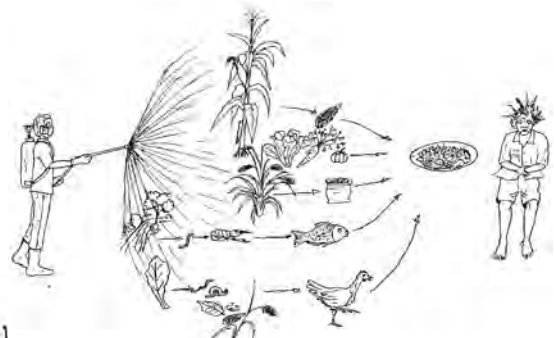
1) Catch and store water

- Use swales and tree terraces on sloped land, even on gentle slopes.
- On flat lands it is essential to control the water flow above the cropland so that it doesn't build up on the flat cropland.

2) Stop burning and use mulch

- Burning damages the soils structure, which makes the soil a lot easier to erode. It also removes plants, which hold the soil together.
- Mulch protects the soil and helps to hold it in place. By using mulch, the soil will improve and build up every year.

Any areas around your croplands that are already eroded need to be replanted. Grasses, bamboos and fast growing legumes trees are best to plant in eroded areas. Plant trees and grasses in the eroded area, and around and above it as well.



Beware of Chemicals

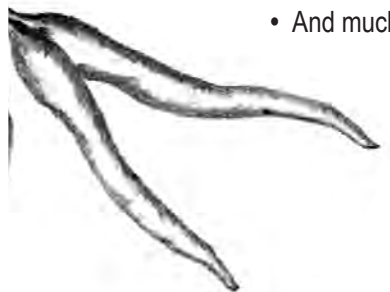
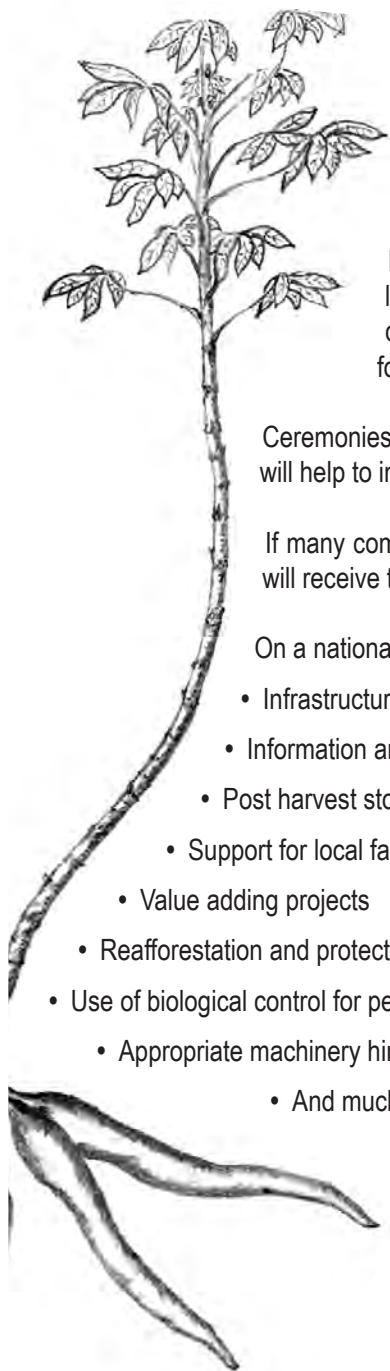
Chemical pesticides, herbicides and fertilizers will damage your land and the surrounding environment.

They provide short-term solutions but also cause damage that might be small now, but will create big problems in the future. The soil is damaged because the soil bacteria and soil animals are killed. This will make your agricultural land less productive and add to erosion problems. Rivers and the ocean become polluted from pesticides and herbicides and too much chemical fertilizer. Underground water will also become polluted.

This is a very serious problem because river water and underground water are used for drinking, cooking and cleaning and MUST be kept clean. Fish, in ponds and in the ocean may also become polluted. Water plants are also affected. This pollution will cause damage to the environment and may also be passed onto people.

All animals that are exposed to the chemicals will absorb a small amount. Even the food that is grown will contain very small amounts of the chemicals. People who eat the plants and animals and drink the water are the worst affected.

**Use natural fertilizers,
natural pest management and mulch.**



Work Together

Communities working together can repair and protect the environment.

At the same time valuable resources for the future can be cared for.

It is very hard to achieve when people work alone. East Timor's environment must look at on a community level and a national level. On a community level, people can work to protect their environment by stopping erosion and land burning, Reafforestation, protecting rivers and cleaning up and recycling rubbish.

Ceremonies, like Tara Bundu, will protect community land from damage. These improvements will help to improve the environment in other communities and districts as well.

If many communities work to improve their own land and environment, then all of East Timor will receive the benefits.

On a national level sustainable agriculture techniques must be encouraged and developed:

- Infrastructure for efficient transport and marketing
- Information and training about sustainable agriculture
- Post harvest storage
 - Support for local farmers groups and community cooperatives
 - Value adding projects
- Reafforestation and protection of the forests and natural environment
- Use of biological control for pests
 - Appropriate machinery hire
 - And much more....

Improvement of large-scale agriculture is essential for the future prosperity of East Timor.

Protection of the natural environment also must take place.

These two goals can be achieved together if good plans and techniques are used.

A sustainable future must be planned for if East Timor is to reach its potential.

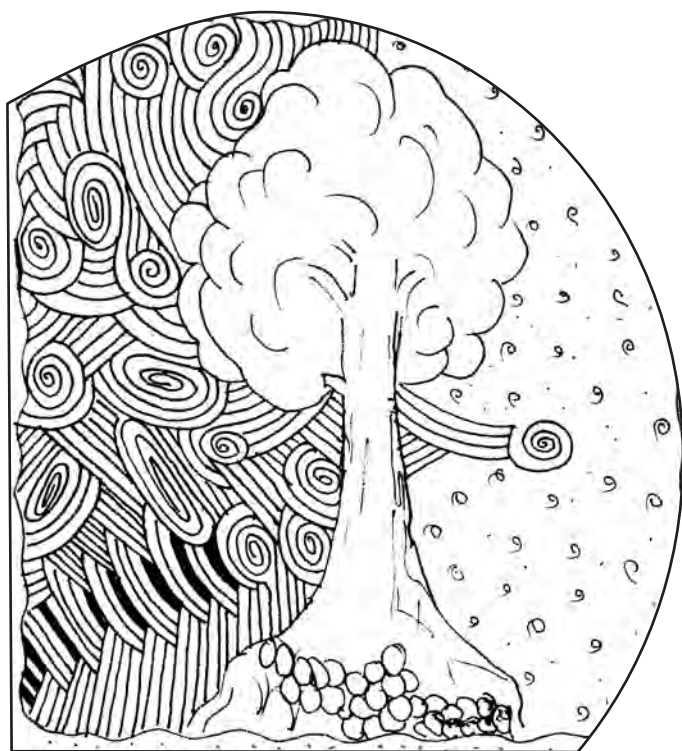






Trees & Bamboo

树木与竹子



CHAPTER

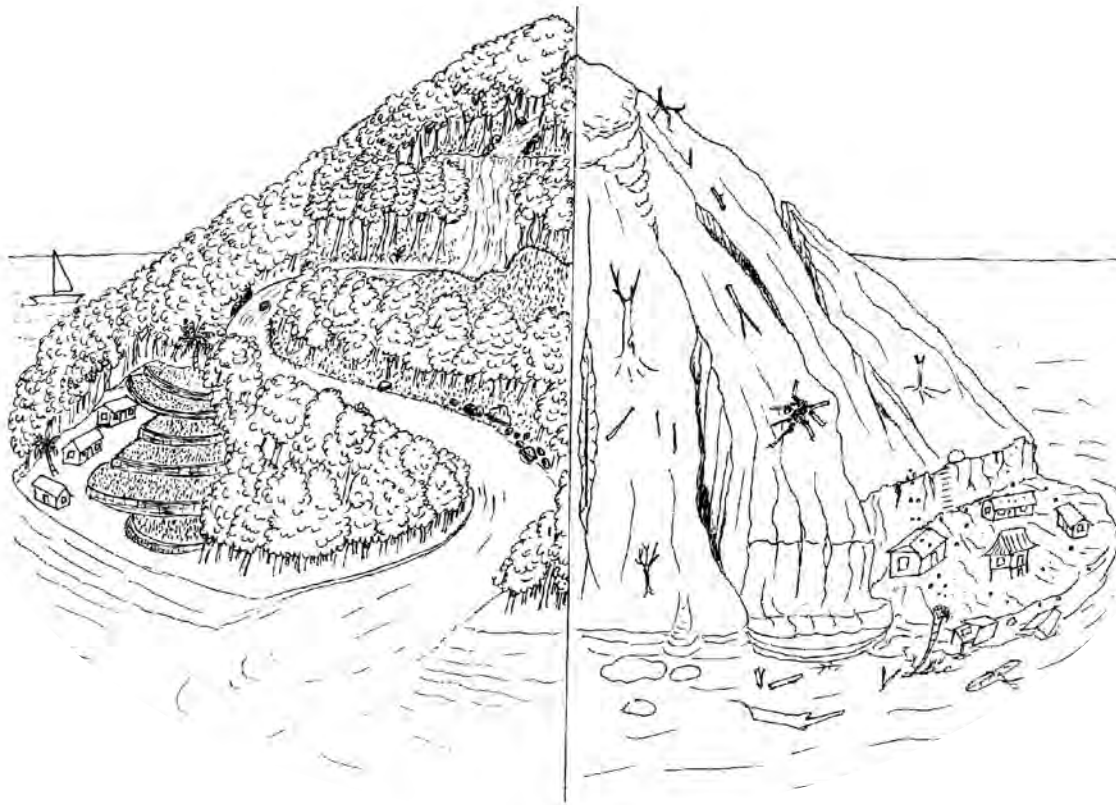


The Importance of Reforestation & Tree Crops

East Timorese people have a strong and continuing connection to the land and the forests. The forests provide food, wood, natural materials, medicine, fuel, homes for animals and birds, and a spirit connection with the ancestors. Areas that have forests need to be protected and carefully managed. These forests are the seed banks for the future.

East Timor has many native plants and animals unique to East Timor. This is because of the climate, the unique landscape and because of the way the land was formed long ago. Preservation of these species will help East Timor to retain its own culture and heritage. Many of these plants also contain medicines, oils and other products and uses that will benefit East Timor and provide products and income in the future.

The first step is to protect and carefully manage the forests. The next step is to reforest areas and restore East Timor's environmental balance. We must maintain the strong connection to the land. East Timor needs long-term solutions to provide for the future and for the environment to be healthy and strong.



Most of East Timor's land is mountainous and a lot of these areas have steep slopes. Many areas where the forests have been removed are suffering from erosion and loss of soils. It is difficult to obtain good productivity on land where soil is depleted and erosion is bad. Often growing crops in such areas can lead to more erosion and problems. Reforestation and tree crops can help to stop erosion and repair damaged land AND can also provide food, timber, firewood, oils, medicine, fibre, income and more. This is security for the people and for the future and while providing sustainable incomes as well.

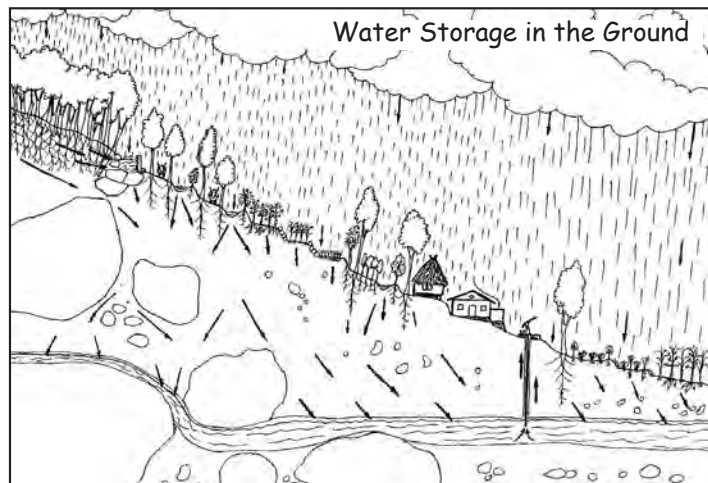
Tree crops can also be integrated with animal systems and annual crops. Products and income from trees and forests are more secure because tree crops are less affected by bad weather conditions.

They add to the diversity of food for people, and produce can be used, sold or traded. A well-designed forest system requires little maintenance once it is established. Forests and tree crops will improve the health of the environment not just on the land where they grow but the surrounding land as well. The improvement will occur all the way down to the sea, and will even improve the sea environment too. This is important for all the people of East Timor.

Reforestation is restoring East Timor's native forests. Tree Crops is growing trees as a managed crop for production.

Steps to a healthy sustainable forest system

1. Store Water in the Ground
2. Protect Soils and Stop Erosion
3. Control Animals
4. Stop Burning
5. Good Management of Forests and Resources



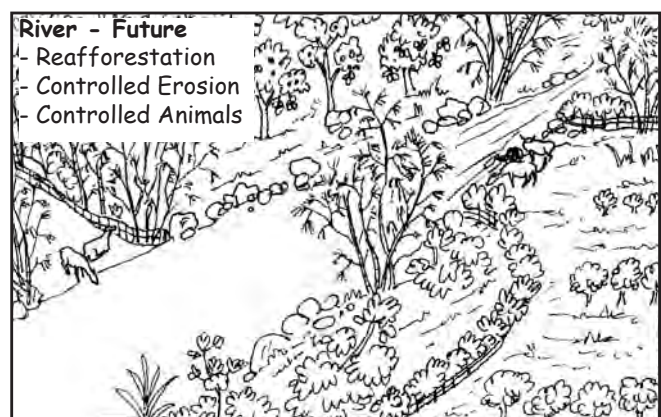
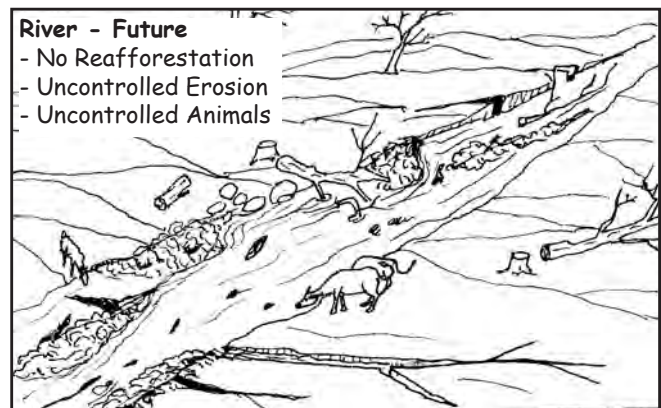
1. Store Water in the Ground

- Water is precious!! Any water that is stored and saved in the ground will benefit the land, the plants and the people.
- If water is stopped and stored in the ground then the soil will be protected and erosion will be greatly reduced.
- If water is stored then annual crop seasons will be longer.
- Trees will grow better in the dry season and will produce better crops.
- Ground water levels will improve and springs won't dry up.
- Trees will also store a lot of water.

2. Protect Soils and Stop Erosion

- Erosion will reduce productivity by removing valuable soil.
- Soil, especially good soil for agriculture, takes a long time to create but can disappear very quickly due to erosion.
- If uncontrolled, erosion will get worse quickly and make bigger problems in the future.
- Erosion will also wash away small plants, seeds and organic matter.
- Cleared land and erosion can lead to landslides that not only destroy land but can be a danger to homes and people as well.
- Reforestation and tree crops are the best long-term solution to protect soils and stop erosion.

Swales and terraces, which hold water and provide the important base for reforestation, tree crops and sloped agriculture, will be explained in detail.

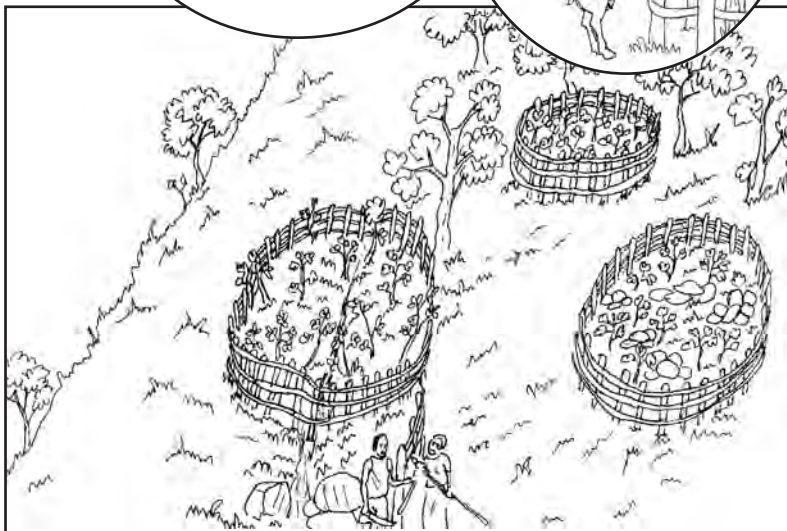
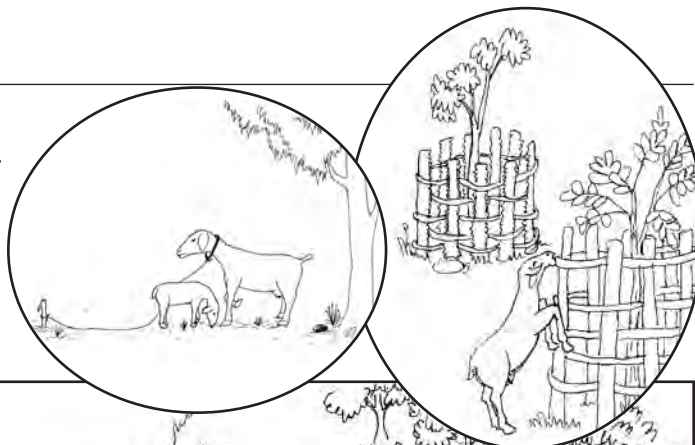


3. Control Animals

- Animals, especially goats, can destroy reforestation and tree crops very quickly. This can waste a lot of hard work and valuable resources.
- **There are many solutions that will suit different situations.**

1. A Tara Bundu can be performed to protect an area.
2. The tree crop/reafforestation area can be fenced from animals.
3. Each tree may be protected by a tree guard.
4. Animals can be tied with rope to a stake.

With each solution community co-operation is essential for success.



4. Stop Burning!

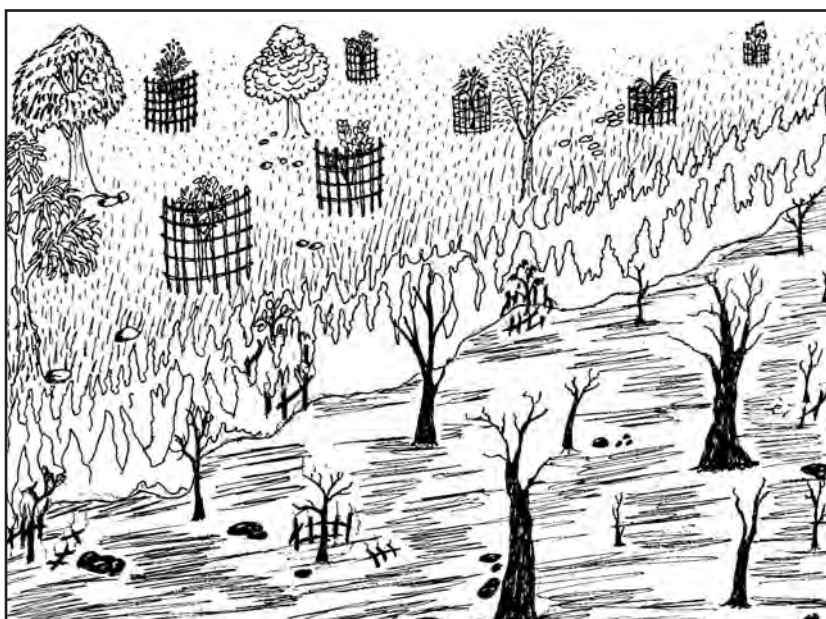
- Burning increases erosion problems.
- Burning reduces the diversity of plants, animals and birds.
- Burning destroys mulch and organic matter that is very important for good soils.
- Water loss is increased from burning.
- Healthy soils are damaged because soil biota are destroyed.
- Burning creates pollution harmful to humans and the environment.
- Burning will destroy reforestation and tree crops.

Burning every year will produce low productivity systems. High productivity systems and integrated systems are damaged or destroyed when the land is burnt.

Many areas in East Timor are burnt to encourage new grass for animals. This does work but it stops the land from becoming more productive in the future. Burning encourages grasses that are low quality food for animals.

Burning can be reduced and eventually stopped as better techniques are introduced.

This book provides solutions and productive methods that will stop the need for burning by providing better alternatives.



5. Good Management of forests and resources

- Community Management Plan.
- Replanting firewood trees and planting firewood trees close to house.
- Tara Bundu protection for sacred land and some community forests, especially on fragile land and next to rivers.

The Community Management Plan must:

- Plan for the future.
- Plan for what can be harvested, from where and when and who can harvest it.
- Plan for who will receive income and if some of that can go back into community forest management.
- Work with the government.
- Not allow any major clearing of land and not give ownership or rights to companies.
- Look at creating sustainable local businesses that can use forest resources wisely. E.g. seeds, medicines, quality furniture, oils, bamboo products, nuts, honey and many more.



Community meeting

Women's groups, and other groups can meet to work out what is important for them regarding land and forest management and then take this information to community meetings so that their needs and ideas are included.

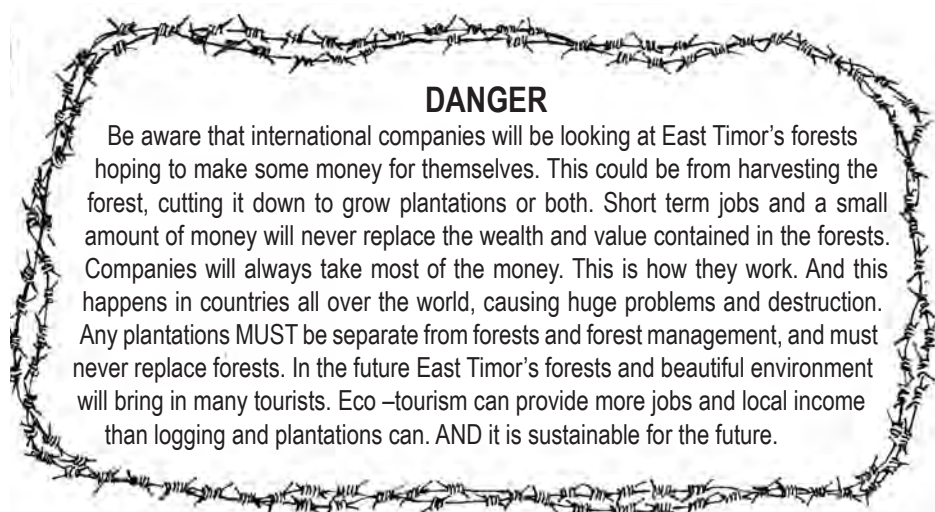
Collecting firewood is causing a huge reduction in trees already in East Timor and changes need to be made so that the problem doesn't become worse.

Collecting firewood is also very hard work that takes a long time, and is mostly done by women and children. Recent surveys have shown that collecting firewood is the hardest and most time consuming work for women in East Timor. Reducing this work will improve life a lot for women and for the whole family. Important changes are:

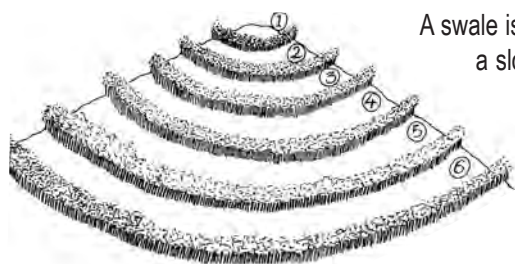
- Planting firewood trees close to the house, including living fences.
- Use stoves and ovens that use less wood.
- Use stoves and ovens that don't use wood.

See Alternative Technology Chapter (CH 14) for many different stoves and ovens.

The solutions and techniques in this chapter look to improve and strengthen East Timor's future. Part of this must be teaching children about caring for the land, reforestation and the need to stop erosion and reduce burning.



Swale and Tree Terrace Systems



A swale is a trench that is dug ON CONTOUR – equal level above sea level along a slope. The soil and rocks dug from the trench are put just below the trench to form a level line from one end of the swale to the other end. Swales can also be a small wall that is built from rocks, branches or other materials. Usually many swales are dug on a hillside, one below the next. They are similar to terraces but are better at stopping and storing water, soil and mulch.

Why Use Swales?

Swales help to improve the soil, catch water and stop erosion. Swales create new microclimates on the land. This means that they provide areas for many different types of, fruit trees, reforestation trees, bamboos, vegetables, grains and water plants to grow. This provides long-term productive solutions for sloped land. Swales can be used for small or large amounts of land.

Small swale systems are also described in the Soils Chapter (CH 4) and Home and Market Gardens Chapter (CH 5).

Swales can be used for vegetable crops, tree crops, animal systems or a combination of these. A combination will provide more stability and security of food and income.

IMPORTANT:

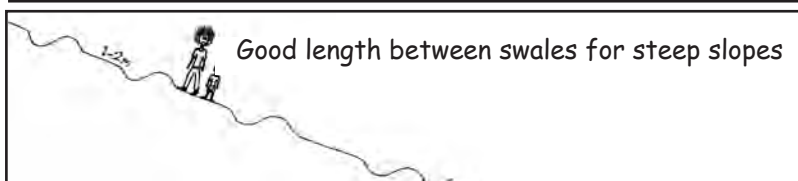
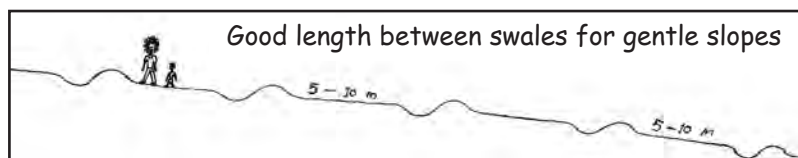
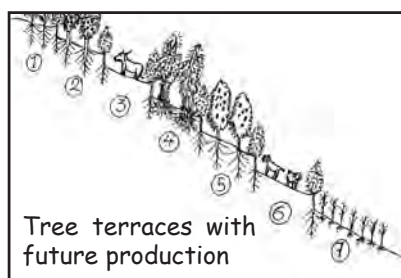
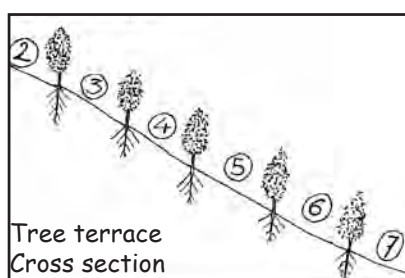
A lot of East Timor's land has limestone rock layer underneath. In very heavy rains, and if the soil is heavy with a lot of water, the soil can sometimes slip. This can be very destructive. Sometimes it cannot be prevented but it is very important to reduce the risk as much as possible. The best way is to plant trees with deep roots. On land where swales are made and especially steep sloped land, trees **MUST** be planted straight away to help prevent this problem. The best trees to use are fast growing large legumes like Leuceana, Gliricidia, Acacia or Casurina. Other trees can be planted as well, such as fruit trees, and may eventually replace the legumes.

Swale sizes

On gentle slopes swales need to be larger in size and made between 3m to 10m apart, depending on the situation. On steep slopes swales need to be smaller in size and made closer together. This is because water runs faster on steep slopes and should not be allowed to build up and flow fast. This causes erosion and can damage or break the swales.

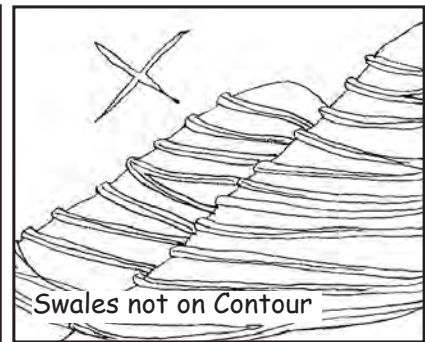
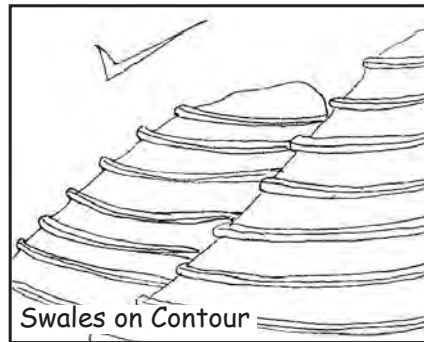
For steep slopes 1 to 2 metres apart is good. It depends on what you want to plant. For vegetables make them closer together, for trees they can be further apart. On very steep slopes it is best not to dig swales because the water runs too fast and the soil doesn't stay when the swale is dug.

A good idea is to plant trees in the ground, on contour. If they are planted very close together they will grow and form a living swale that will slow the water and reduce erosion. Rocks and dead sticks can also be placed against the living swale to help stop more soil and water and improve the result. Eventually the soil will build up behind the trees and form a small terrace. Other trees, or vines like pumpkin, luffa or passionfruit can be grown as well.



How to make a swale system

It is very important that the swales are level - on contour. If they are level the water will sit in the swale and soak into the ground evenly. If not the water will run along the swale and break the swale at the end or at its lowest point. This can cause a lot of damage in the wet season.



How to make an A-Frame

An A-Frame is a measuring tool made out of wood or bamboo that will help you to make level swales. It is about 2 metres high, and is the shape of an "A". It is used to mark on the land where the swale will go. A-Frames are very easy to make and to use.

Construction

First, construct the "A" from the wood or bamboo.

Make sure that the cross piece is the same distance from the top on both sides.

Materials needed

- 2 equal lengths of wood or bamboo, about 2 metres long
- 1 length of wood or bamboo for the cross piece, about 1 metre
- 2 metres of string or thin rope
- Hammer and saw or machete
- Nails, binding string or strong grass
- 1 Rock
- Knife or pen marker

Tie the string to the top of the A-Frame.

Tie the rock to the bottom of the string.

The rock must be below the crosspiece.

Find a flat area and stand the A-Frame.

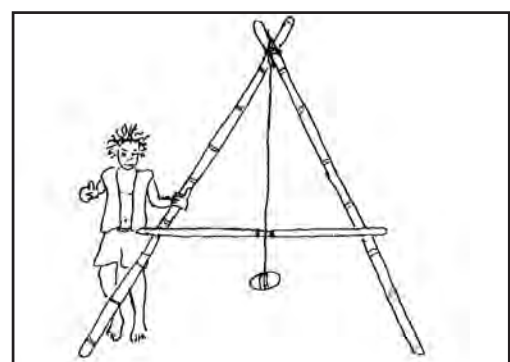
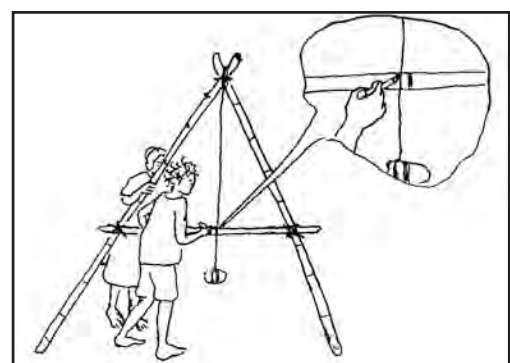
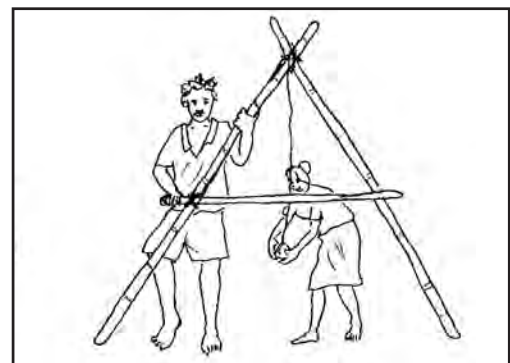
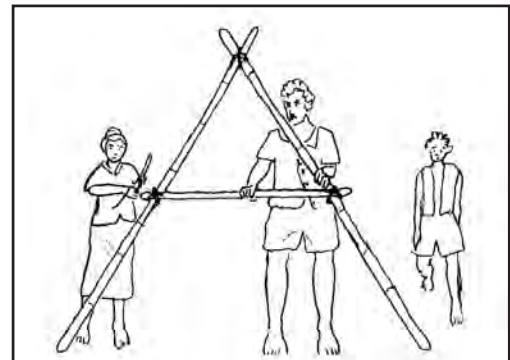
Make a mark on the ground where the legs stand.

Mark the cross piece with a knife or pen marker exactly where the string touches it.

Turn the A-Frame around and place the legs on the marks on the ground.

Again, mark the cross piece where the string touches it.

The A-Frame is exactly level when the string sits in the middle of the two marks. Put a 3rd mark here.



How to use the A-Frame

STEP 1:

Observe the area where the swales are to be dug. Make a plan of how many swales you want to make and where they are going to go. Remember to use the ideas about swale size and distance between the swales

STEP 2:

Start at one end of the TOP swale that will be marked out. Cut tall grasses that may obstruct marking out contour lines.

Always start at the top.

STEP 3:

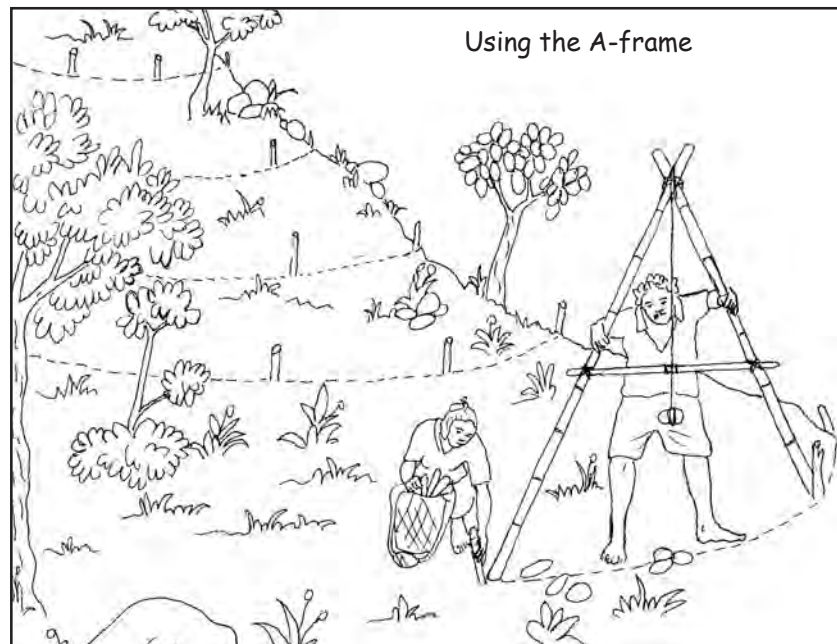
Place the A-Frame on the ground so that it is level and the string is touching the middle mark on the crosspiece. The A-Frame is now on contour. Place a stake at either end of the A-Frame to start marking the line. Put the stakes below the frame legs and continue to do this with every stake.

STEP 4:

The A-Frame can now be moved forward. Place the back leg at the stake where the front leg was and repeat Step 3. When the string shows that the A-Frame is level then put another stake below the front leg. As you continue a line across the mountain will be marked out. This is the contour line.

STEP 5:

Repeat the process until the line is complete, and then start again below with the next line. Continue until all the contour lines needed are marked out with stakes.



SMART IDEAS:

- When using the A-Frame it is a lot easier and faster with two people. One person can operate the A-Frame while the other can mark out the contour line with the stakes.
- Do not place either end of the A-Frame on rocks, or in small mounds or small holes. This will make the line inaccurate and will cause problems later.
- Now the swales can be constructed.

Types of Swales

There are three main types of swales.

Trench swales are when a trench is dug and the soil and rocks that are dug up are put below the trench to form a mound.

Ploughed contour lines are when a buffalo plough is used to plough a line along the marked contour line.

Rock swales are made by making a mound or small wall from rocks instead of digging.

Usually rock swales are made where:

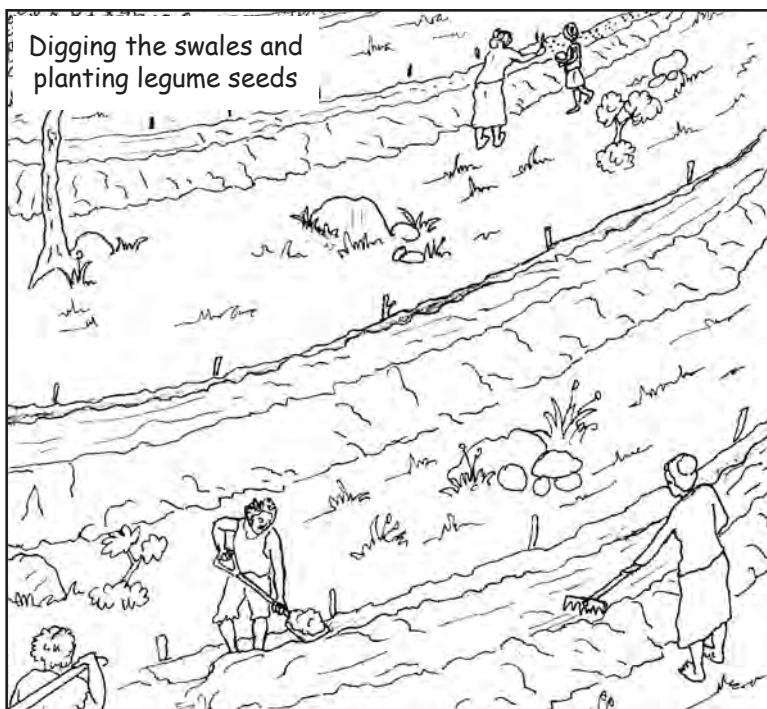
- The land is too hard to dig because it is too dry
- There are too many rocks.
- There is a steep slope

Which type you use is up to you. You can use both types on the same land if you want. All 3 types should be planted with thick legume tree rows immediately to:

- Hold the soil
- Provide future tree terraces or “living” terraces
- Provide mulch and nitrogen

Trench Swales

It is important to start at the top first. Start by digging the trench above the stake line. Make an even mound below the stake line from the soil that is dug up. The size of the trench depends on the slope of the land.



• **On steep slopes** they should be about 3-foot lengths wide (1/2metre) and about 2 hand lengths deep (30cm).

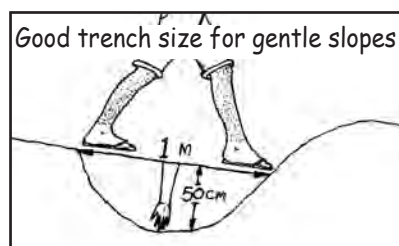
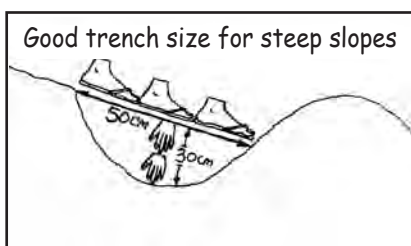
• **On gentle slopes** the swales should be about 1 large step wide (1metre) and deep up to your elbow (about 40-50cm).

Continue until all the swales are dug.

For the best results try to make the swales as similar as possible.

The bottom of the swale must be as level also. This is so that when water runs into the swale it doesn't flow along the swale. This can be easily tested. If possible run some water into the swale when you are almost finished digging and watch which way the water flows. Make changes as necessary to make the bottom level. If

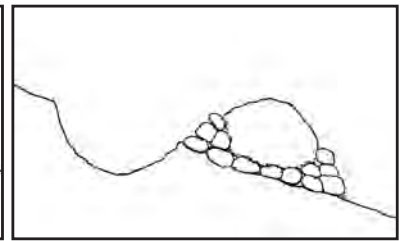
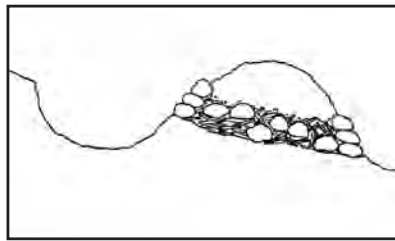
there is no water access, make the bottom as level as you can and then wait until the first rains. Watch what happens to the water flows, and then change the level as is necessary. Or, you can use the A-Frame to test it. This takes more time but it is accurate.





SMART IDEAS:

- To make the mound higher, and therefore work better, you can first put rocks or old branches and then put the soil on top.

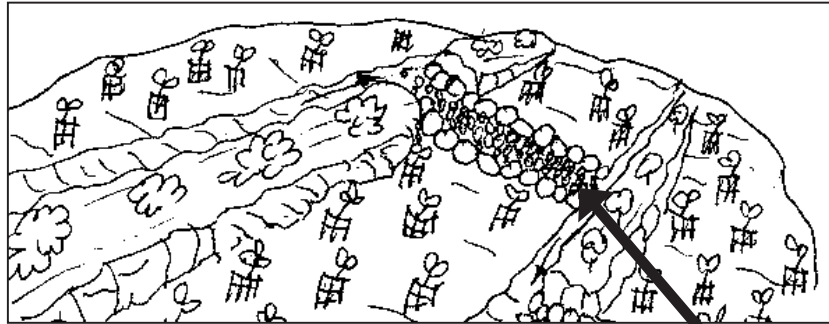


To protect the soil mounds from erosion:

1. Mulch the swales with a thick layer of mulch. It is good to mulch in the trenches as well.
2. Plant seeds on the mounds straight away. The type of seeds that you plant depends on if the swale is for vegetables, tree crops or reforestation. Use the plants or trees that best suit your situation. E.g. Legume trees, pumpkins, beans.

Plan for extreme conditions

The swales will catch and store rain in the wet season and they will also help when there is not much rain in the dry season.



BUT, what happens in very heavy rains?

Will the swales overflow and where will they overflow? This might happen only once every 2 or 3 or even 10 years but it will happen.

It is important to plan for this. If not the swales could break and cause big problems, especially on steep slopes:

1. Make sure that the swales are level (on contour) and that the bottoms of the trenches are level as well. This will prevent water from collecting in one spot that could break the swale and cause erosion.



2. **Plan for overflows.** At one end of each swale (or at both ends) make the mound lower than the rest of the swale.

This is so that when the water reaches a certain height it will overflow where you want it to and not continue to build up and break the swale mound.

Place rocks around your overflow points to stop erosion.

A hole dug in the trench just before the overflow will catch soil from the water as the water flows out. This will help to further reduce erosion and the soil, which will be good quality, and can be dug out and re-used.



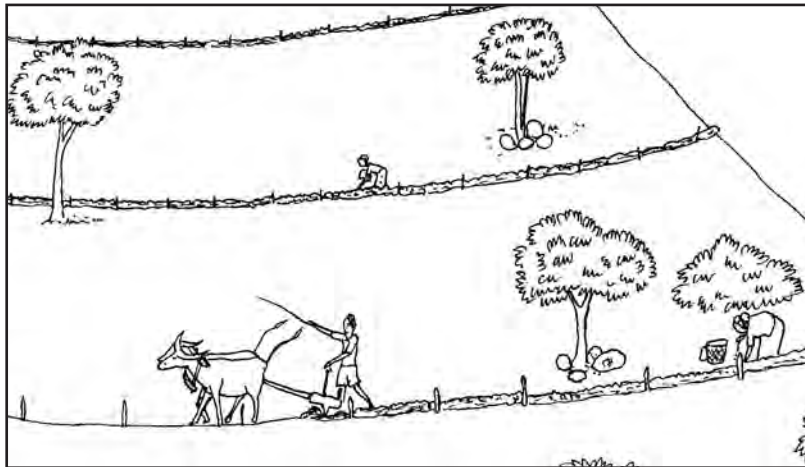
Connecting the swales together

The overflow from each swale can run into the next swale which can then run into the next swale and then the next swale and so on. Eventually the water can run into ponds for aquaculture, banana pits.

Ploughed contour lines

A simple method that can be used is to plough along the contour line.

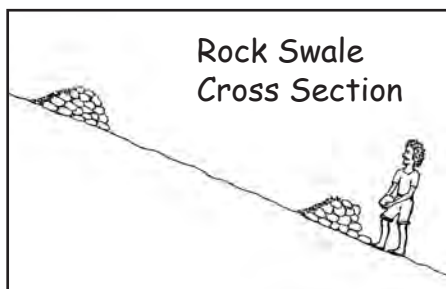
Use the stakes as a guide. The plough line can be dug by using a buffalo plough, a hand tractor or by hand. A buffalo plough will give the best results for less money than a hand tractor.



Ploughed contour lines take 1 or 2 years longer to have the same benefits as swales they but take less time to make. They are good if you are working with large amounts of land.

It is best to prepare the swales or ploughed contour lines before or at the start of the wet season. This depends on what type of soil you have. Dig when it is easiest, but try to allow as much time as possible in the wet season for plants to become established.

Rock Swales



Rock swales are important where the land is rocky or hard and digging swales is difficult. They also work very well for reforestation, especially in dry areas. They are made by following the same steps and guidelines used to make trench swales.

STEP 1: Plan how many swales you want and where you want them.

STEP 2: Use the A-Frame and stakes to mark out the contour lines for the swales.

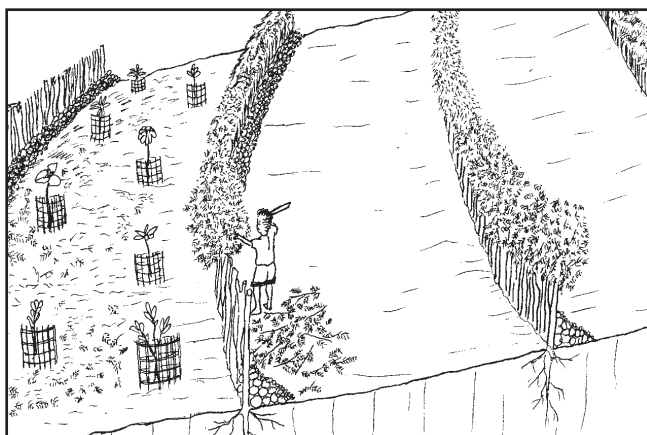
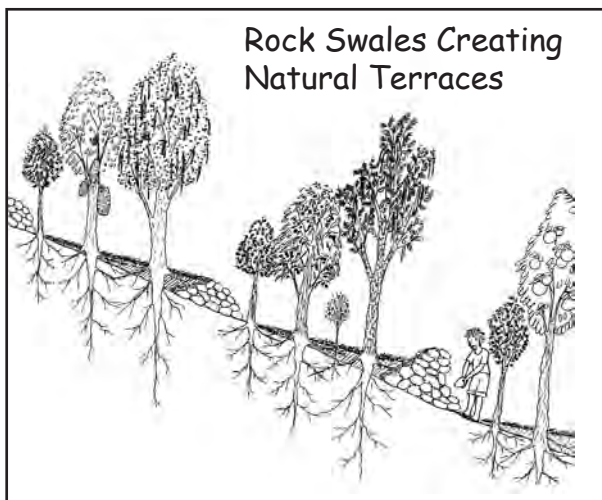
STEP 3: Make a mound or small wall along the contour line using the rocks. The rock swales can be knee high on an adult, higher if possible.

As the soil is washed down the slope with the rains it will be stopped by the rock swales. Slowly the soil, sticks and leaves will build up and create a terrace. The height of the rock swales can be raised as the terrace is created.

Plant legume trees as soon as possible. The trees will improve the soil and provide fertilizer, mulch and shade for tree crops. You can remove the legumes as you need room for tree or other crops. The process is slower than trench swales but the result is the same.

Rock swales can be used for large areas; they can be used for steep slopes and for small areas as well. There are many different patterns and shapes that can be used. Look in the Dry land section in this chapter for many more ideas.

The land will be improved anywhere that rocks are placed to stop water and soil.





SMART IDEAS:

- Put larger rocks at the back of the swale (bottom side) and smaller rocks at the front of the swale. The smaller rocks will stop more soil and water than the larger rocks.
- Rock swales are natural fences for buffalo and cows. They can be used to control the areas where they eat. Gaps can be left in the swales and gates built so that animals can pass through. Goats can be used as well but they will probably climb over the rock swales so some other type of control will be needed.

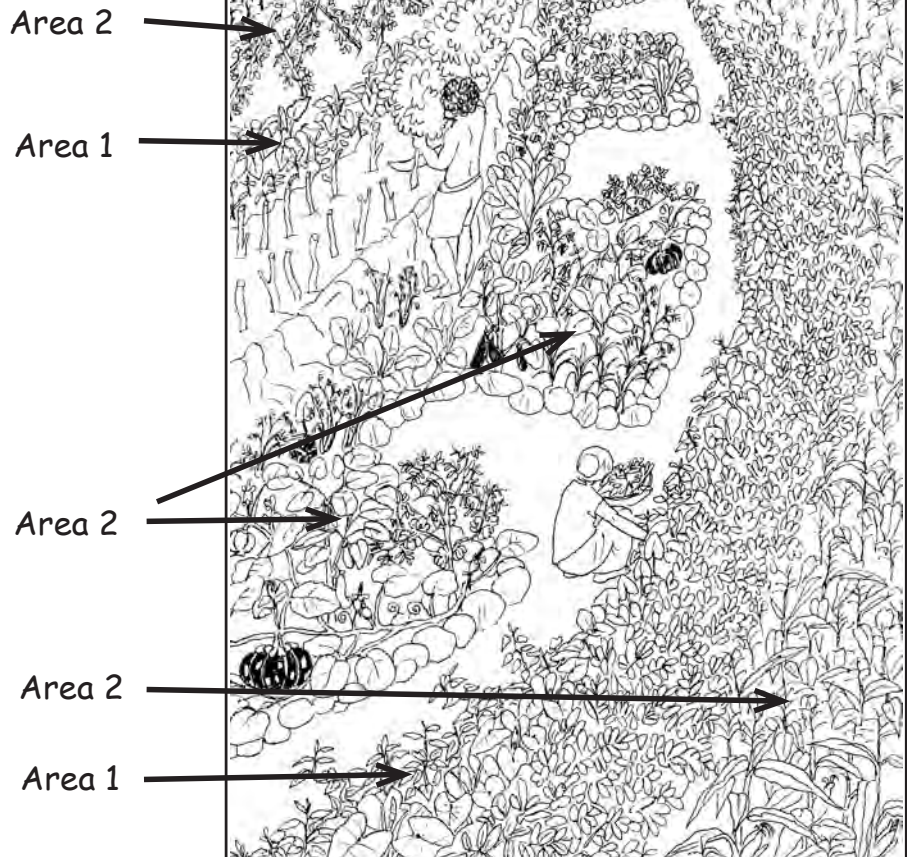


Small Swale Planting Ideas

Wet season

Area 1: Taro, kang kong, watercress and other plants that like a lot of water can be planted in the bottom and sides of the trench. Plants that like a lot of water but don't like being under water can be planted along the edges of the trench. E.g. lemon grass.

Area 2: Other vegetables and small trees can be grown on top and below the mound. E.g. tomatoes, eggplants, pumpkins, cassava, chillies, capsicums, cabbages, green leaf vegetables, sweet potatoes, papayas, bananas, watermelons, beans, peas, cucumbers, corn, lettuce, pineapples and many more.



Dry Season

If water is available in good supply then you can continue to use the same ideas as for the wet season. If only a small amount of water is available then the trenches can be used for vegetables and on top and below the swale can continue to grow long term plants such as cassava, pineapples, eggplants, bananas and so on. Or the area can be mulched and left to wait for next wet season. If no water is available, then some long-term crops will still grow and will grow a lot better than without swales. Mulch the land and wait for the next wet season. The growing season for these vegetables is increased because the water in the soil lasts for longer, especially in areas that have little or no water. In the mountains, where dry season rainfall is more common than the coast, swales will create good conditions for year round growing of vegetables and other plants. Over time small animals can also be integrated into the system. Remember to use soil improvement techniques to get the most benefit from the swale gardens.



SMART IDEA:

- You can also use the trench as a compost trench to quickly improve the soil. Use them in the same way as with basket and trench composts. (See Soils/composts section)

Large swale planting ideas

On a large scale trench swales are very effective.

Many different crops can be planted, both perennial tree crops and annual vegetables. Animals can also be integrated. The more diversity of crops and animals you have the better. The types of tree crops you choose will depend on:



- What tree crops will grow best in your area.
- What tree crops will provide income.
- What tree crops will provide more food, timber, firewood and other resources.

The choices should be made together by all members of the family and community who are involved and who will use the crops.

Be Careful

If you want to introduce new types of trees or plants, especially from overseas, do some research to find out if the tree could become a problem in the future.

- Will it become a weed problem and takeover local trees and plants?
- Will it introduce new pests or diseases?
- Has it caused problems in other countries or places in East Timor?

This is very important for protecting the environment and resources for the future.

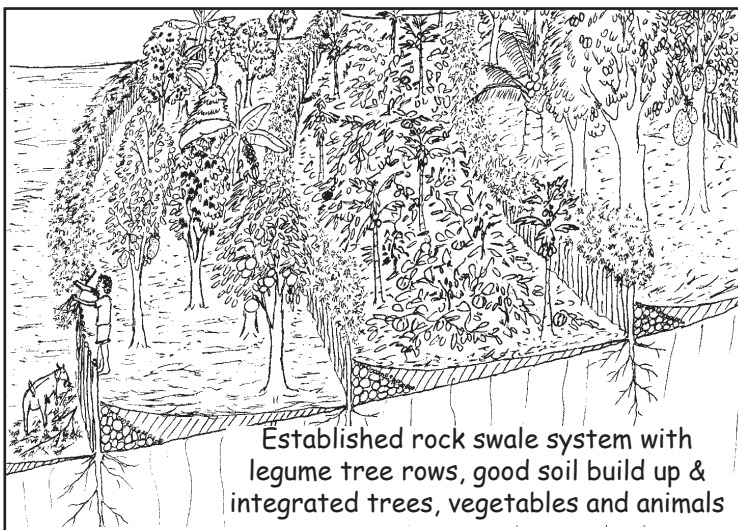
The following examples can be used for either trench swales or for ploughed contour lines. The two main sections are agriculture/tree crop systems and reforestation systems. The sections on rock swales and dry land strategies give techniques for specific needs that augment the agriculture/tree crop and reforestation sections. These techniques can all be integrated, mixed or changed as needed. Every situation is different!

We will give as many different ideas as possible but always be willing to experiment and use your own ideas and knowledge to change and improve the techniques.

Agriculture / tree crop swale system

STEP 1: Planting legumes

Plant fast growing legume trees along the top of the swale mounds or along the ploughed contour lines at the start of the wet season. Plant them very close together, 3 to 5cm.



These legumes have many uses:

- They will hold the soil together and eventually form a hedge that can be continuously pruned for many years. The prunings are valuable mulch and fertilizer and as the legumes are pruned they will release nitrogen into the soil.
- The legumes will also act as a windbreak and help to protect young trees and annual crops.
- After 2 – 3 years the legume hedge will turn into a living fence.
- Natural terraces will eventually be created

Gliricidia and Leuceana are the best legumes to use here. For the first season a crop of beans and pumpkins can be grown as well.

STEP 2: Alley Crops

In between the rows of legumes now are large rows or “alleys” that can be used for many different crops and eventually animals. A good idea is to make a plan for the land

Not all of the land needs to be used straight away. It is better to complete a few sections each year. The other sections can be planted with legume trees, and possibly pigeon peas, papayas, cassava, sweet potato, peanuts, corn, pumpkins, beans or green manure crops until trees are planted or animals are introduced.

A technique that is good to use for tree crops is called **Time Stacking**. This is making the maximum use of the land over many years by planting trees (and vegetables) that grow different sizes, at different speeds and have different life span. Many examples given in this Manual use this idea.

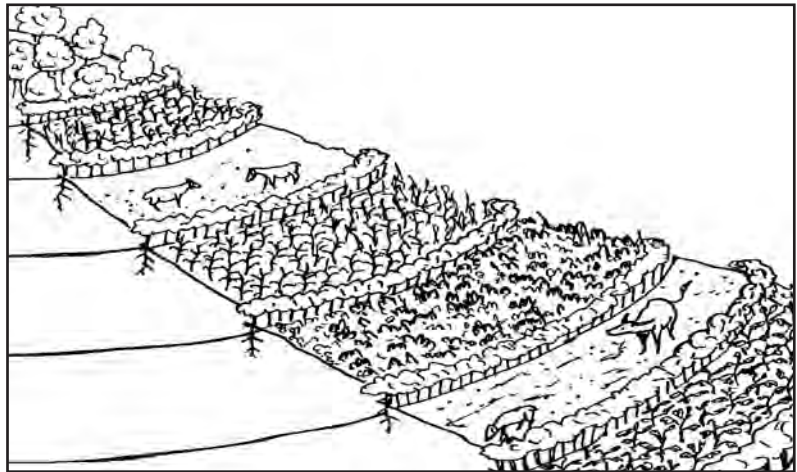
For example:

Year 1: Plant legume trees like casurina, sesbania, Moringa and acacia. Leave room for the fruit trees. These grow fast and will be cut back later to give the other trees more space.

Year 1 and 2: Plant custard apples, breadfruit trees, lime trees and orange trees, and many more between the legumes. The legumes will provide some shade and protection for the young fruit trees. As the fruit trees grow up the legumes can be pruned back to give space. The fruit trees will eventually take over. Animals can be introduced into the system as well.

Eventually a mix of different tree crops and vegetable crops is best, integrated with animals. More diversity in trees, vegetable and animals means a much better range of food and products and a more stable income.

For soil with many rocks, for dry areas or for large amounts of land plant more tree crops than vegetable crops. Trees require less maintenance and still produce crops in harsh conditions.



SMART IDEAS:

- It is best to plant your trees at the beginning of the wet.
- Vegetable crops like pumpkins, melons, chillies and beans can be grown with the tree crops for the first few years until the tree crops become too large.
- Shade tolerant crops can be grown with the tree crops once they are tall. E.g. Coffee, Taro, vanilla.
- Plan your crops so that in the future tall trees don't block the sun to vegetable crops.
- It is good to plant many different types of plants in each row but be careful not to plant trees that will grow too large and take all the sun, water and nutrients from other trees. Plant small trees together and large trees together.

When the first rows (alleyways) are established then the other rows can be worked on. If you have planted legume tree in these rows first then you can now remove some of these to make room for the tree crops. The legumes will have greatly improved the soil and now provide mulch and fertilizer as well.

It is better not to remove the hedgerows of legumes. Prune them once every month to two months in the wet season and put the branches around the tree and vegetable crops as mulch or feed them to your animals.

This is a natural system that works with nature's principle of succession. If we work with this principle and use it for our benefit then the growth rate of the system and the trees will be much faster and yields will improve.

Different examples of crop integration patterns and farming practices that can be used in the alleyways (rows):

Small trees can be grown together.

E.g. citrus, bananas, cacao, guava, custard apple, papayas, sesbanias, pigeon pea and Moringa, Coffee and taro. Spices like ginger, chillies, cloves, ginger and tumeric and vegetables like sweet potatoes, yam and cassava can be grown together with the small fruit trees as well.

Large fruit trees can be grown together.

E.g. Mangos, Avocados, Jackfruit, coconuts, bamboo. When the trees are established, after 4-5 years, animals can be grazed through the system.

Timber trees, oil trees, bamboo, fibre trees, medicine trees, firewood trees and more can all be planted too.

These all provide valuable resources to use, sell or trade. Animals can eventually be grazed in these systems as well. These trees are good for large areas and revegetation of forests and can be mixed with large fruit trees. Short-term crops like spices, sweet potatoes, pumpkins, papaya and even bananas can be grown when the trees are still young.

Different vegetables grown together

- a. E.g. corn, pumpkins and beans
- b. E.g. cassava, sweet potato, papaya, pigeon pea
- c. E.g. tomatoes, chillies, garlic, onions
- d. E.g. whatever you think is best

Smaller terraces can be established in the rows to increase the production for vegetables and small fruit trees like pineapples, bananas and papaya. Different combinations of vegetable and small fruit tree production can be used.

Taro, kang kong, watercress and other water plants can be grown in the trenches in the wet season.

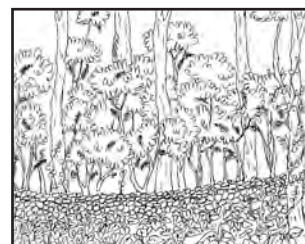
Plants that like a lot of water, like lemongrass and arrowroot can be grown on the edges of the trenches.

Once legume living fences are established, some rows can be used to graze cows and buffalo.

Goats can also be grazed if they are tied up. If you do use animals in the system, animal food trees need to be grown to help supply a good diet for the animals. The legume living fences can be used for animal food as well. Animal medicine trees can be grown too. Growing trees for animal food will increase the amount of animals you can graze in an area.

Traditional coffee planting can be augmented with taro, vanilla, sesbania and Moringa.

What you end up doing and the combinations of different trees, vegetables, spices and animals is up to you!



Plan and make your system to suit your own climate, land and plants.



SMART IDEAS:

- **Rotate Crops** - Vegetable and annual crops need to be rotated to different plots each season for the best results. Growing different vegetables together also helps to keep your soil healthy.
- **Compost Trenches** - Swale trenches can be used for making compost. Some nutrients will soak into the ground from the compost and when it is ready it can be spread around the plants. Compost pits, compost baskets and liquid compost can also be made wherever you need them. Nutrients used by the plants need to be replaced each season.



Flat Land Tree Crops

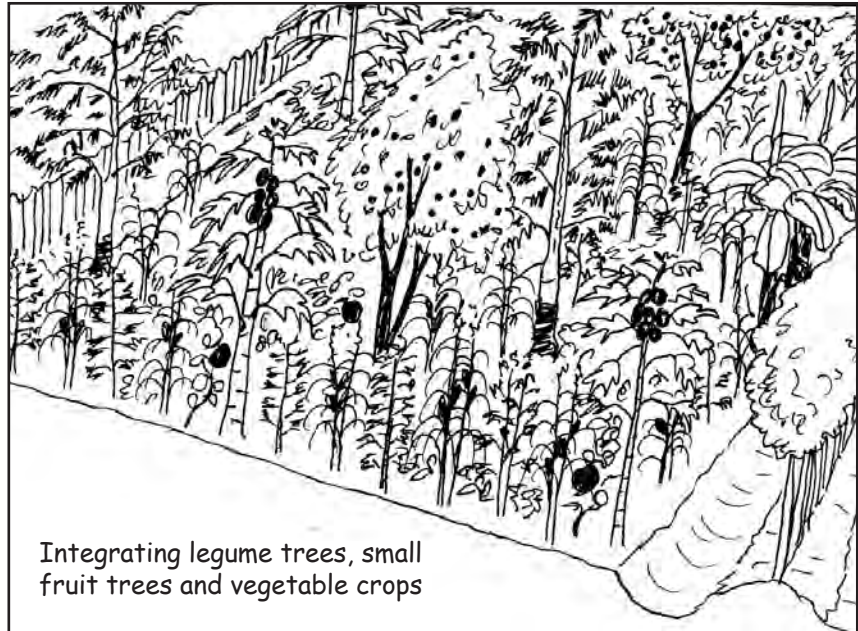
Because there is very little flat land in East Timor, it is understandably used for grain and vegetable crops. However tree crops can be integrated with grain and vegetable crops in many ways.

The tree crops will increase the number of different crops, and can also be used to improve the production of grains and vegetables. Tree crops are especially good in dry areas.

Examples:

- Small trees like citrus, bananas, papayas, cloves, pigeon peas can be grown in rows with grains and vegetables. These trees provide crops and also provide shelter for the annual crops.
- Legumes like acacia and sesbania can also be used. The legumes provide crops and shelter and also provide mulch and nitrogen for the soil.

Pest problems can be controlled more easily because it is harder for the insects to go from row to row. The trees provide a break and a barrier.



Integrating legume trees, small fruit trees and vegetable crops

The succession system for tree crops that is explained in the swale section can also be used on flat lands, and can be integrated with grains and vegetables as well.

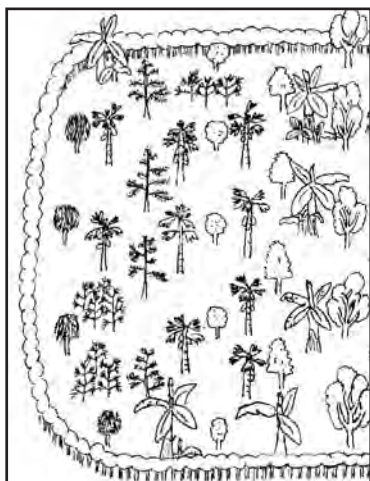
The benefits of this system is that in the tree crop area, vegetables, grains, papayas and bananas can be grown to provide food and income while waiting for the large trees to grow and produce crops.



SMART IDEA:

- Flat land agriculture will be improved if all rain is collected and stored in the ground. This includes water that comes down from the mountains. Trenches and banana pits can be used to collect water from heavy rains. Swales and terraces will catch the water on the slopes and can be used to direct the water where you want it to go.

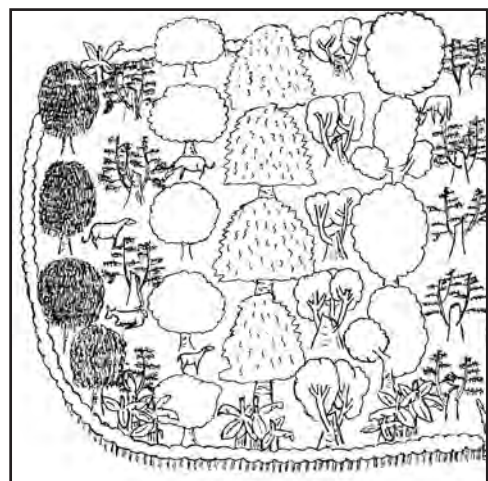
There are many more examples of flat land tree crops and integration with vegetable and grain crops in the Large Scale Agriculture Chapter (CH 9).



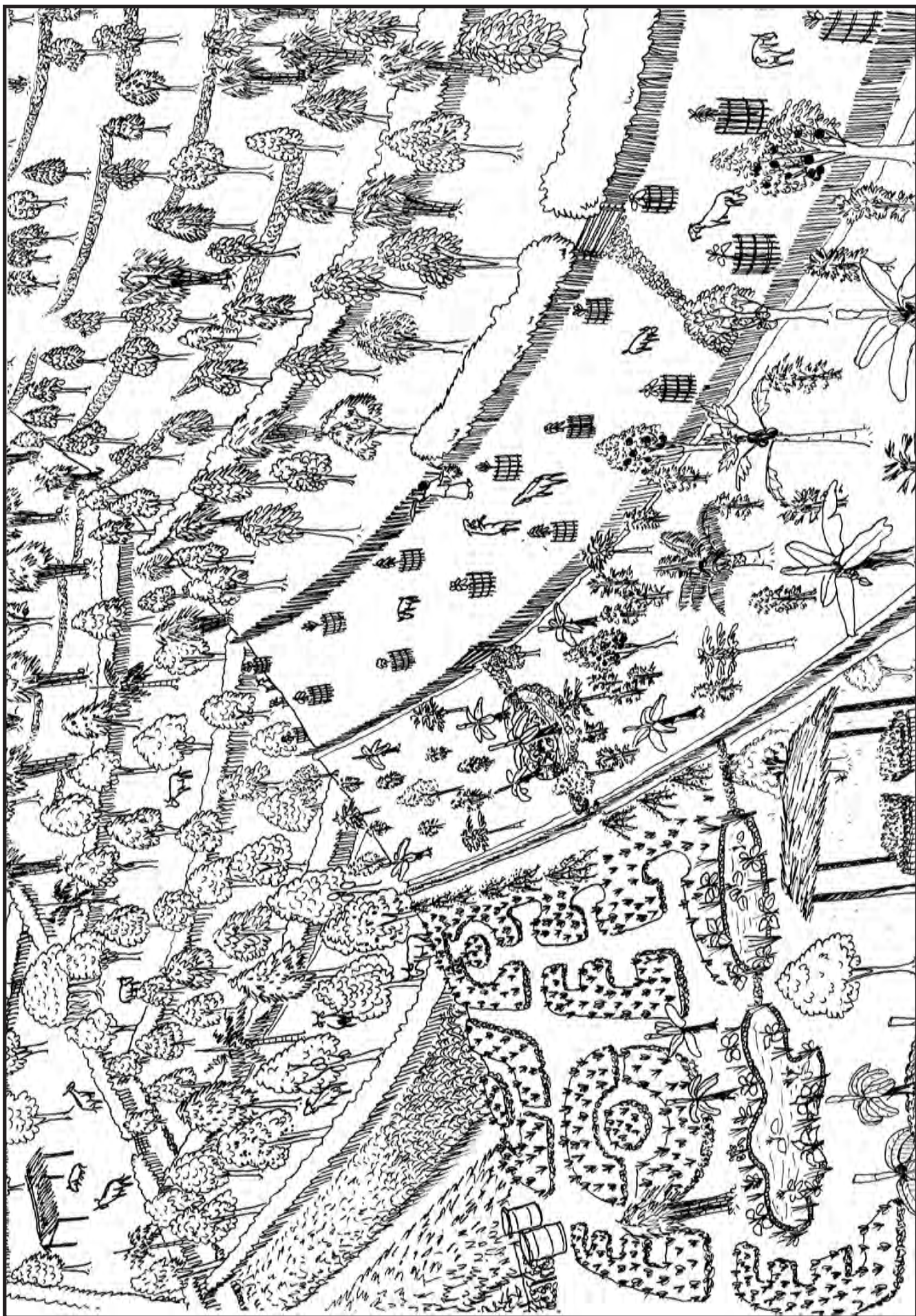
2 years



5 years



10 years



Integrated rock swale, trench swale and tree terrace system with trees, animals, vegetables and fish ponds

Reafforestation

Reafforestation areas are areas where natural forest is restored.

They are less intensive systems than fruit tree crops/agriculture swale systems but they can still provide many essential products, like bamboo, nuts, oils, fibre, timber, firewood, fruit and medicine.

Reafforestation is very important for preserving the environment and stopping erosion.

Swales

Plan where you want the swales to go, mark the swales with an A-Frame and then make the swales with the technique that best suits you and the land. Trench swales, ploughed contour lines and rock swales can all be used

Dry land Strategies

In the drier areas of East Timor water storage is especially important.

In the dry areas often the ground has many rocks as well. In these areas rock swales and rock terraces work very well. Different techniques and patterns can also be used to stop soil and water and improve results.

The following techniques can be used anywhere in East Timor because all districts have dry spells.

They can also be used for tree crops and vegetable crops. Use whatever technique suits your needs, or try your own ideas for catching and storing water.



Boomerang Swales

The boomerang is a traditional hunting weapon of the Australian Aboriginal people. Boomerang swales have their name because they are the same shape as the boomerang.

Boomerang swales are much smaller than trench swales. They can be as small as 2 metres but work best if they are between 5 to 10 metres. They are usually made of rocks but also can be dug. If they are dug then put a layer of rocks on top to protect the soil, especially in the middle where the water will sit. For the best results, boomerang swales should be about knee height (adult). Higher is even better.

Put smaller rocks on the front (top) side and large rocks on the back (bottom) side, the same as rock trench swales. This will help to collect more soil, water, leaves and plant material.



Planting in boomerang swales

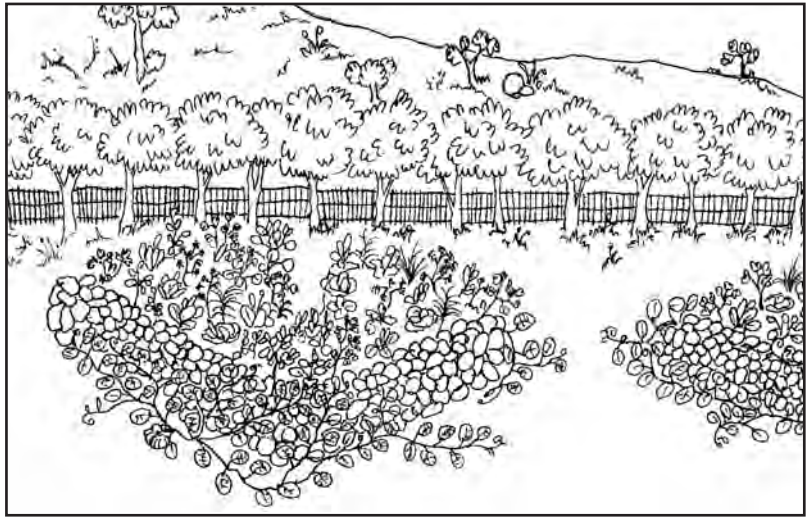
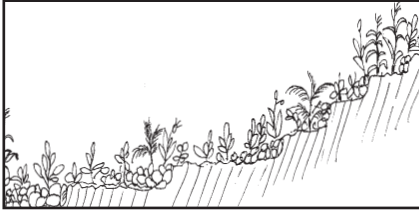
Start by planting trees in the middle of the swales then expand as the trees become established. It is a good idea to start with legume trees and seed balls (read seed ball section). When these trees grow they will hold and improve the soil. In future years the legumes will provide the new trees you plant with mulch, nitrogen and protection from wind and sun.



If many boomerang swales are made together in an area they can feed any excess water from one to another. This will improve the results and productivity of all the boomerang swales.

Vegetable gardens

Rock swales can also be used for vegetable gardens on gentle slopes. The small terraces that are formed will be highly productive growing areas.

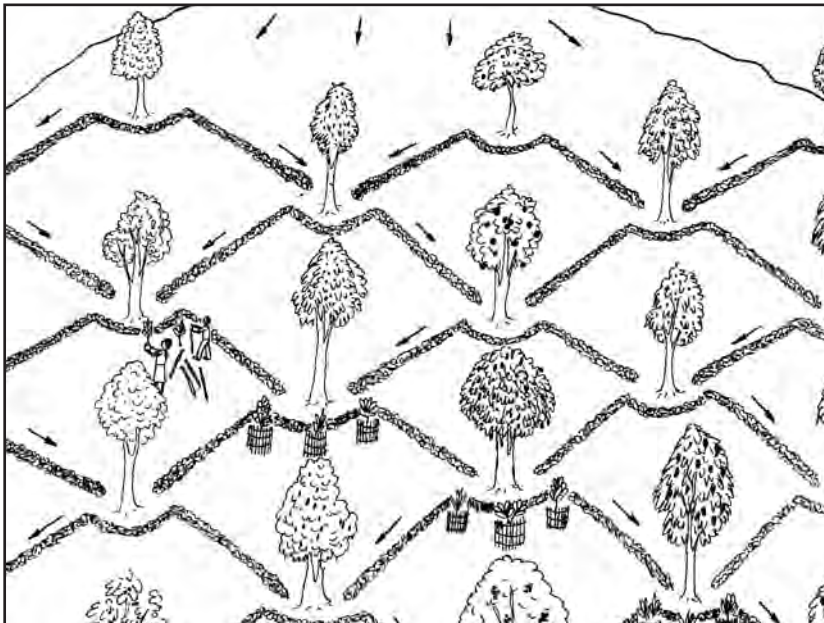


Net and Pan System

This system is best for gently sloped land. It is called “Net and Pan” because a “Net” is made to catch water and a “Pan” holds the water. The technique is similar to the boomerang swale but it has a V-shape.

Each side of the “V” is about 3 metres long and about knee high. They can be made from stone or dug out. A combination of both is good.

If many “Net and Pans” are made together they make a system where the overflow from one net and pan runs into the next net and pan and so on. Use small trenches or rock lines to connect the V shapes and direct the water.



What are the benefits?

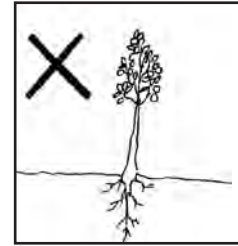
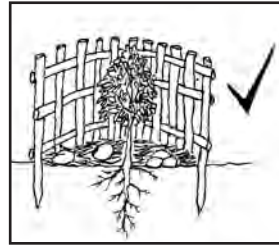
- Every tree that is planted will be healthier and more productive because there is more water and the soil will build up and improve
- There will be a lot less erosion
- Small trees are protected from wind
- Each “Net and Pan” can be planted with short-term and long-term crops

Directing and catching water with the Net and Pan System

Microclimates

A microclimate is the climate in a particular area. It can be an area of 1 or 2 acres, a mountainside or as small as a vegetable garden, a pond or a swale. Each type of plant has a microclimate in which it grows best. Most plants like microclimates with:

- Protection from strong winds
- Available water.
- Good soil
- Sunlight for most of the day
- More shade when the plant is young



Providing a good microclimate is especially important for young trees and plants.

Microclimates can be changed and improved with good techniques. All the techniques that have been explained will change and improve the microclimates on your land. Plants will be more healthy and productive. These techniques use specific shapes and materials to catch and store water and stop erosion. Any technique used to catch and store water and reduce erosion will improve the microclimate and provide better growing conditions for plants.



Collecting Night Condensation

Any construction made from rocks – rock swales, rock terraces, net and pan systems, boomerang swales etc – will help to improve the microclimate and environment. The rocks provide homes for small animals and insects.

At night, when the temperature is cold, the rocks will become cold and moisture from the air will collect on the rocks. This moisture will soak into the soil to be used by the plants. It is an important source of water in dry areas.

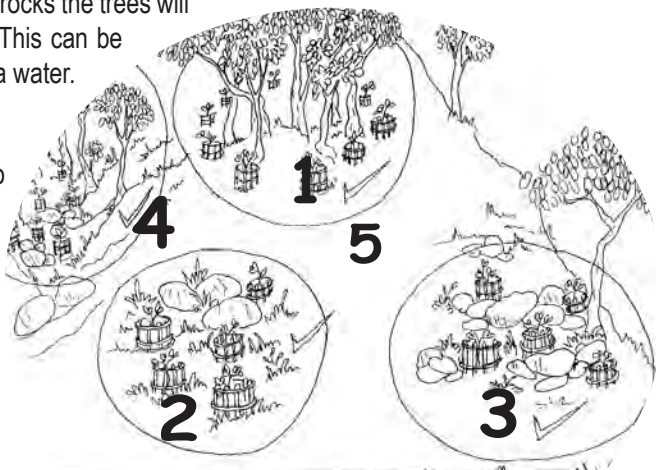
Good areas to start reforestation

From observation you will be able to find areas on your land that are naturally good microclimates for plants and trees.

These areas are the best places to start reforestation. If you plant trees in these areas first you will improve your success rates and trees will grow better.

Look for:

1. An existing group of trees. The trees will grow in a particular spot because the microclimate is better. The existing trees will also provide mulch, shade and wind protection for young trees.
2. Areas that have grasses and small plants rather than areas that don't. In very dry areas with few trees, the grasses and small plants indicate that there is better soil and possibly more water available in the soil. Plant trees in these areas first because the trees will have a much better chance of growing. Areas with little or no grasses and plants show that there is poor soil, probably a lot of rocks underneath and not much water.
3. Large rocks or groups of rocks. If you plant below the rocks the trees will receive more water from the run-off from the rocks. This can be improved even more by catching and storing the extra water.
4. Areas that water will naturally run to and collect.
5. The northern side of a mountain is the best side to start reforestation. This is because it will get a good amount of sunlight and has better climate for plant growth. The western side will be the hottest because it receives the hot afternoon sun. The southern side will receive the least amount of direct sunlight. If it is very steep it will only get a small amount of direct sun so try growing plants that like shade.



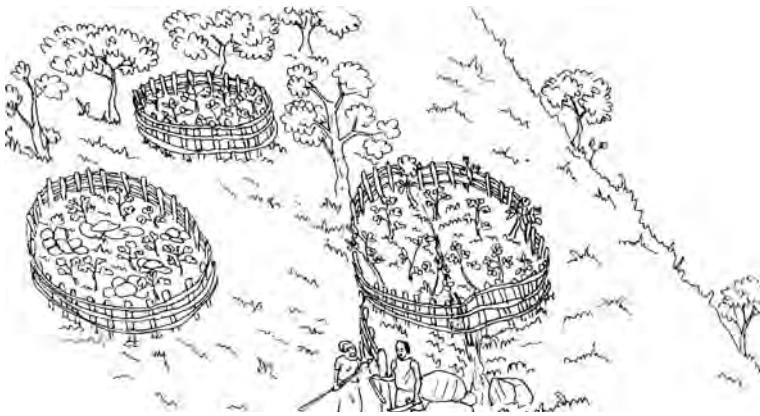
How to assist natural reforestation

Nature is always working towards a healthy environment with a diversity of trees, plants, animal, birds and insects. For areas that you want to Reafforest, working with nature will speed up the process of reforestation.

1. Stop Burning

Burning every year will kill young plants and prevent new plants from growing. Only a few types of plants will survive. E.g. Eucalypts. Grasses give protection to young shrubs and trees. By burning the grasses you will remove their protection and also their source of mulch and nutrient. This makes it much harder for the young trees to grow.

2. Birds are very important for natural reforestation They also improve areas where trees are planted. This is because birds eat and then spread seed through their manure. The manure helps to improve the soil and some seeds will grow into new trees. Birds are an essential part any forest or ecosystem and must be protected and encouraged. If this happens then birds will help East Timor's environment to improve quickly.



3. First plant trees in small groups if you want to reafforest a large area.

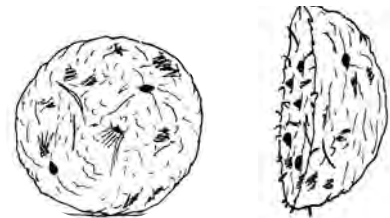
The trees will provide protection and mulch for each other. Therefore you will achieve better results and the trees will grow faster. In following years when planting, add to the groups with new trees. The older trees will protect and help the new trees.

Seed Balls

A seed ball is a small ball, about 4cm in size made from clay that contains tree seeds and a small amount of dry cow or goat manure.

Seed balls are a very good technique to start reforestation in areas that:

- Are very dry
- Have steep slopes
- Have few or no trees



They are simply placed in the areas that you choose just before wet season. When it rains the seeds will grow. The clay protects the seeds from animals and birds until the rains come and the manure provides nutrients to help the plant to grow. Use seeds of fast growing legume trees, and choose species that grow well locally. E.g. acacia, causerina, leuceana, sesbania. The trees that grow from the seed balls will improve the soil and provide protection and mulch for future trees.

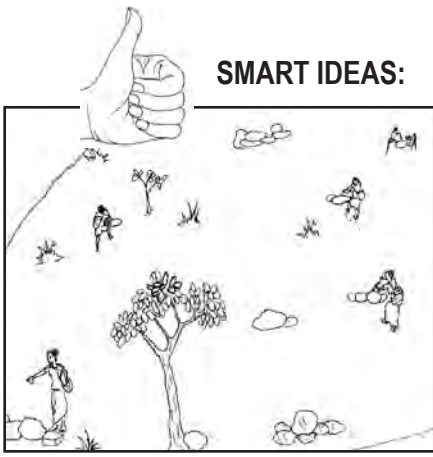
How to make seed balls



Collect the materials together. Choose clay that still sticks together when rolled into a snake shape. Add water to the clay until it is easy to make into balls. Mix in a small amount of dry manure a little at a time, but make sure that the clay still sticks together. Make the balls and then add some seeds to each ball. About 5 - 10 seeds is good. The seeds need to be well covered by the clay. Put the balls in the sun straight away to dry them. 1 or 2 hrs will do. If the seed balls stay wet the seeds will grow.

Put them in a dry shady place to finish drying before they crack. When they are dry store them in a dry place until you use them.





SMART IDEAS:

- Making small catchments of rocks will improve the success rate of the seed balls by catching soil and water for the young trees.
- Seed balls can be used with small or large swales.
- Seed balls will help if you have a lot of land that you want to Reafforest and can't plant all the land in one season. You can plant trees on the best land for planting while seed balls can be used to start the process of reforestation in the other areas.

Protection from Animals, Fire, Wind and Erosion

All fruit trees, tree crops and reforestation must be protected from fire, animals, strong winds and erosion.

Fire and animals will quickly destroy many trees and waste a lot of hard work.

Strong winds can damage young trees, slow down growth and the trees will need a lot more water.

If the trees are protected they will grow and produce well. Erosion will wash away young trees and the soil that they need to grow.

The first step and most important part of tree protection is community participation.

Community Participation

Neighbours and communities need to be involved in and understand any project that affects themselves or their area. Community meetings can be held to discuss important issues such as:

- Preventing animals from going into areas where young trees are growing.
- The benefits of not burning and preventing fire from spreading from one families land to another.
- Sharing water, and sharing labour and construction costs of collecting and storing water.

If the whole community understands the benefits of not burning and of animal control, reforestation can be successful.

Appropriate community plans can be developed to manage the land and help prevent problems from occurring.

- Ceremonies and traditional community law can be used to show the importance of the reforestation and protect the trees. E.g. Tara Bundu.
- Community education about reforestation and stopping burning and erosion will benefit EVERYONE in the community and improve the results of reforestation projects. Schools, local groups, churches, government agriculture workers and community radio are all groups that can be involved.
- User groups for water and other resources can be formed to manage resources and provide fair distribution to benefit all users.
- Exchanges for labour and resources can be set up.
- Short-term and long-term plans can be made for erosion control, tree growing, tree planting and transporting and selling products.

Ideas and plans for community land management should be discussed with government agriculture workers and other government departments. Working together with the government will help to improve results and increase community involvement.



Community Ownership

Community ownership and development is very important, especially for community land.

There are many benefits from community projects and from more than one landowner participating in a project. E.g. community nursery, construction of swales and other water catchments, water supply, animal housing and fencing.

- Costs of materials and labour for projects can be shared and are therefore reduced.
- Swales and other water catchments work better if different landowners are involved. This is especially true for lands that share water catchment.
- Produce can be traded.
- Transport of produce to markets and sale of produce can be shared.
- **Protection of trees from fire and animals will be more successful because people will be working together.**

An important part of community education and working together is understanding the FUTURE benefits.

If reforestation is well managed, in 3 to 5 years animals can be reintroduced into the area without damaging the trees. The animals will be healthier from more shade and good quality food. Animals will provide weed control and manure for the trees. The land will be much more productive.

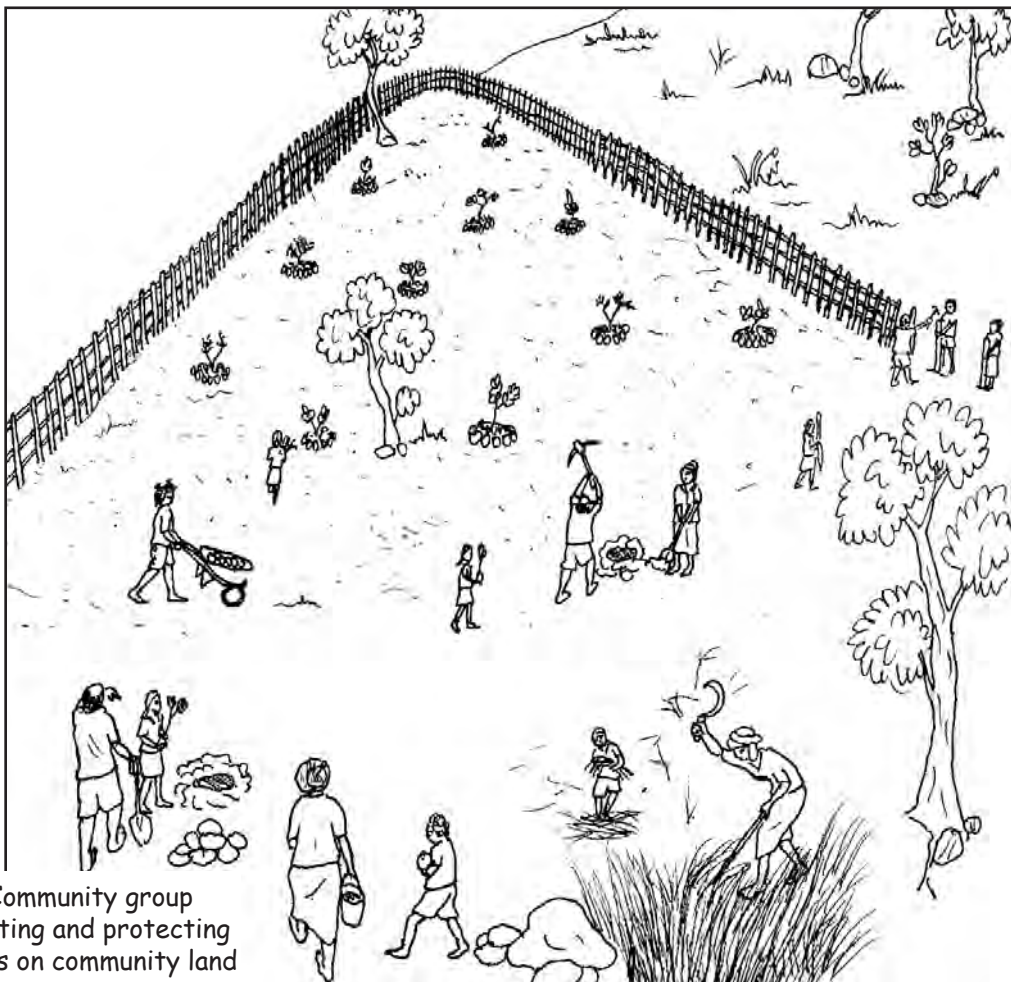


SMART IDEA:

- It is very important to make long-term plans for large areas of land, especially for erosion problems. It is even more important to do the work step by step and make each small step a success rather than try to Reafforest a large area and not be able to manage it properly.

Now we will look at practical techniques for tree protection.

Remember to find multifunctional solutions.



Community group planting and protecting trees on community land

Protection from Fire

Question: Where is a fire most likely to come from?

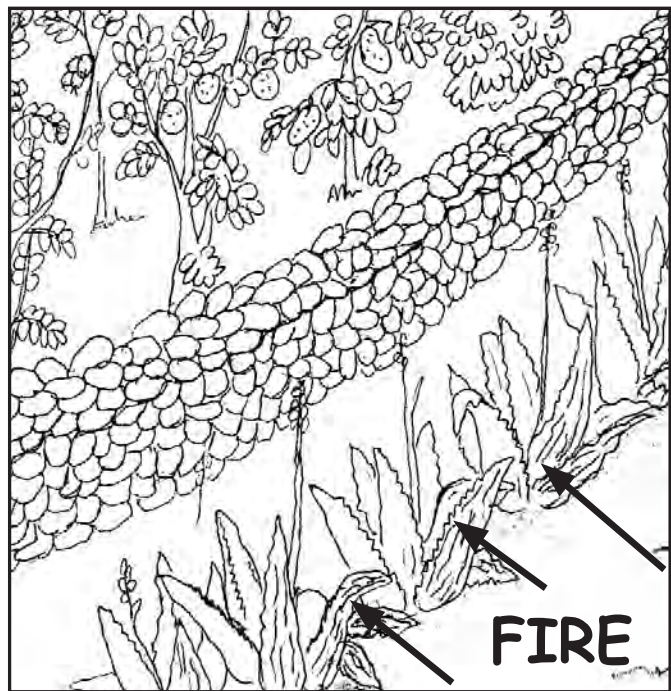
Answer: From where the wind usually comes from in the dry season or from lower down the mountain.

Put your fire protection in this area first.

Fire protection can be:

1. Living fences made from trees that will not burn.
2. Rock walls. A rock wall is good because it provides fire and animal protection.
3. Firebreaks. A firebreak is a bare strip of land that is kept clear of plants. When a fire reaches a fire-break it will slow down or stop because there is nothing to burn.

These techniques work much better if they are combined together.



Protection from Animals

A fence or tree guards must be used if there is any chance of animals eating the trees. Goats, buffalo, cows and pigs can destroy large numbers of trees very quickly. Fences are good for fruit tree crops, reforestation and groups of trees.

They can be made from:

- Living fences made from trees that animals won't eat. E.g. Ai tasi, cactus, flame tree
- Wood, palm branches or bamboo
- Rock
- Wire
- A combination of materials

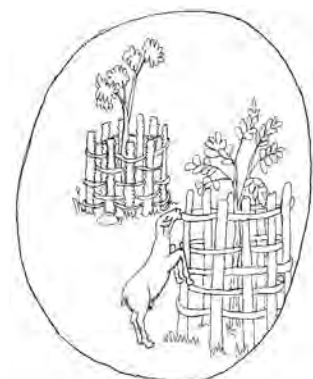
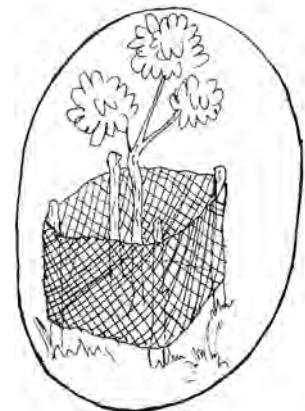
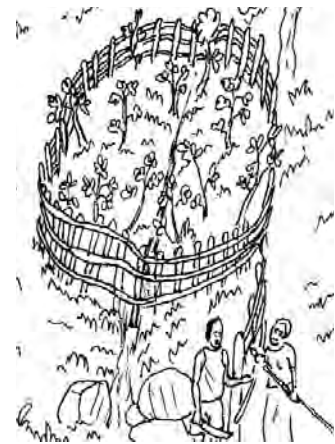
Tree guards are good for fruit trees, trees near the house and trees that will grow large.

They can be made from:

- Palm branches – spiky palm branches are best
- Bamboo
- Wire
- Wood
- Rocks
- Old fishing nets
- Anything that will successfully stop animals

Tree guard and fences must be strong to stop hungry animals.

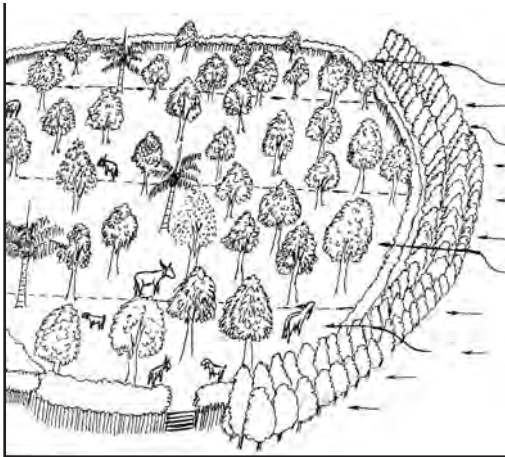
Rocks also provide moisture on cold nights, and fire protection. Tree guards can be re-used or turned into mulch. Remember that when trees have grown up animals can be carefully reintroduced into the system.



Protection from wind



If trees have protection from wind they will grow fast and healthy, especially when they are small, and water use is reduced. Tree guards will provide some wind protection for young trees. Fences will also provide some wind protection for young trees, especially if vines are grown on the fences or living fences are made.



For tree crops and fruit trees:

- Windbreaks can be planted in the areas where strong winds come from. A windbreak is a line or lines of trees planted specifically to slow and stop wind. Windbreaks can be grown from many different useful trees. Look in the Large-Scale Agriculture Chapter (CH 9) for more windbreak examples.

For reforestation:

- Plant trees first in areas that are protected from strong winds.
- Plant trees in groups. As they grow the trees will protect each other. The next year use these groups of trees to protect the new trees.

Protection from Erosion

Trees are the best long-term solution for erosion but when trees are small they need protection. Many solutions have been explained already in this section, including swales, terraces, boomerang swales and more. Grasses and ground cover are very important for stopping erosion as well. Burning damages and kills grasses, ground covers and young trees and must be stopped if erosion is to be stopped.



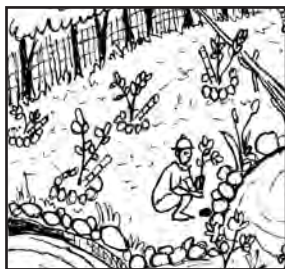
Tree Maintenance

Tree Planting

How you plant trees is very important. If you use a good technique to plant trees, and take care of the trees when you plant them, the tree will grow much faster and will be healthier.

There are many different techniques that you can use, but the basic ideas are the same:

- Don't plant in the heat of the day. Late afternoon is the best time
- The more water you give to the tree the better
- Take care of the roots, disturb them as little as possible
- Create a small "bowl" around the tree for water to collect and stay.
- Add a watering pipe if possible
- Put lots of mulch around the tree



Fruit Trees and Tree Crops

Fruit trees and other trees that produce food or are part of a tree crop system will benefit a lot from a little more work when planting.

When to plant

If you have water, fruit trees can be planted any time of the year. If not, plant them when the ground is wet and consistent rains have started.

A Technique for planting fruit trees

Step 1: Dig a hole knee deep or more if possible. Fill the hole with water. Water the tree (still in tree bag) at the same time.

Step 2: Put a bamboo watering pipe in the hole. Place some small rocks below the pipe to help water flow. Don't forget to break through the inside layers of the bamboo or the water will take a long, long time to reach the soil!

Step 3: Fill a plastic bag with animal manure and place at the bottom of the hole. Cover the manure with soil and make a small mound in the soil for the tree to sit on.

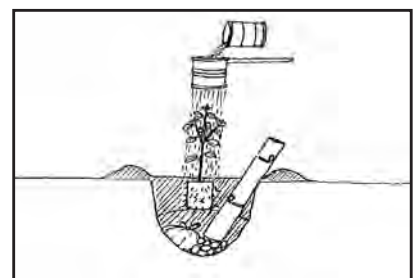
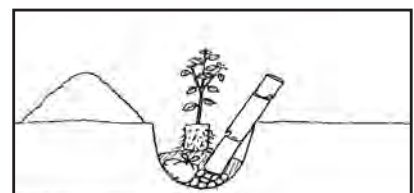
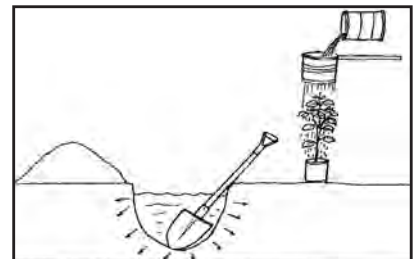
Step 4: GENTLY remove the tree from its container, taking care not to break the roots. If there are many roots, gently loosen the bottom roots of the tree. Place the tree in the hole, and make sure that the root point down.

Step 5: Fill the hole with soil. Make a shallow bowl at the surface to collect water and help watering. Make sure that the top of the tree roots are covered with at least 2 cm of soil to stop the roots from drying out.

Step 6: Put lots of mulch around the tree.

Step 7: Water the tree.

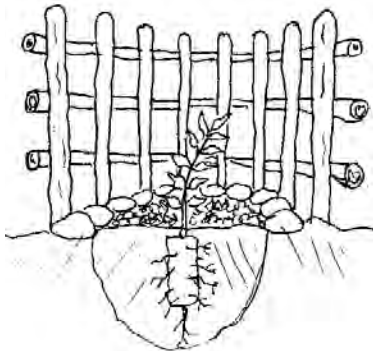
Step 8: Make a tree guard if one is needed.



Reafforestation Trees

Reafforestation trees are planted using a similar planting technique as for fruit trees but with a few small changes. This is because:

- They are usually planted further away from the nursery and resource area.
- They need less fertilizer.
- They will usually not be watered so natural water storage is important.
- The ground is often harder to dig.



When to plant

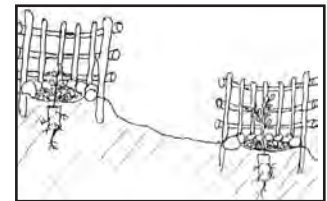
Plant reafforestation trees early in the wet season, when consistent rains have started. Follow the same steps as for fruit trees but:

- Water the trees before you take them out to the planting area, and keep them in the shade until they are planted.
- Dig a smaller hole.
- No need for the bag of manure.
- Make a large bowl for catching water. But try to make sure that the bowl is above the ground. This will help to prevent too much water in the wet season.
- Use bamboo watering pipes if you are going to water the trees in the dry season.



SMART IDEAS:

- Always place the soil that you dig **BELOW** the hole that is made. Extra soil can then be used to make a small bowl to catch water for each tree.
- A good way to soak the ground before planting is to dig holes for the trees and then wait for the next rain. Water will collect in the holes and soften the soil and the trees will grow better.
- Planting with swales will always improve results and help the trees to grow much faster.



Watering

Fruit trees and tree crops

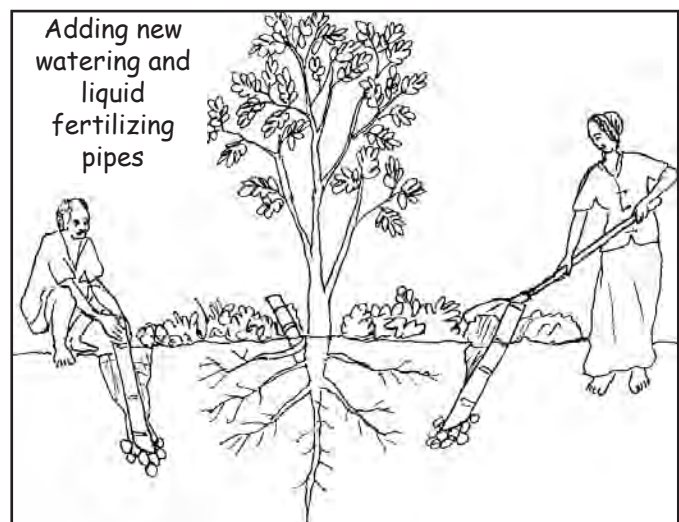
Fruit trees and tree crops must be watered in the dry season if you want good production and large fruit, especially for the first few years.

- It's **MUCH** better to water with a lot of water once per week than with a small amount of water every day or 2. This encourages the roots to grow down looking for water, and they will therefore reach the ground water much faster.
- Use the bamboo watering pipes
- Water late in the afternoon or early in the morning

Reafforestation trees

Some water in the dry season will improve success rates and increase growth.

Always water early in the morning or late afternoon.



Natural Tree Fertilizing

Tree use nutrients from the ground as they grow and as they produce fruit, nuts and seeds.

Therefore you need to replace the nutrients each year for the tree to be healthy and to produce good crops. It is the same as for people and animals, but luckily for us trees don't have to eat every day.

Fruit Trees and Tree Crops

Fruit trees grow best if they are fed from a variety of sources.

Compost, liquid compost, manures, seaweed, and mulch provide a wide range of nutrients and other benefits.

Look up Soil Chapter (CH 4) for techniques for making and using compost, liquid compost and mulch.



Where, when and how much to fertilize?

It is best to put the fertilizer where the tree roots can use it best. Underneath the outside leaves of each tree is the "root feeding zone". This is where the plants outside roots are and where the tree will be easily able to use the nutrients.

A small mound circle can be made just out from the outside leaves to improve watering and fertilizing results. This mound circle can be moved out as the tree grows.

For young trees, a bamboo watering pipe can also be used to feed liquid compost directly to the tree roots in the ground.

Compost and manures

Apply mostly around the "root-feeding zone". Apply twice a year, just before wet season starts and at the end of the wet season. A layer of 5cm will provide plenty of nutrients. Cover the compost with mulch.

Liquid compost

Put half in the bamboo watering pipe and half around the "root feeding zone". Apply once every 2 months in the the wet season and once in the middle of the dry season. For young trees up to 3 years old, use 1 large (20 litre) bucket. For older trees use up to 3 large buckets.

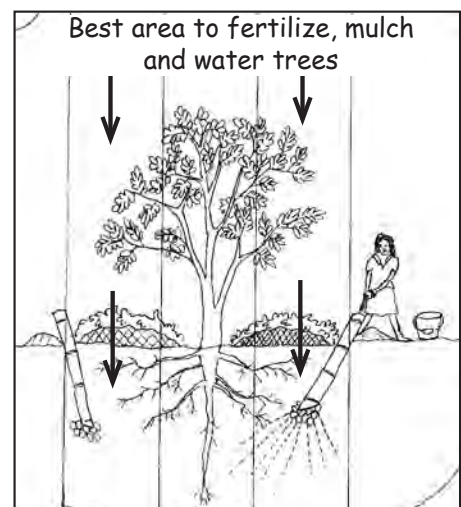
Mulch and seaweed

Apply from the just outside the root feeding zone to near the trunk of the tree. Mulch or seaweed should not touch the trunk or disease or fungus might damage the tree. Leave a 10cm gap. Apply continuously. Put up to 10cm thick. A thick layer is important so that the mulch works properly to keep the ground moist and improve the soil quickly.

Diluted urine is also an excellent, continuous source of natural fertilizer. It contains a lot of nitrogen. Citrus trees especially like diluted urine fertilizer. Give it to a different tree each time, but not too much for young trees.

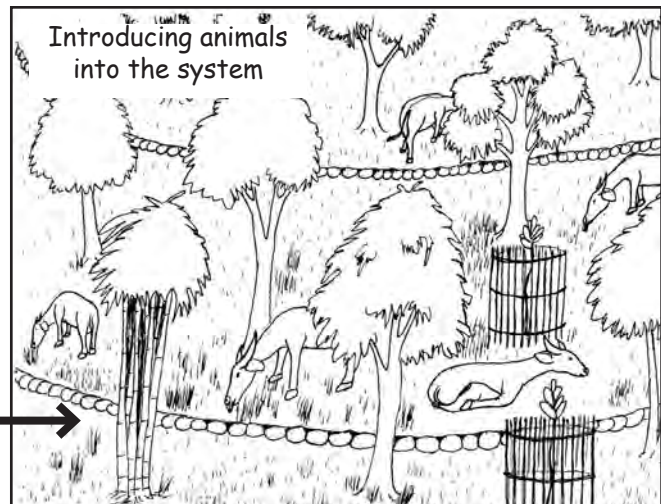
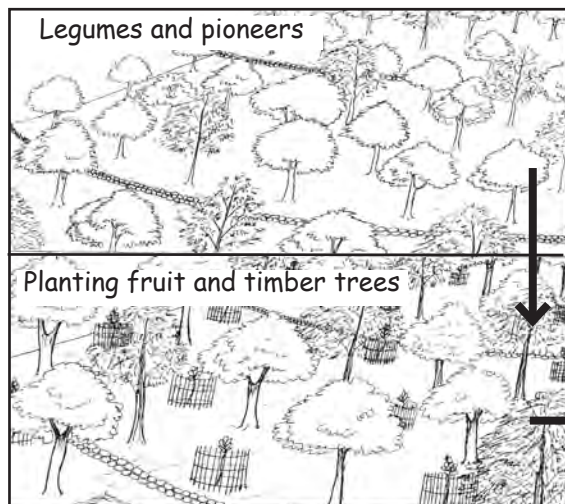
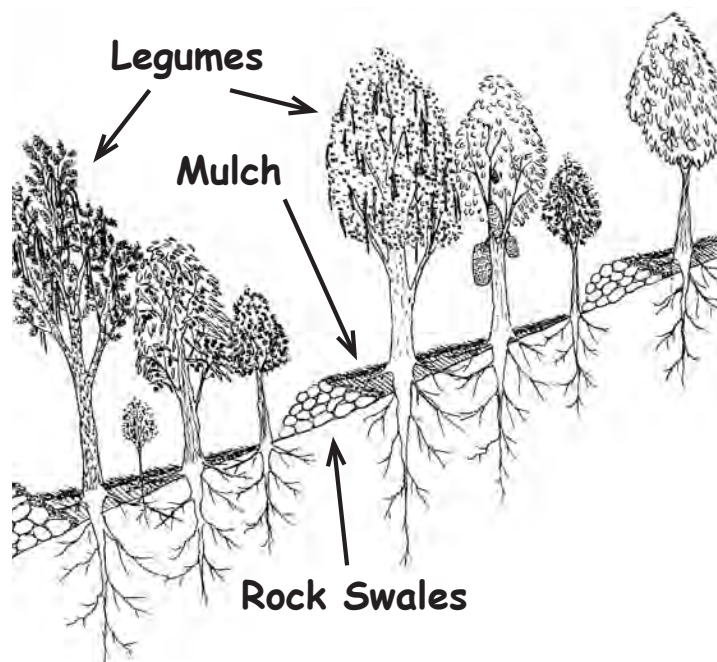
Reafforestation Trees

Reafforestation trees need a lot less fertilizer than fruit trees but they still need some fertilizer, especially when they are young. Often where reafforestation is to happen, the soil will have been eroded and often burnt. The result is that many nutrients are not available for plants. If these nutrients are replaced the tree will be healthy and grow faster.



Natural fertilizing techniques for reforestation

- If possible use some compost, manure or seaweed when planting to provide some nutrients for the young trees.
- Legume trees are a very important source of nutrients. Their roots provide nitrogen and they can be pruned up to 5 times each wet season to make mulch. Use them as “pioneers” and as mulch and nitrogen providers for your other trees.
- Mulch gives many benefits to your trees. For reforestation trees it also provides a lot of the nutrients that the trees need.
- By using swales, rocks and other methods of catching water, you will also naturally catch mulch and fertilizer for the trees.
- After 3 years animals can be carefully re-introduced. The animal manure will provide fertilizer for the trees.

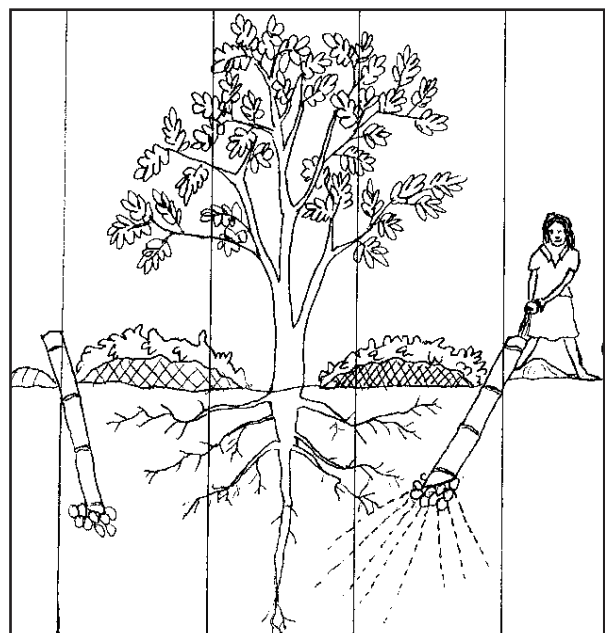


Tree mulching

Mulch is a very important part of tree maintenance.

It provides many benefits:

- Water stays in the ground and doesn't wash away. The wet season is extended because the ground stays wetter for longer.
- Mulch should be placed on top of manure and compost to maximize their benefits.
- Mulch is an important source of nutrients for trees and will provide a lot of the nutrients they need.
- Mulch improves the soil quickly by increasing organic matter and soil biota in the soil.



Fruit trees and tree crops

Mulch your trees continuously.

A layer of 10cm or more will give the best results.

Do not let the mulch touch the tree trunk, to prevent fungus and disease from damaging the tree.

Different types of mulch:

- Compost and dried manures should be placed under mulch and combined with the other mulch materials.



- Rice husks, coffee husks, seaweed (wash seaweed first), tree leaves, cuttings from legumes, grasses and dried weeds all make excellent mulch.
- Rocks, old paper and boxes, rotten wood and bamboo and any other natural materials also make good mulch and supplement the other mulch, compost and dried manure.



Reafforestation Trees

Natural mulch, such as tree leaves, grasses and weeds, will very quickly build up when the land is not burned. This mulch can be collected and placed around the trees. Legume trees and other trees can be pruned each wet season to provide mulch as well.



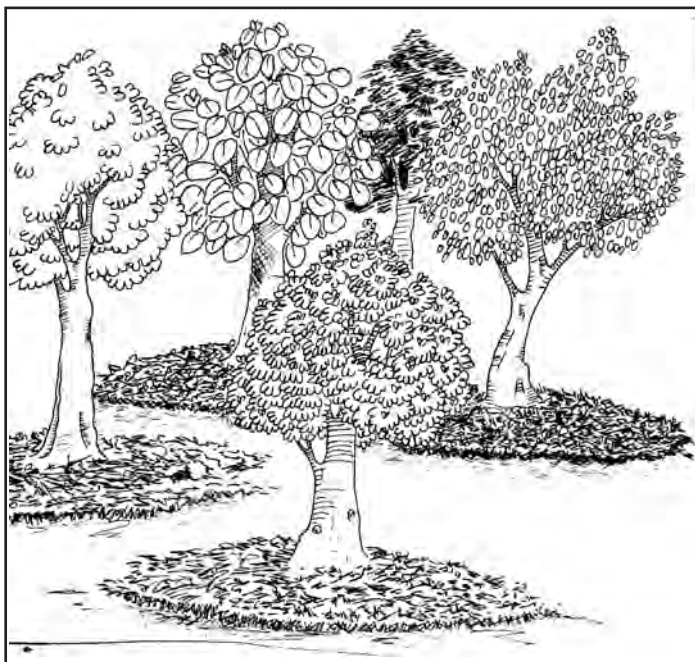
Mulch will stay in place and provide the most benefits if swales and other types of water and mulch storage are used. Rocks can also be used to hold down the mulch.

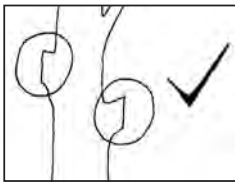
Rocks can act as mulch themselves, especially in dry areas and will provide extra water for your trees in the dry season. Read microclimates in this section for more information.



SMART IDEA:

- In the dry season mulch will burn easily and make a fire hotter. Therefore burning the land must be stopped on your land and prevented from entering your land. Community participation and understanding is important as well as practical techniques, such as firebreaks.

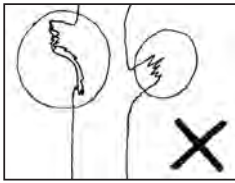




Tree Pruning

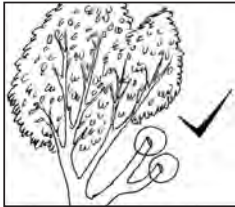
Pruning trees is necessary for maintaining tree health and productivity.

Diseases and fungus can spread easily if trees are not pruned. Harvesting is much easier as well because trees are lower to the ground and easier to access.



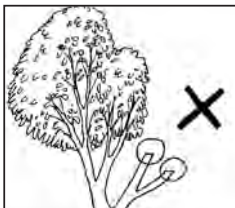
How to prune a branch

The right technique is VERY important because the tree will grow back much faster, suffer less stress and be much less likely to suffer from disease or fungus.

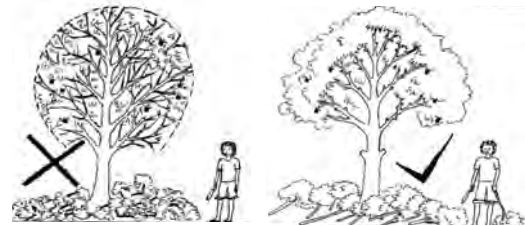


STEP 1: Use a saw if possible or a very sharp knife or machete.

STEP 2: Prune the branch as close to the next main branch as possible. Make the cut as smooth as possible. Make it angled or up and down but not flat. A flat cut will increase the chances of disease.



STEP 3: For fruit trees and other important trees you can paint a layer of jackfruit tree sap on the cut. This will stop any disease or fungus from entering the cut.



Fruit Trees and Tree Crops

For most tropical fruit trees it is recommended to only prune when necessary. Reasons for pruning are:

- To remove dead and diseased branches. By removing the dead or diseased wood you will reduce the chance of fungus or disease growth. Cut the branches off before the diseased or dead wood begins. This should be done once a year or as necessary. Any diseased branches that are pruned must be taken away and burnt to stop disease from spreading.
- To allow more sunlight into the middle of the trees. This will improve production of fruit and reduce chances of fungus problems. Only prune if it is needed.

Don't prune all the tips of the branches (trimming) but a few longer branches (thinning). Prune the tree evenly. To encourage new growth on older trees : when trees are old and not producing very well pruning the tree back to the frame will encourage new growth and better fruiting.

Reafforestation Trees

Reafforestation trees need less pruning and maintenance than fruit trees but some pruning can help to improve growth and quality. Reasons for pruning reafforestation:

- Any dead branches can be removed for firewood. Also remove any diseased branches.
- Removing the lower branches will make access much easier, improved conditions for animals to graze and for growing small plants underneath like coffee and vanilla. Don't remove lower branches of windbreaks because it will reduce their effectiveness.



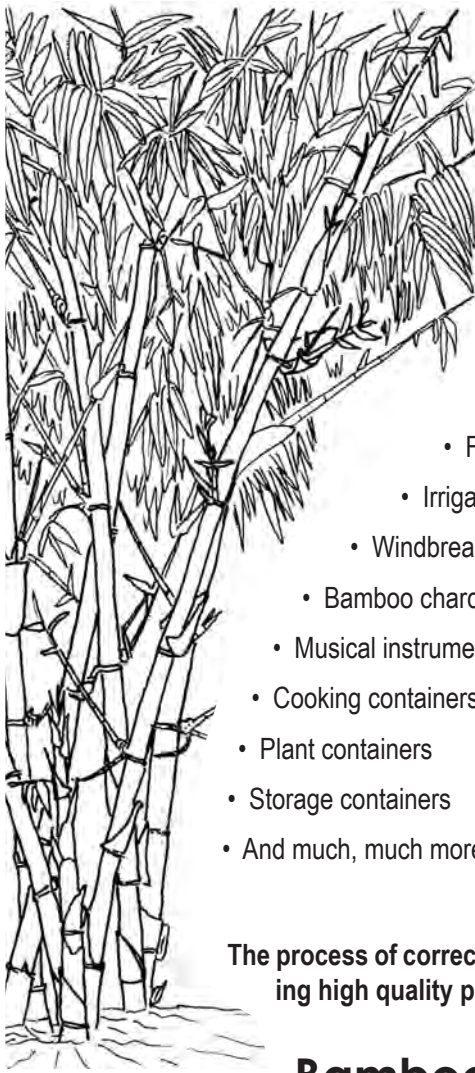
Legumes

Legume trees that are grown for mulch, soil repair or as living fences are pruned regularly. By pruning legume trees you will put nitrogen back into the soil. Look in the Soil Chapter (CH 4) for more information. Prune them back to waist height for easy management, and prune the whole tree evenly for the best results.



Forest and tree crops combined with water management, aquaculture, swales and vegetable crops

Bamboo



Bamboo grows all over East Timor.

It is a plant that has many uses and functions and is very important for East Timor and its people.

Bamboo provides:

- Income
- Building materials
- Furniture building materials
- Food for people and animals
- Fencing materials and living fences.
- Irrigation pipes
- Windbreaks.
- Bamboo charcoal for cooking
- Musical instruments.
- Cooking containers
- Plant containers
- Storage containers
- And much, much more



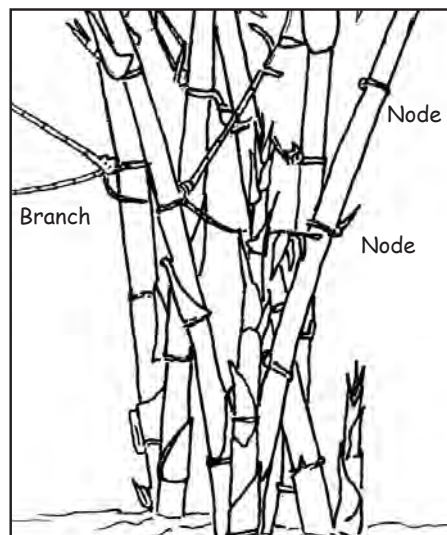
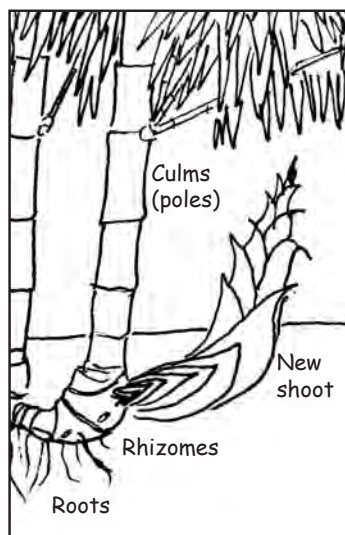
The process of correctly growing and managing bamboo clumps is the first step to producing high quality poles that are easy to harvest.

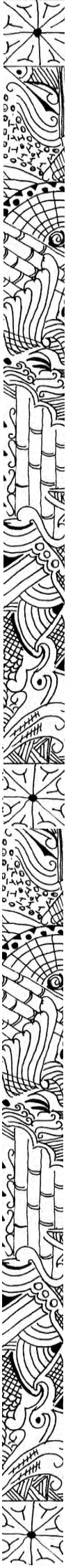
Bamboo Propagation

There are two main techniques for propagation of bamboo. These are Rhizome propagation and Culm Cutting propagation. The method you use will depend on the type of bamboo, and what you want to use the bamboo for.

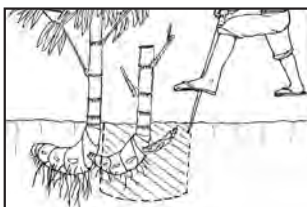
Time to propagate

September to November is the best time of year to propagate bamboo but with careful management, and if water is available, it can be done at any time. If no water is available, propagate when the wet season has started.





Rhizome propagation



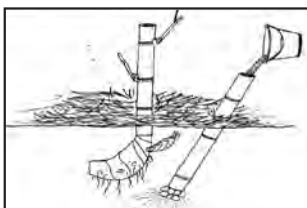
Rhizome propagation is good for small-scale planting because it has a high success rate. Rhizome propagation is more involved than culm cutting propagation, but its success rate is higher.

Type of bamboo

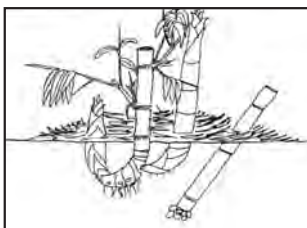


Rhizome propagation will work with almost all types of bamboo, but rhizomes of large species are difficult to dig up. Therefore rhizome propagation is best for species of small bamboo with many rhizomes and culms.

Method



- 1) Select the rhizome and culms that you want to propagate. Three year old culms on the outside of the clump are easiest and best.
- 2) Cut the culm (pole) 3 or 4 nodes above the ground level.
- 3) Cut through the rhizome where it joins the next rhizome (mother rhizome). Usually this is towards the center of the clump. Dig the roots and soil 10-15cm away from the culm so that when you remove the rhizome there are roots and soil attached.
- 4) Replant immediately. If this is not possible keep the rhizome roots wet at all times until planting. Wet the leaves as well. Keep the rhizome and roots away from sunlight.
- 5) Plant the rhizome 15cm into the ground and give it LOTS of water. Fertilize the new bamboo with compost and manures and put a thick layer of mulch around it. Water regularly. New leaves and branches will grow from the nodes and at the beginning of the wet season new shoots will grow from the rhizome. Sometimes new shoots grow straight away.



Culm (Pole) Cutting Propagation

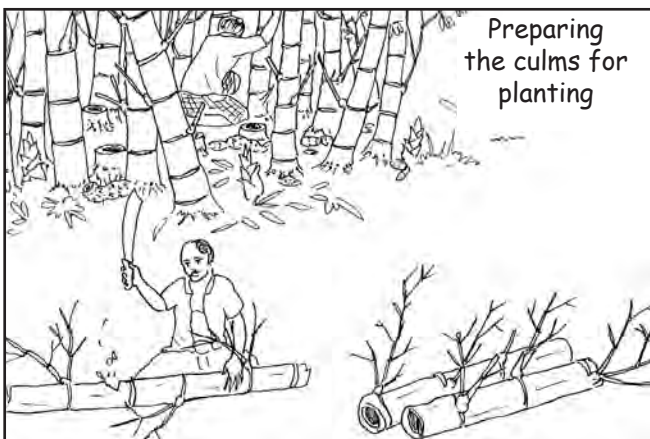
Culm cutting propagation is good for plantations and windbreaks because it is a simpler process. The best time to propagate is at the beginning of the wet season.

Type of bamboo

This technique is best with large bamboos that are too hard to propagate from rhizomes, but you will have some success with most types of bamboo.

Method

- 1) Choose a culm that is 2 to 3 years old and has branches.
- 2) Cut it as close to the ground as possible, and then cut the culm into 1 to 2 metre lengths.

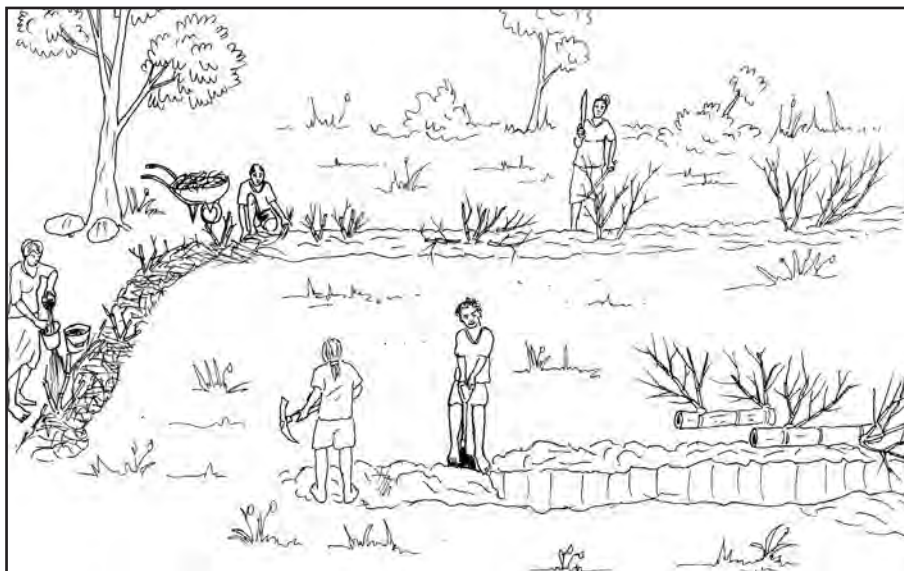


- 3) Cut off all branches and leaves after the first node on each branch but leave 2 or 3 branches on one side.
- 4) Dig trenches for the bamboo culms. Bury them 15cm below the ground, with the branches pointing up out of the ground. When the culms are buried cut the remaining branches at 2 nodes above the ground. This will help you to see where the bamboos are!
- 5) Water well every day for the first week. After that water twice a week for a month.

Planting the culms

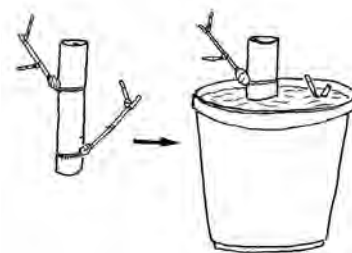
* The culms can be planted and propagated in the place where you want to grow them

* They can be dug up, cut up and replanted once they are growing, at the beginning of wet season.



Nursery Propagation

Culm cutting propagation can be used for growing bamboos in containers as well. A large container is needed. Cut the culm into sections, each section with 1 or 2 nodes that has branches. Plant the section vertically with 1 of the nodes at least 5cm under the soil. Cut the branches 2 nodes above the soil or 2 nodes after the branch starts. Water the bamboo so that the soil stays moist. Rhizomes don't grow well in containers and should be planted straight into the ground.



SMART IDEAS:

- Don't use the top 1/3 of each culm because the success rates for propagation will be very small.
- Cut a hole between each node before burying culms to help hold water.

How to Grow High Quality Bamboo

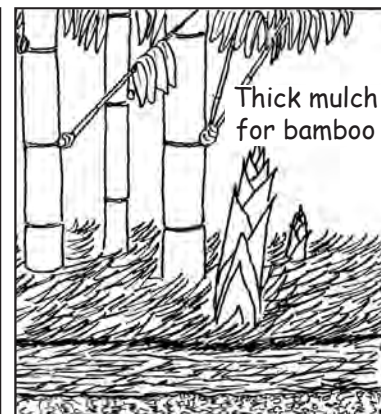
Most areas of East Timor have 4 or 5 different bamboos growing. There are at least 20 different species in East Timor.

By sharing and planting different species of bamboo in different areas, everyone can have access to a large range of good quality bamboos.

To grow high quality bamboo it is important to feed the plants when they are first planted. Compost or manures are best. Bamboo plants are heavy feeders. This means that they LOVE food. They also have root systems that grow close to the surface. Therefore it is best to feed bamboo small amounts regularly (every 3 – 6 months) rather than large amounts once a year. Make sure they are fertilized just before the wet season. Be very careful if you use urea. It is very strong and because bamboo roots are close to the surface large amounts of urea can kill them. The best manure to use for bamboo is pig manure; it has the most complete nutrients for bamboo and helps it to grow much faster.

It is also very important to mulch the plants. Bamboo grows best with at least 30cm of mulch. When the plants are 2 years old you can put a thin sprinkle (1 small shovel full) of cement powder around the clump (put this under the mulch). Cement contains silica, the mineral that makes bamboo hard, and it will help to improve pole quality.

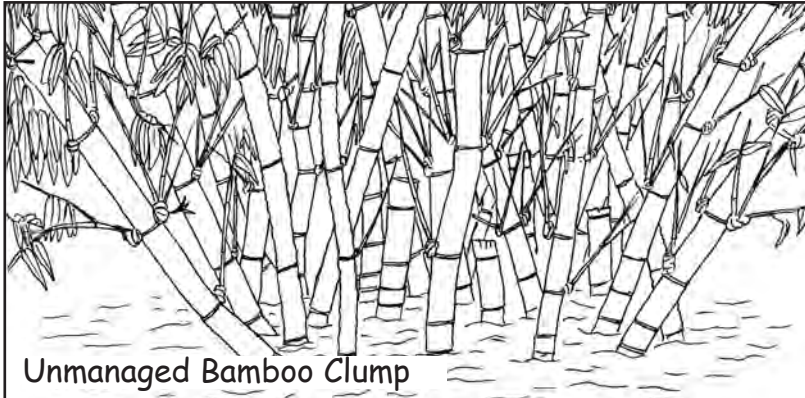
Tests done on bamboo show that the timber is stronger if it is grown on hillsides rather than near the river.



Clump Management

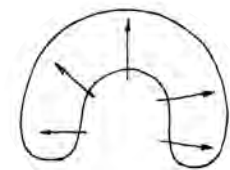
A properly managed clump of bamboo will produce high quality timber and harvest will be quicker and easier.

A managed clump will look open and healthy and will have a range of culms from shoots through to those ready to harvest. An unmanaged clump will be tightly packed, often with dead or dying culms in the middle. It will be difficult to harvest.



The first step in managing a clump is to remove all dead or old culms.

This is often difficult because these will be in the middle of the clump. One way to do this is to cut into one side of the clump to the middle, and then cut out the old culms. Cut them as close to the ground as possible.

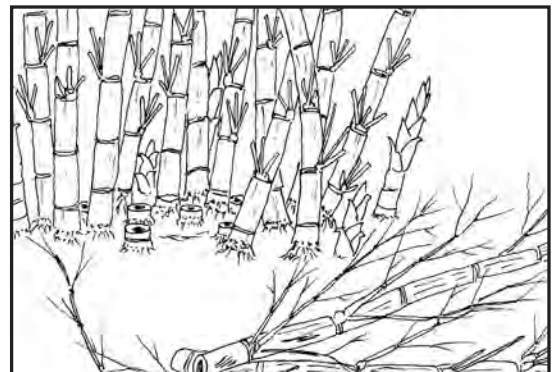


This will create a shape that allows us to harvest the mature culms from the center of the clump without damaging the new shoots that are usually on the outside of the clump.

Thinning

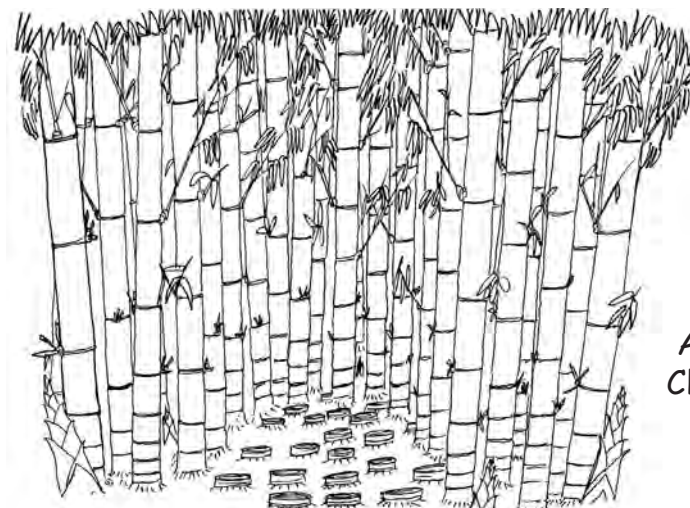


Once the old culms have been removed it is good to thin the clump. Take out any culms that are damaged, bent or too close to other culms. If the clump has been harvested before it will have a lot of culm stumps. Cut them at ground level to make access easier.



Branch pruning

By removing lower branches, management and access to the clump is improved. It is important to cut the branches at the second or third node on the branch so that fungus cannot get into the culm. Once the clump is thinned, tidied and branches pruned, it should have 3, 2 and 1 year old culms and new shoots. It is best to have 6 or 8 of each, making a total of 24 to 32 culms. They should be well spaced so that at harvest it is easy to cut.



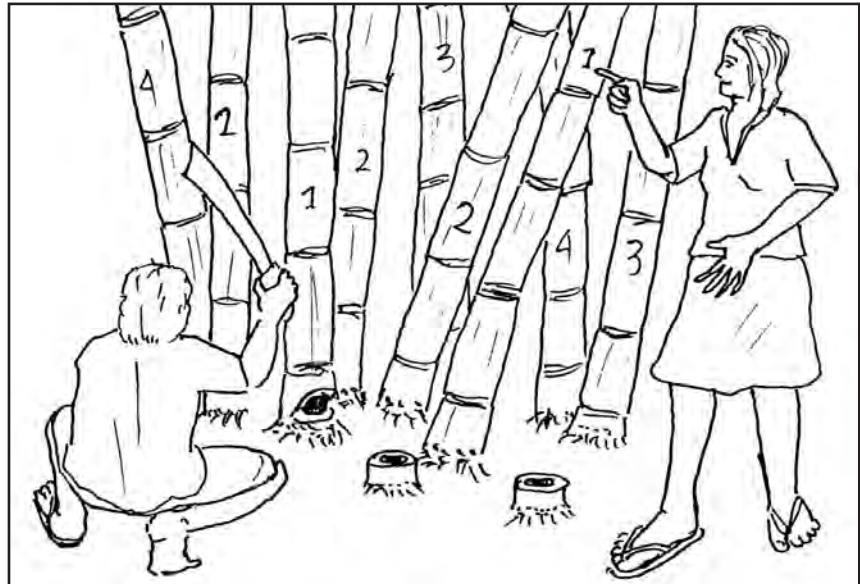
A Well Managed Clump of Bamboo

New Shoot cutting and marking

During the shoot season it is easy to maintain your clump. When the clump starts to grow new shoots, choose shoots that are healthy and in a good position and allow 6 or 8 of these to grow. Chop out all others. By cutting shoots you will stimulate the growth of other shoots so there will be plenty of shoots to choose from. The shoots you cut out can be used as food for people or animals.

It is a good idea to mark the shoots each year so that you know how old they are. This is because all culms (poles) should be 3 years old or more before they are harvested. The poles will be stronger, suffer less borer attack and last a lot longer! If you take a sharp knife or a nail and scratch the culm before it has any leaves, it will leave a permanent tattoo.

Mark all the shoots at the same height, about 1 metre above ground. The end of the wet season is a good time to mark the shoots with the year they have come up. For example, for the year 2004 mark the trees with a 4. They will be ready for harvest in 2007. So, in 2007 you will know that any culm with a 4 on it is definitely 3 years old.



Bamboo Plantations

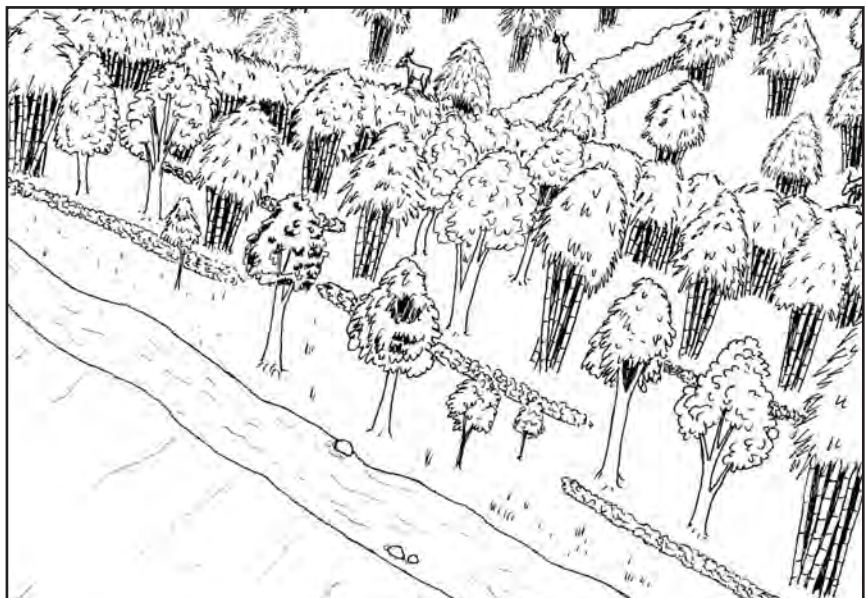
It can be difficult to manage clumps when they are in the forest growing wild. It is much easier when the bamboo is grown near to their house, or as part of a managed system.

A bamboo plantation is the most efficient way to produce high quality bamboo. A bamboo plantation will produce much more than just bamboo poles. It can also produce shoots for vegetables, leaves for animal food and bamboo charcoal. The bamboo can be planted so that it is a windbreak, fence or controls erosion.

Intensive plantations

An intensive bamboo plantation is one where bamboo is the main crop. It is best to plant bamboo in rows with 4 to 6 meters between the clumps and 8 to 10 meters between the rows. On sloped land plant the bamboo on contour. Leaving 8 to 10 meters between the rows means that you have plenty of room at harvest time to cut and collect the poles.

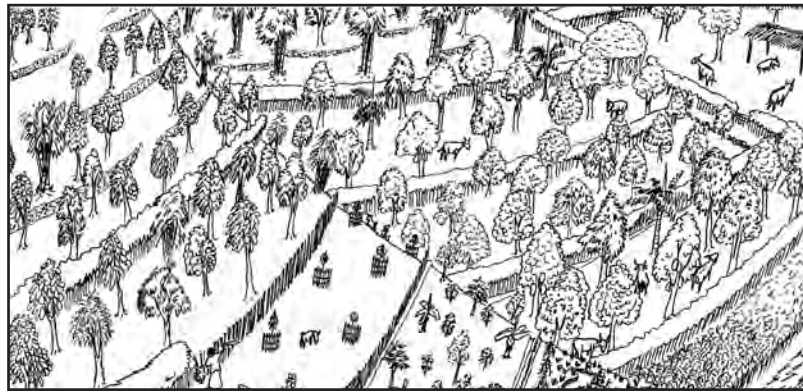
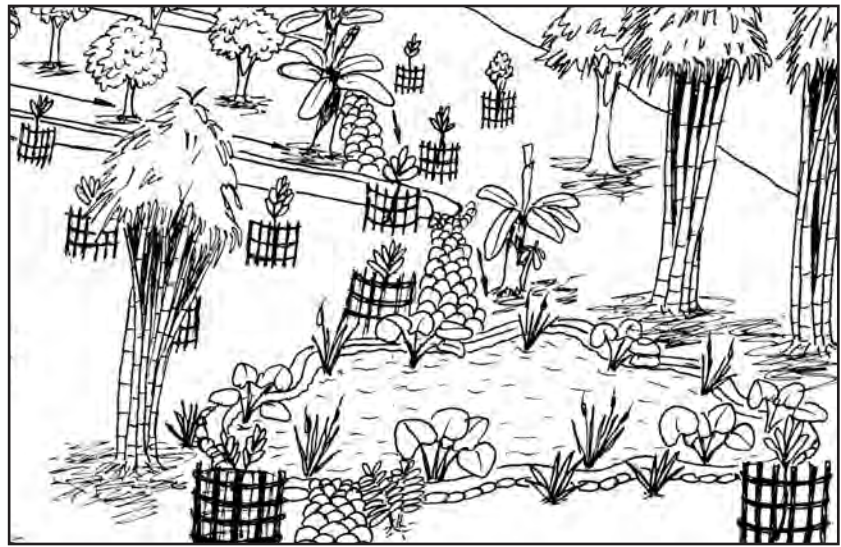
You can also graze animals between the rows.



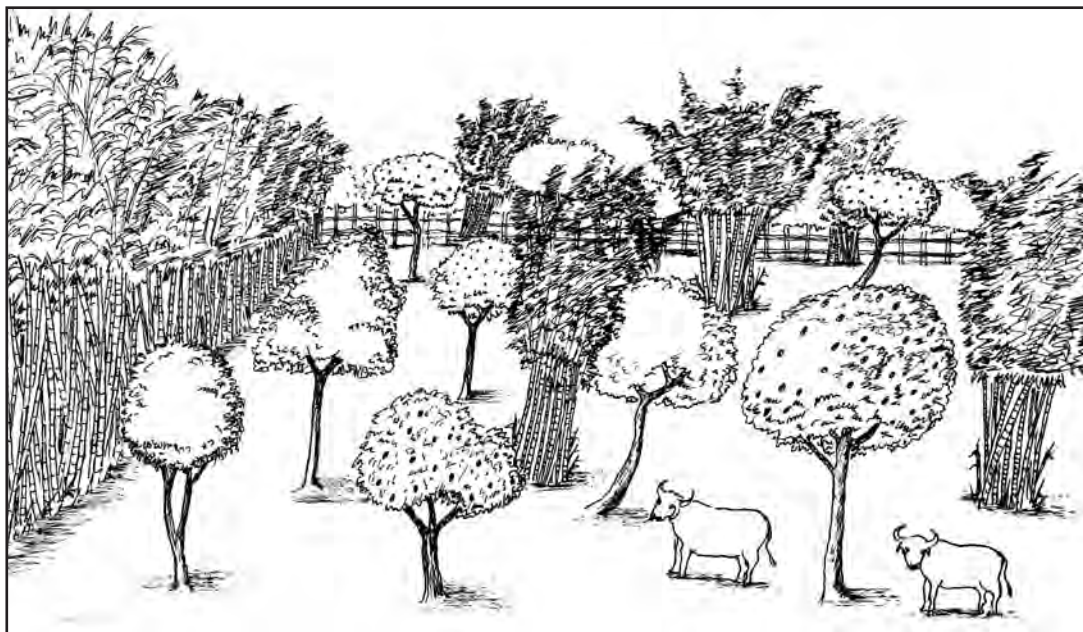
Mixed plantations

These are plantations where the bamboo is just one of many crops. For example:

- A coffee plantation with bamboo marking the boundary or as a windbreak.
- Rows of bamboo 20 to 25 metres apart with coffee or bananas, citrus, other fruit trees and even annual crops.
- Bamboos can be mixed with tree crops that are similar heights to the bamboos. E.g. mangos, coconuts, avocados, jackfruit, oil trees, timber trees, fibre trees and many more.
- Animals can be added to the system as well.
- A row of bamboo planted on the contour of a hill to prevent and catch any landslides or to stabilize the edge of a terrace.



The combinations of trees you grow together are up to you but remember to leave enough room for bamboo harvesting.



The production of high quality bamboo products must begin with the use of high quality bamboo poles.

What makes high quality bamboo poles?

1. The right species grown in the right conditions
2. Poles harvested at the right time
3. Poles harvested at the right age
4. Poles cured and stored well
5. Poles preserved against borer (Borer is the insect that lives in and eats the bamboo poles)

1. The right species

Some bamboos are naturally stronger and more resistant to borer than others.

In East Timor the best bamboos to grow and use are:

- Au betun
- Au betar
- Au betar laku
- Au betar fatuk
- Au fatuk
- Au metan
- Au fafulu bo'ot
- Au fafulu fatuk kinur
- Au fafulu fatuk metan
- Au fuik (from the south side of the Island)

There are more species of bamboo in East Timor that are yet to be identified.

Some bamboos that are not as strong and that the borer likes are:

- Au Dian
- Au kinur
- Au fafulu ki'ik
- Au laku bo'ot
- Au funan
- Au laku ki'ik
- Au laku bo'ot and Au laku ki'ik are very strong but borers love to eat it so it is worth using only if it is preserved

2. Age of Bamboo Poles

For harvestable poles the bamboo must be at least 3 years old. For some species 4 or 5 or even 6 years old is better.

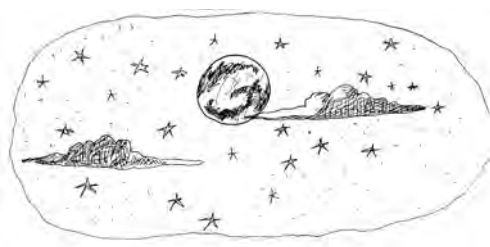
- Au fufulu is best cut at 3 years
- Au betun at 4 or 5

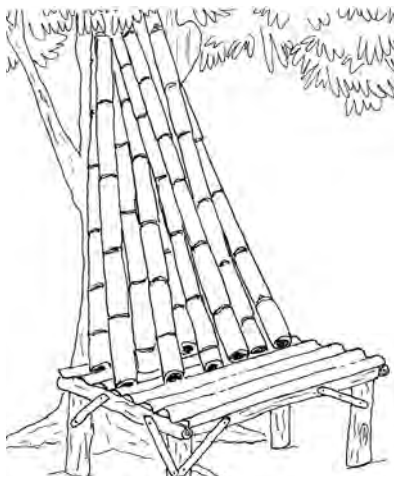
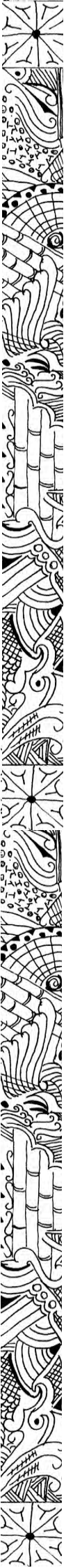
When bamboo poles are 1 or 2 years old they contain a lot of starch (compound sugar), which is soft and which borers love to eat. After 3 years the starch changes to silica (a mineral), which borers don't like and which makes bamboo poles hard.

Bamboo harvested at younger than 3 years will shrink and crack and have more borer. Bamboo that is harvested at 3 years old or older will last MANY YEARS longer, have fewer borers and will be stronger.

3. Harvest time

The best time to harvest is during the dry season. The very best time is when the new shoots are almost at their maximum height and are just beginning to develop branches and leaves at the top. At this time the bamboo is strongest. Many communities in East Timor only harvest on the full moon. This is a common practice throughout Asia. This is to help to prevent borer in the bamboo poles. The poles also have less moisture at full moon, which is good for quality.



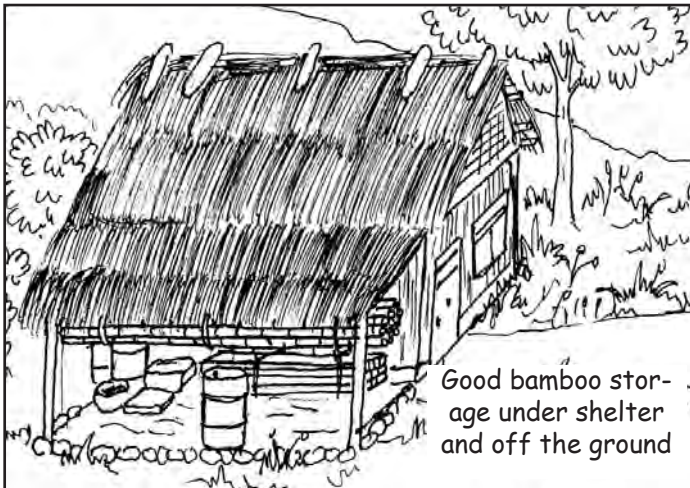


4. Curing and Storage

This is very important. Bamboo that is cured and stored well will be stronger and last a lot longer. Bamboo will take 4 to 6 weeks to dry ready for working. If it is stored vertically it will be 4 weeks, horizontally it will take 8 weeks. It must be cured and stored in the shade, off the ground and out of the rain.

5. Preservation of Poles

Borer (fuhuk) and fungus are the biggest problems with bamboo. You need to preserve the bamboo so that it will not be attacked. It is important to understand how the borer works. Borers are small flying beetles that lay their eggs on any part of the bamboo where the skin has been damaged. This is at the cut ends, where the branches have been removed and where the skin has been scratched. The eggs will hatch at different times and the borer will eat the starch (compound sugar) in the bamboo. Therefore a lot of borer attack can be prevented by good management and by not scratching or damaging the poles.



Good bamboo storage under shelter and off the ground

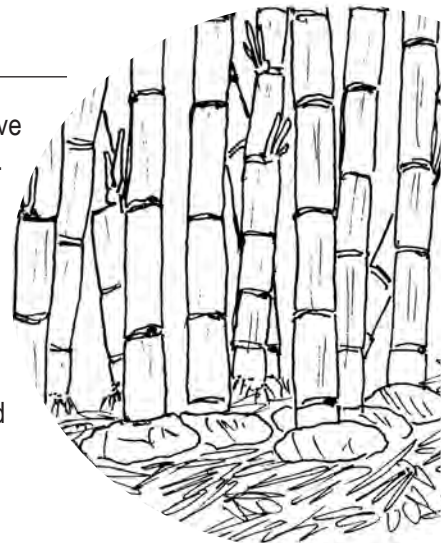
The first step in the preservation of bamboo is to reduce the amount of starch in the bamboo. This is why you should harvest only in the dry season and only 3 year old, or older culms. The amount of starch in the bamboo is lowest in the dry season and in the older culms. The next step is to reduce the starch content even further. This can be done in many different ways.

Clump curing

The poles can be cut and left in the clump for 4 to 6 weeks until the leaves have fallen. The pole (culm) needs to be lifted onto a rock to keep it off the ground. The leaves will use up a lot of the starch and the pole will dry slowly without any areas for the borer to lay their eggs.

Water Treatment

The culms can be laid in fresh running water for 2 to 3 weeks. The water will destroy most of the starch. After the water treatment the culms must be dried slowly in the shade. If they are left in the sun they will crack.



Seawater treatment

A common way to treat bamboo is to use seawater.

One method is to put the bamboo in the ocean. Tie it down very securely with rocks so that it doesn't float or move with the tides.

Don't let the bamboo be exposed at low tides or it will crack. Another, perhaps easier method is to dig out a soakage pit on land near the ocean.

The pit will naturally fill with sea water as you dig down below sea level. For both methods, leave the bamboo for 2 weeks. Then leave to dry, off the ground in a shady place.



Whoops! Forgot to preserve the bamboo!

Tuha Treatment

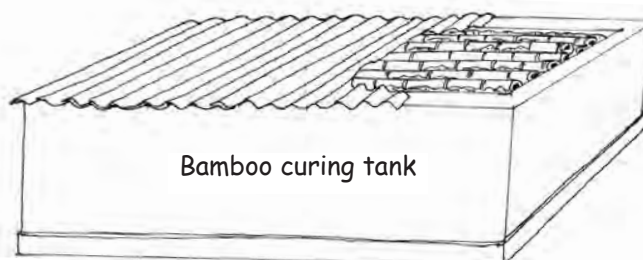
In East Timor there is a plant you can use called Tuha. Tuha is poisonous to people and animals and so it must be used with care. To use the tuha, make a solution of 1 bucket of tuha to 200 litres of water.

You can use a drum or a tank for treating bamboo.

Short pieces of bamboo can be cured in a drum. Poles of bamboo that have just been cut can be placed in a drum with the leaves still on. The liquid in the drum will be drawn up through the pole to the leaves. As this happens the pole will be treated by the tuha.

Add more tuha liquid to the drum as is needed, and leave for 1 week. Then remove the leaves and dry the poles in the shade and off the ground.

A tank can be above ground or in the ground, but it must have a cover to stop rain getting in and to stop children or animals getting in. The bamboo needs to be cut to length and to have the branches removed. Place the poles in the tank for 4 to 6 weeks. Then it is dried in the shade and is ready for use. If you use the water treatment first, then the tuha treatment will only take 2 weeks.



Borax treatment

Bamboo can also be treated with Borax. It is a chemical that will kill the borers and their eggs. Borax is best to use for treating large amounts of bamboo quickly and especially for exporting bamboo. Most countries will not import bamboo that hasn't been treated with borax or another chemical. The bamboo is put into a water and borax solution for 2 weeks and then dried in the shade and off of the ground.

Careful: Borax is a strong chemical. Proper protective clothing must be worn. People must wash thoroughly after working with the borax solution. The borax solution must be disposed properly.

If it is diluted with water it can be put around fruit trees. Spread it as widely as possible. It has mild pesticide and herbicide properties, and also is a trace element. If it is diluted to .1% (1part borax to 1000 parts water) it can be put onto vegetable gardens. Don't dispose of it into a river or drain.

Oil and Varnish

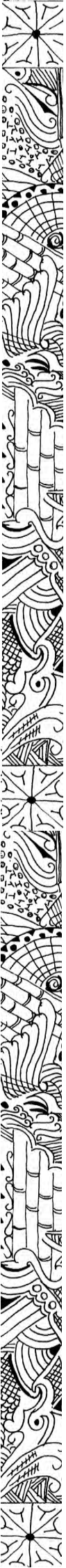
Once a piece of furniture or craft item has been finished, it can be oiled or varnished. This will prevent fungus and rot and extend the life of the product.

It will also increase the value of the product.

To produce high quality bamboo for building or craft products the best way is to:

1. Harvest the year's supply of poles in the dry season. (Only 3-year or older culms.)
2. Use clump curing or the water treatment.
3. Use the tuha or borax treatment.
4. Dry the culms vertically in the shade and off the ground.
5. Store them off the ground, under a roof.
6. Inspect them regularly and remove and burn any that have borer.

This way you will have a wonderful supply of high quality bamboo to use throughout the year to make beautiful, long lasting buildings and products.



Using Bamboo

Building materials

Bamboo can be used to make houses, walls, floors, roofs, animal houses and much more. It is strong, lightweight and easy to use. Bamboo is also very decorative and can be used to make a house more beautiful. For specific techniques, look in the reference section of this manual for groups, books and websites.

Furniture building materials

Bamboo furniture is beautiful and long lasting if treated bamboo is used. It can be a good way to make money. Chairs, tables, beds, wall panels, shelves and much more can be made from bamboo. To learn and build furniture requires training, some tools and imagination. Look in the reference section for more information.

Food

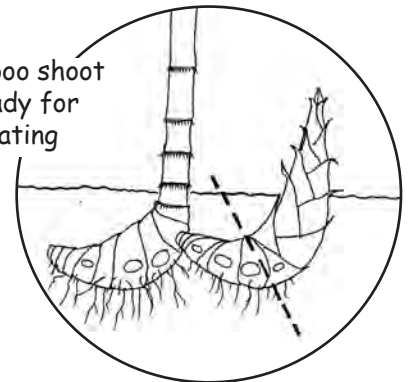
Food For people

Bamboo is highly nutritious food that can be cooked in many ways. It is eaten a lot in China, Japan, Thailand, Indonesia and many other Asian countries. Some types of bamboo produce shoots that can be eaten and some don't.

The types of bamboo in East Timor that can be eaten are:

- Au betun – a very good tasting bamboo.
- Au betar
- Au betar laku
- Au betar fatuk – these are more bitter but can still be eaten and still taste good if cooked well.

Bamboo shoot ready for eating

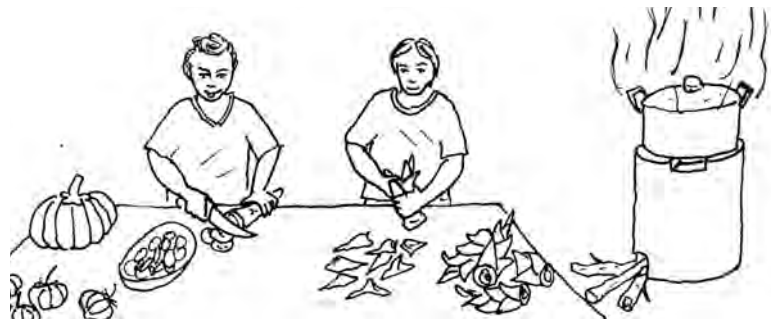


What part to eat?

In the wet season, new bamboo shoots grow, generally at the outer edge of the clump. When the tip of the shoot starts breaking through the ground surface, cut the new shoot from the old roots where the shoot becomes hard. If the shoot is any older than this it will be too tough and bitter to eat.

How to eat the shoots

Bamboo shoots need to be eaten fresh within 2 –3 days of harvest. Wash the shoots and peel or cut off the outer leaves until you have just the white flesh. Cut the shoots into thin slices or cubes.



1. Boil the shoots in water with a little bit of salt for 10 to 20 minutes. If the bamboo shoots are too bitter, rinse the water and cook again for the same amount of time. Rice can be cooked with the bamboo shoots and will help to reduce the bitter taste.
2. Some bamboo shoots can be cut up and the fried in a little oil with garlic and red onions.
3. The bamboo shoots can be fried up with mixed vegetables and take about the same amount of time as carrots to cook.
4. There are many other ways to cook them too, just use your imagination!

Bamboo shoots can also be pickled, dried or fermented to last longer.



SMART IDEA:

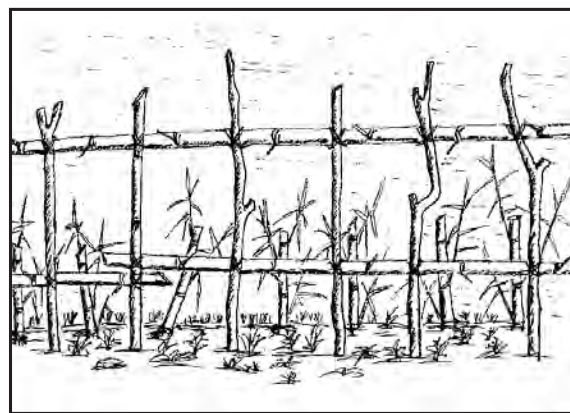
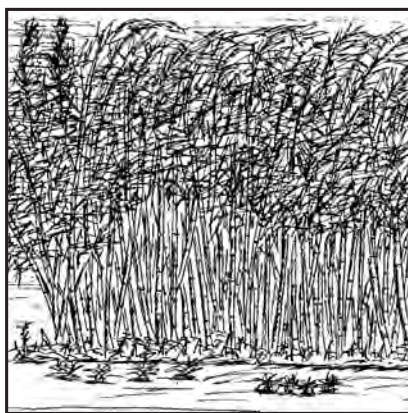
Don't start harvesting shoots to eat until the bamboo plant is at least 3 years old. Before this time cutting shoots will damage the root system and slow growth.

Food For animals

Bamboo shoots also make excellent animal food, especially for pigs. Cut the shoots the same way as for people and cook it together with the other food for the animals – cassava, sweet potato, yams, leaves and so on. Bamboo leaves and stalks are also high quality animal food, particularly for goats and cows who benefit from the silica content, which improves milk production and breeding.

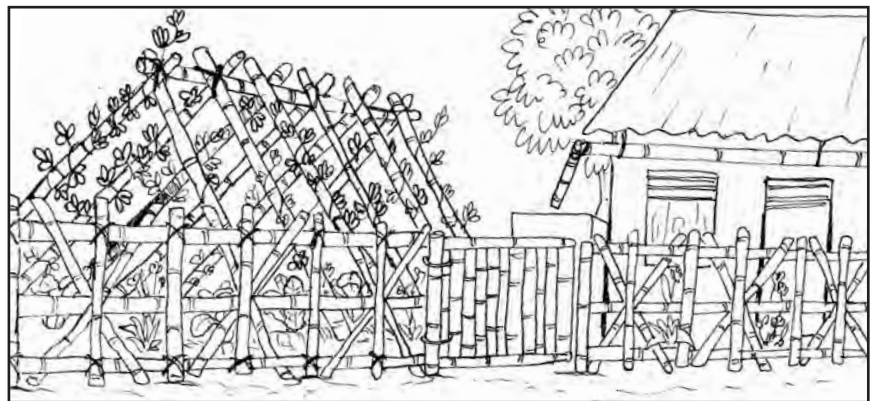
Living fences

Bamboo plants make an excellent living fence. It will take a few years to become thick enough so a temporary fence needs to be built. Bamboo living fences are excellent for animal yards including chickens, ducks, cows, buffalo and pigs. They provide shade, some food and reduce wind. They can be used around orchards as part of an animal/orchard system. They are not good to plant close to vegetable crops because they will take water and nutrient and may give too much shade.



Trellising

Trellising is important for increasing the amount of produce from the garden. Bamboo poles are easy to use for trellising because they are light and easy to move. They can be used to make any shape you want and can be very decorative as well, adding beauty to your garden.



Fencing materials

Bamboo poles are used a lot for fences. It is best to cut up and use them as cross support, not as posts as they will rot quickly in the ground.

Windbreaks

Bamboo plants can be part of a large windbreak. The bamboo will eventually make a fence as well if they are planted close together. Bamboo clumps can be used as a small windbreak to protect a house. Read the windbreak section (CH 9) for how to make a windbreak.





Irrigation pipes

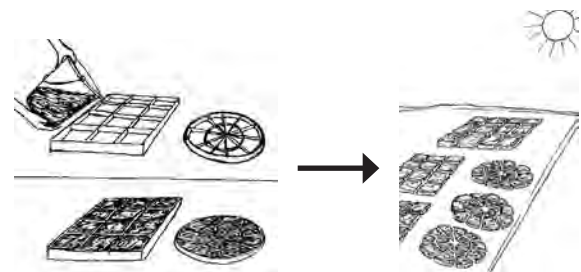
There is many ways to use bamboo for irrigation.

1. It can be split in half and used to run water from one place to another. This is very common and a great way to reduce to heavy job of carrying water.
2. It can be cut into .5 to 1 metre long sections and dug into the ground to water fruit trees and vegetables. Put holes in the inner nodes to let the water through. This technique saves a lot of water and improves growth.
3. Flat irrigation using long poles can be used for vegetables. This technique saves water and makes watering much easier. Read in the Home and Market Gardens Chapter (**CH 5**) for how to make it.



Bamboo charcoal for cooking

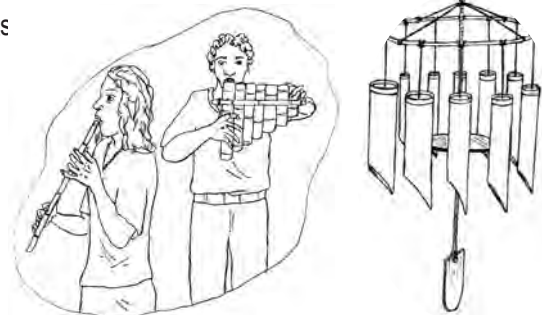
Charcoal Bricks can be made to use for cooking instead of wood. It is a mix of burnt bamboo pieces – charcoal – and a small amount of arrowroot powder and water. Much easier than collecting firewood! The dry bricks burn well and don't produce much smoke. Read in the Alternative Technology Chapter (**CH 14**) for how to make them.



Musical instruments

Bamboo can be used to make many different musical instruments

- Flutes
- Pipes
- Wind chimes
- Shakers



Cooking containers

Bamboo pole sections are traditionally used for cooking meats and soups.

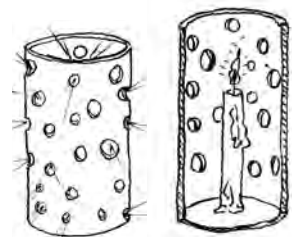
Storage containers

Bamboo poles can be cut into sections used to make storage containers for seeds, food, jewellery, pens, pencils, knives, forks, spoons, hair ties, money, sewing goods, lighters and much more.

Open containers can even be used for dried flowers or candle holders.

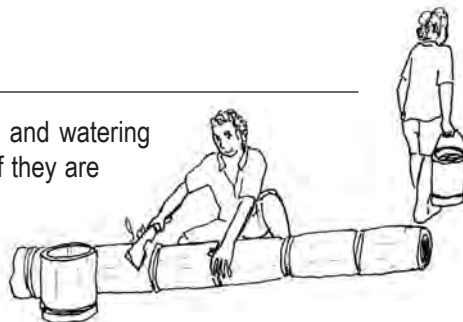
The containers can be carved, painted and decorated and make a good product to sell.

They will last much longer if the bamboo is treated and oiled. If the containers are used for seeds, including beans, corn or rice, the bamboo that is used **MUST** be treated to stop borers in the bamboo eating the seed. But don't use bamboo treated with tuha for storing food because the tuha is poisonous.



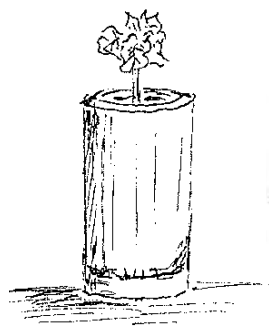
Bamboo buckets

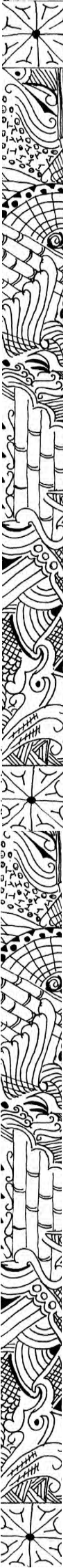
Large bamboo poles can easily be cut up and used to make buckets and watering containers. Wire handles can be attached. They will last much longer if they are oiled before use.



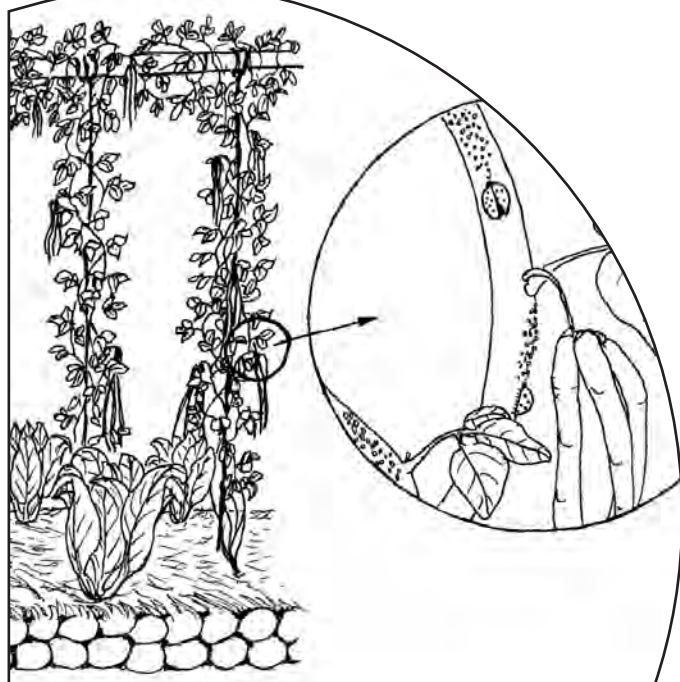
Plant containers

Large and small bamboo poles can be cut to make plant containers. Don't forget to put some small holes in the bottom to let the water drain out. Small poles can be cut into sections and used in nurseries for seedlings and young trees. Large poles can be cut into sections and used for flowers and plants around the house. Long sections of large poles can also be used.



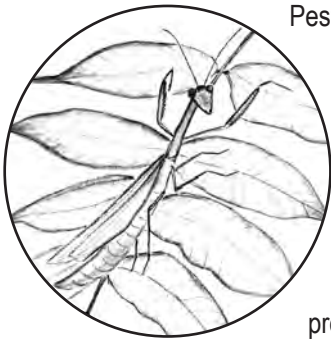


Integrated Pest Management I.P.M.



CHAPTER





Pest problems occur because a system is not in balance.

Different reasons for pest problems:

- Fires, floods and land clearing.
- Using large areas of land for only one crop.
- The introduction of a pest to an area.
- Destruction of pest predators because of using general pesticides and removing pest predator habitats.

Long-term pest management solutions must aim to bring back a natural balance between croplands, gardens and the natural environment. This can sometimes take many years, so short-term solutions, like natural pesticides, may also need to be used.

Integrated Pest Management (I.P.M.) combines different natural techniques for pest management to:



- 1. Reduce the chances of pest problems happening.**
- 2. Reduce the size of the pest problem if it does happen.**
- 3. Use natural treatments for any problem that does happen.**

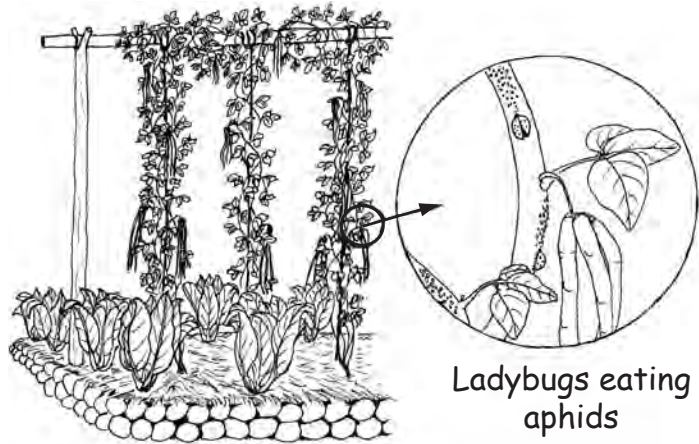


Every part of the environment is connected to every other part, including people. What happens to one part of a system or environment WILL affect every other part of the system or environment. This is an important philosophy behind I.P.M. and future sustainability.

We need to understand how different parts of a system work and how they can work together. (E.g. soil, insects, plants and trees, birds, animals, water, people, technology).

This will lead to:

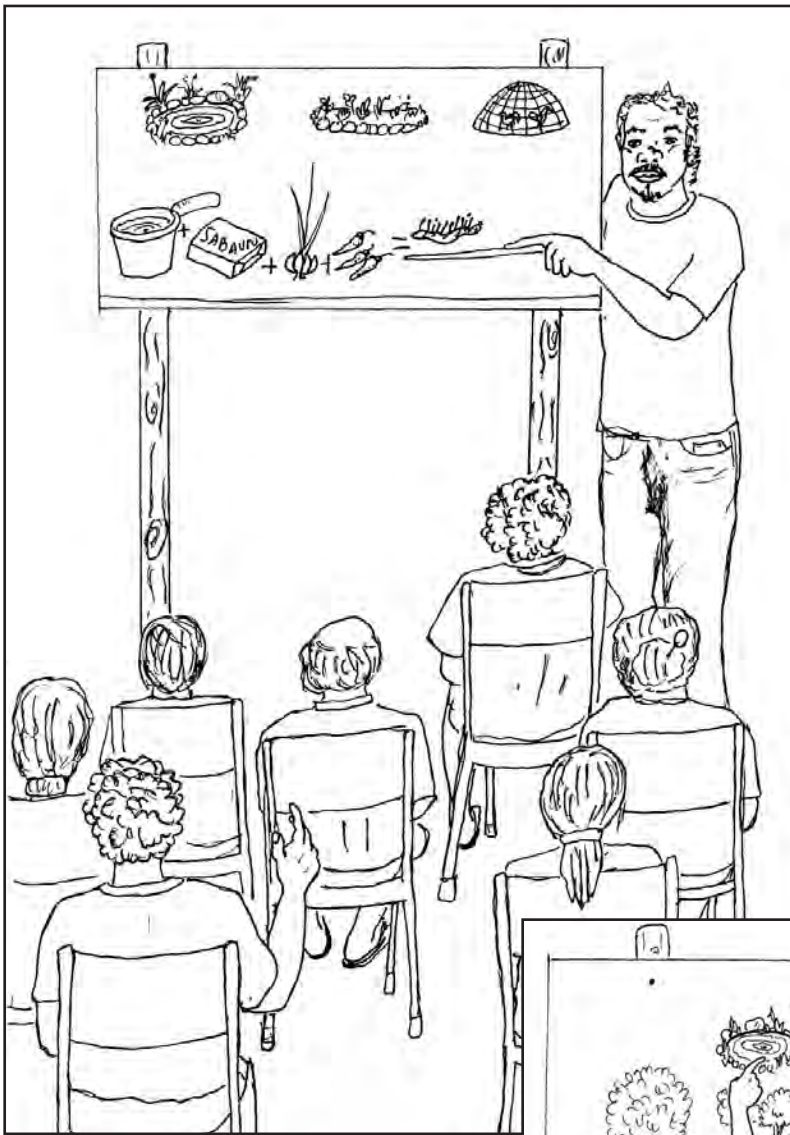
- Using less resources and less expensive products because the farm will maintain itself more and more. Also, the resources that are needed are mostly local resources.
- A continual improvement of the soil, plants and environment, not a gradual destruction.
- Increased overall productivity of the land.
- Increased diversity and resilience to pests, diseases and extreme weather.
- Improved health of people.



Ladybugs eating aphids

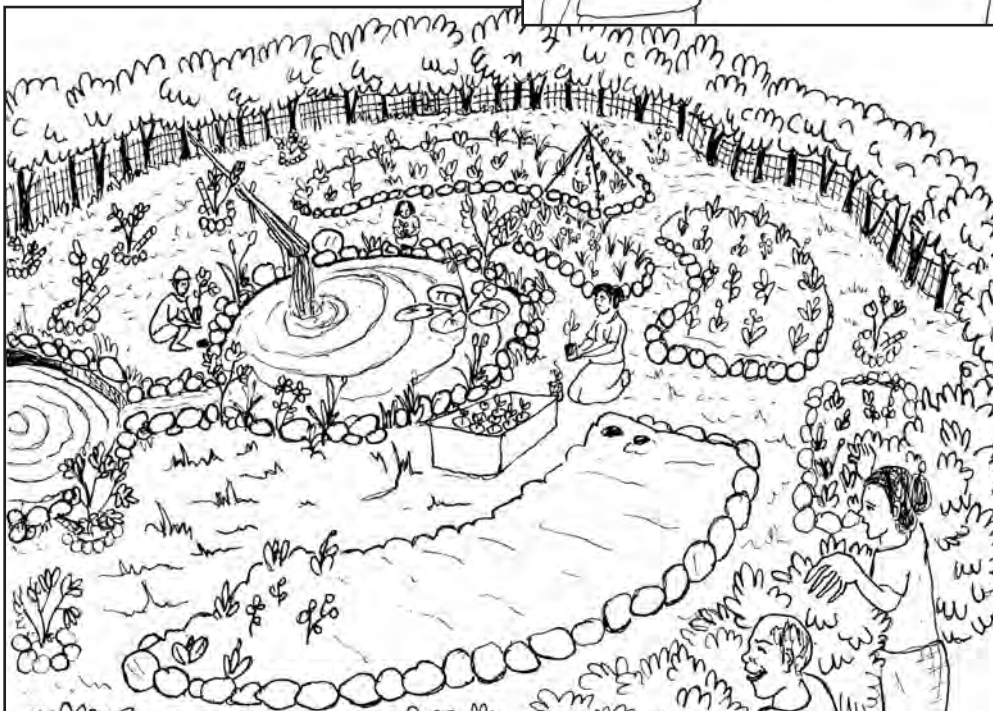
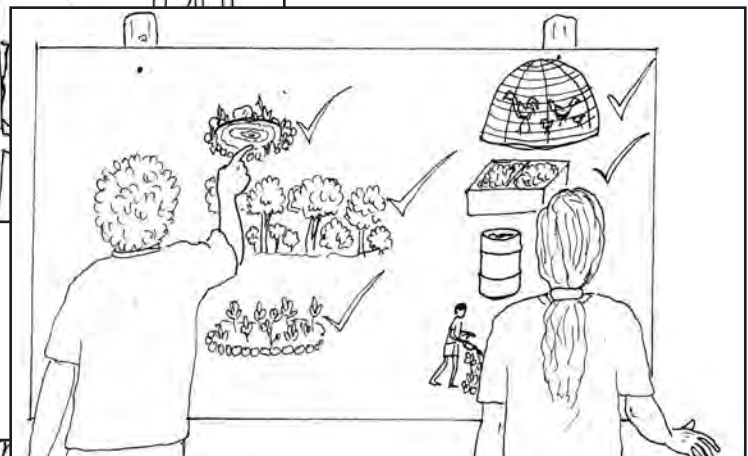


Integrated Pest Management applies to all sizes of agriculture from small home gardens to market gardens to large crops, rice production, fruit trees and all mixed systems as well.



1. Mery and Anselmo attend an I.P.M. workshop.

2. "I want to make a pond to increase our pest predators, and then we can have fish too"



3. "What are Mery and Anselmo doing?"

I.P.M. Techniques

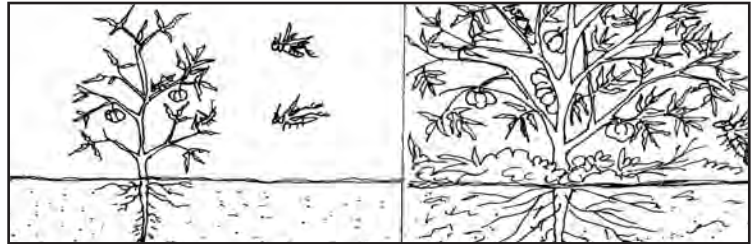


1. Importance of healthy, living soil

Healthy, living soil that contains all the different nutrients that plants need is THE MOST IMPORTANT I.P.M. TECHNIQUE for preventing pest and disease problems. If a person is healthy they will usually live longer, not get sick very often and get better faster when they are sick. They will be stronger, able to work more and produce healthier children. IT IS THE SAME FOR PLANTS!!!! The base for good health for plants and people is also the same.

- A balanced variety of nutrients and minerals. (good variety of food)
- Healthy, living, non-compacted, mulched soil to grow in. (comfortable house)
- Water, Sun and Healthy Environment

If a plant is healthy it will grow stronger and will be less likely to be attacked by pests and disease. If it is attacked it will suffer damage more slowly and recover more quickly.



The time and effort and money used to provide good plant food and soil will save a lot more time, effort and money from not having to control many pest problems later. With good, natural techniques the soil will improve each year, therefore healthier plants and less problems.



SMART IDEA:

- Too much fertilizer and water can make a plant grow too fast and become weak, making it more at risk to insect attack. Compost is good to use because it releases nutrients slowly into the soil.

2. Encouraging natural pest predators

In a healthy, balanced system most pests are kept under control by natural pest predators.

Each plant has pests that attack it, and each pest has predators that eat them.

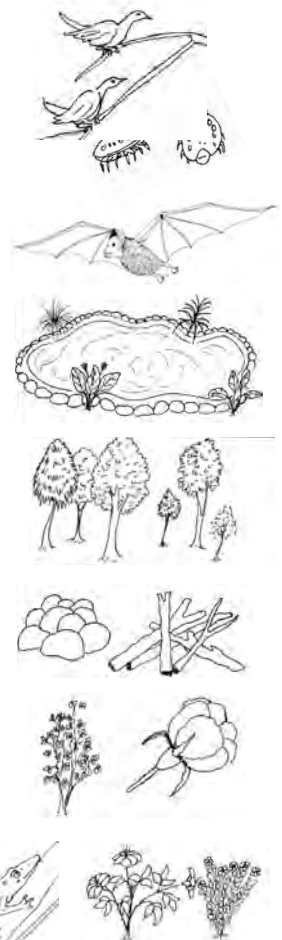
Birds, lizards, frogs, bats, dragonflies, wasps, spiders, praying mantis, ladybugs, ground beetles, lacewings and even some flies are effective natural pest predators that will do most of your pest control work for you. You just need to provide homes for them!

Homes and attractants for natural pest predators:

- **Ponds** – for birds, frogs, dragonflies, bees, wasps and fish. (Some fish eat mosquito larvae)
- **Trees** – for birds, bats, wasps, bees and spiders.
- **Rocks, rotting wood** – lizards, spiders.
- **Flowers, small trees, vines** – wasps, bees, spiders, ladybirds, praying mantis, beetles, lacewings.

It can take a few years to build up a good natural pest predator population. Other pest control methods may need to be used while this happens.

Beware: chemical pesticides and some natural pesticides will also kill pest predators and other beneficial insects. They will damage or even destroy beneficial insect populations. Use them very carefully, only when necessary, and only after trying all other methods.



Pest predators' homes

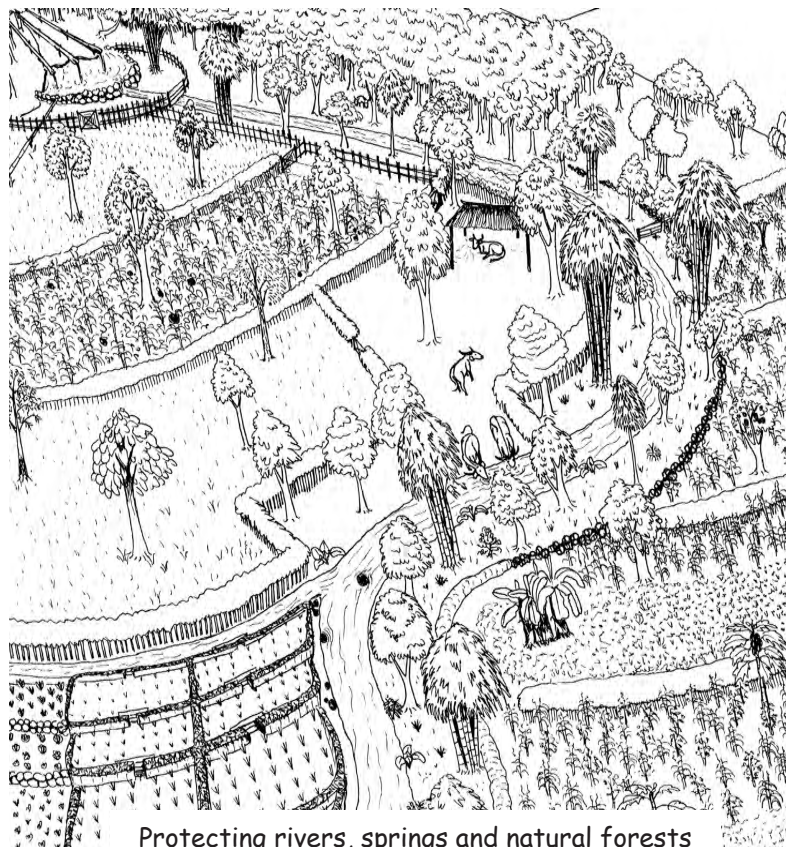
3. Healthy Environment

If the land surrounding the agricultural land is healthy and diverse then the chances of large pest problems are greatly reduced.

It is an essential part of keeping the system in balance.

This includes rivers, forests, steep sloped land, house area, etc. Protecting water sources, stopping burning and preventing erosion are important steps towards achieving a healthy environment.

The result is that all other IPM techniques are enhanced, especially living soil, and providing pest predator habitats.



Protecting rivers, springs and natural forests

4. Use non-hybrid, open pollinated seeds

Saving, using and improving good quality local seed is very important. It will increase the natural pest and disease resistance of the plants. Non-hybrid, open pollinated seed should always be used because the type of seed will stay the same and the quality will improve when good seed saving techniques are used. Look in seed saving chapter for more explanation.

By saving some seed from the BEST plants of each crop the plants will become more used to the local climate, soils and conditions.

Observe the plants that are most disease and pest resistant.

On a family or community level, observe which crop is the best, most disease and pest resistant and choose the seeds from those plants. Some compensation could be given to the grower or you could swap the seed for produce.



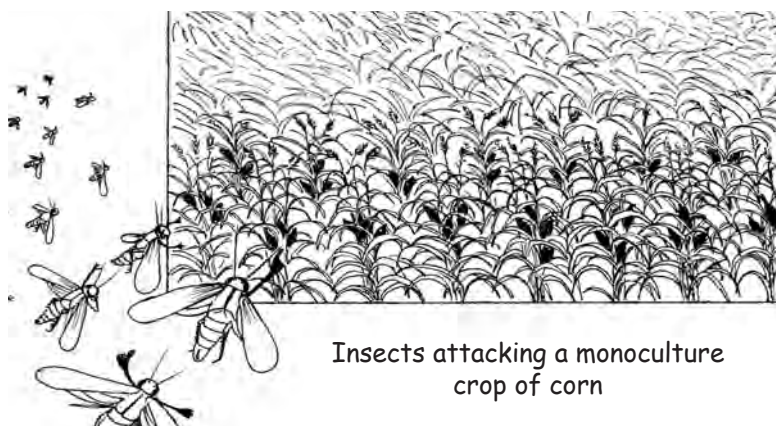
And importantly ask why the crop did so well. Good soil, pest predators, use of compost, amount of water and sunlight, etc. The idea is to breed better crops each year by collecting the best seed. They will therefore grow better and be more resistant to pests and diseases.



5. Good crop management

Planting many crops together, crop rotation and natural patterns.

If a farmer plants many croplands with only one crop, there is more of a chance that pests or disease will come, and in larger numbers. When pests or disease attack in large numbers they are hard and expensive to control, and can cause great damage. This can happen with large single crops because it is easy for the pest or disease to spread from one plant to the next plant. Also, because there are large amounts of food, the pest numbers can build up very quickly.



Insects attacking a monoculture crop of corn

When large areas are planted with one plant there is usually not the number of pest predators needed to naturally control a pest attack.

It is much better to combine different plants together, in rows, sections or planted together. This will slow down pests spreading from plant to plant, and help to reduce the number of pests. Problems are therefore much easier to treat.

For example: rows of corn provide a physical barrier to protect plants grown between them. Small legume trees are especially useful. Look in home and market gardens, tree crops and large-scale agriculture chapters for many examples and ideas. Or use your own. Market gardens and home gardens are also affected in the same way, and problems can be reduced using the same techniques.

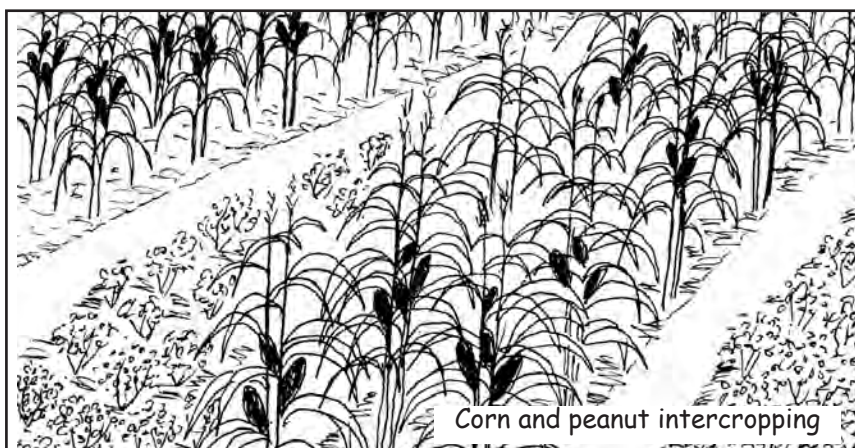


Good mixed cropping

Crop rotation is very important for reducing disease and pest problems. Some pests and diseases live in the soil and will cause a lot of damage if the same type of crop is grown on the same land over and over again. Changing crops will allow diseases and pests to die out before the plant that they attack is replanted in that soil.

An Example is brassicas (cabbage, cauliflower, broccoli, etc). A fungus that attacks their roots lives in most soils and can cause big problems if the plants are grown in the same place every year. This is because the fungus grows on the roots and increases in number every year. By rotating the crops, the fungus has nothing to eat and the numbers die back. Therefore the problem stays at a minimum.

Using Natural patterns instead of straight lines makes it easier to attract pest predators. They provide more edges and more diversity, and make it harder for pests to go from plant to plant.



Corn and peanut intercropping

6. Companion planting techniques

Some plants grow very well together. Sometimes though, plants do not grow well together and can slow growth and reduce production. This happens in small gardens, with vegetables, fruit and also in forests and tree crops. Knowledge about plant companions can help to improve growth and natural pest and disease control, and allow more production from your land. Some examples are given in Chapter 5, Home And Market Gardens.

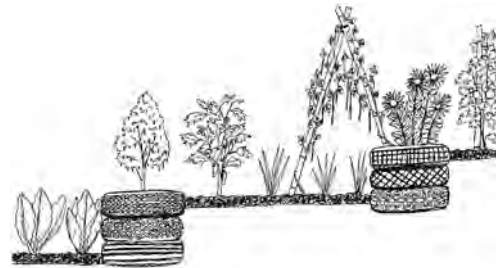
Reasons and examples for companion planting

Repel insects - Plants and flowers that have strong smelling leaves or flowers will confuse and repel pest insects that use smell to find the plants that they want to eat. E.g. garlic, marigolds, daisies, ginger.

Attract predator insects and animals - Flowers help to attract predators to the garden. They are good to plant around vegetables, crops and even fruit trees. They also look beautiful! E.g. roses, dill, hibiscus, marigolds, legume shrubs...

Slow pests spreading - Planting different crops together will slow pests spreading and reduce pest numbers. This is the same for small gardens, large crops and trees.

Root growth - Different types of plants have different types of root growth. Knowledge of different root types will allow plants and trees to be grown closer together. Symbol examples of trees and vegetables with different root growth. Some plants give out substances from their roots that make it hard for other plants to grow near them. E.g. Eucalypt trees.



Different root sizes

Marigolds help to repel nematodes, which live in the soil and can damage plant roots. There is a lot of traditional knowledge in East Timor about plants that grow well together. This knowledge needs to be collected and shared so that it is not forgotten.

7. Preventative measures

Observation will prevent many pest problems before they start.

- Are the plants healthy and growing well?
- Are pests attacking the plants?
- What types of pests?



- Where do the pests come from?
- Are predators eating the pests?
- Are there homes for pest predators to live?

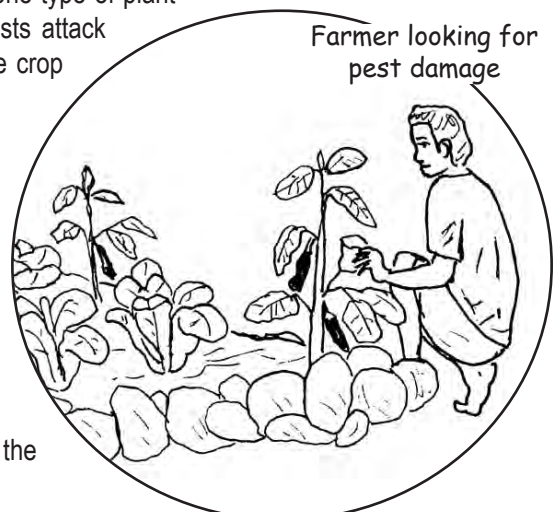
If pests and diseases are seen early then management is much easier. Look for all stages of insect life: eggs, worm/grub and adult. (E.g. moth, fruit fly) Identification of the pest or disease is very important. If you do not know it then collect a sample to give to people who can tell you – farmers group, government agriculture workers, NGO agriculture workers etc.

Each plant has specific pests that will attack it. Pests that attack one type of plant may not attack other plants nearby. This knowledge of which pests attack which plants can be used in many ways to prevent problems, like crop rotation, companion planting and crop integration.

Also, different methods and sprays control different pests.

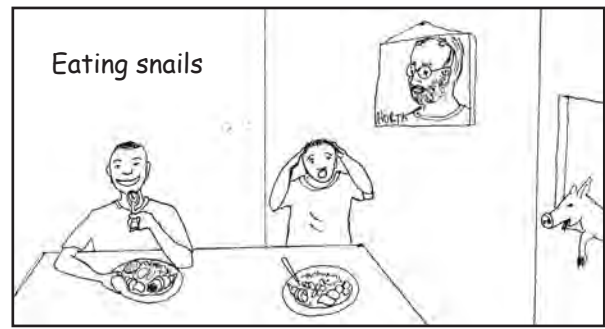
Using a specific control method or spray is much better than using a general spray that will kill many different insects. Where the pests come from is also very important. E.g. are the eggs in the ground? Do they get laid by flying insects? Etc This knowledge will help A LOT to find and use the correct control technique.

Women will have a lot of knowledge already as they do most of the weeding and maintenance, especially in home gardens.





Observation of pest problems and pest control can happen everyday during other garden chores. Children can be taught about the pest insects and good insects and about pest control. If a pest is observed, then removing pests by hand is often the most effective pest control, especially for home and market gardens. Pest insects can be collected and fed to chickens and ducks or killed in a bucket of water. Giant snails can be cooked to make excellent pig or chicken food. In many countries people also cook them and eat them!



Pest insects also like to eat weeds. Through observation you can find which weeds attract insect pests. These weeds can then be grown to attract the pests away from your crops. Once the weeds are infested they can be removed and fed to animals, put in liquid compost, or burnt.

Plant diseases and fungus

Trees suffering from fungus may be helped by pruning some branches to let in more sun and wind. Fungus needs moisture to grow. Sun and wind will help to keep the tree dry. Always remove dead wood from fruit trees to reduce chances of fungus and disease. Some vegetables can be trellised to reduce fungus risk.

If a disease is observed on a plant or tree, and doesn't respond to treatment, removing the diseased part and burning it will slow or stop the disease from spreading. Keep close observation on other trees or plants for signs of disease. If the disease continues then other solutions may need to be used.



Pest Control for seedlings

Many young seedlings are a favourite food of snails and slugs. E.g. cabbages, lettuce, green-leaf vegetables, eggplants. Ants can also damage seedlings and remove seed. By growing the seedlings in a nursery it is much easier to stop these pests from eating your seedlings. If you use tables in your nursery, place the legs of the tables in containers of water to stop pests from climbing up. A thick band of grease (hand width) on the table legs also works.

A ring of grease around tree trunks will stop pests from climbing up to eat the leaves or fruit.

This works for pests that lay their eggs in the soil each year, like fruit fly and some caterpillars and worms, and for ants, which can spread disease and other pests like aphids. Trees that will benefit include orange, mandarin, lime, pomelo, custard apples, soursop, mango and avocado.

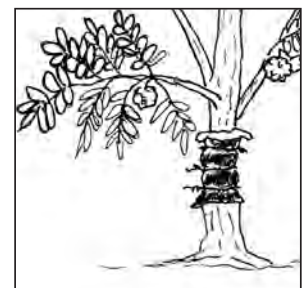


STEP 1: Place a band of material, thick plastic or tin foil around the tree trunk and tie it securely. 10cm wide is good. Make sure that insects can't get underneath.

STEP 2: Cover the band with grease. Fold the top over to make it waterproof.

STEP 3: Check every 2 weeks that the grease is still in place.

Beware: Do not put grease directly on the tree trunk, especially for young trees. The grease will damage them and may even kill them.



Black palm fruit in rice paddies will make rats itchy and will deter them from coming back.
Method - Cut 20 – 30 black palm fruit and put in the irrigation channel where the water enters the rice paddies.

When - Sunset

How often - 3 times a week when rice grain is ripening.

CAREFUL: Too much fruit is poisonous and could affect the health of people harvesting and eating the rice.



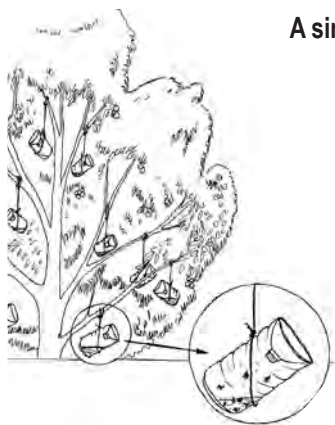
8. Making and using baits and traps

Baits and traps are a good way to prevent pest numbers from building up and causing damage to your crops and trees.



Baits for fruit fly

Fruit fly can damage and destroy many different types of fruit such as wax jambu, mango, guava, avocado, papaya, mandarin, oranges and many more.



A simple trap can be made using plastic water bottles.

1. Cut the end off the bottle and put it back in the bottle backwards.
2. Fill 1/4 of the bottle with liquid bait. This can be:
 - a. Vinegar, sugar and water mixture
 - b. Fermented fruit and water mixture
 - c. Water smelling of rotten fish or meat
 - d. Old beer
3. Hang from the affected trees with string, strong grass or wire. Ten bottles for each tree will minimize the fruit fly numbers.

Another method is to spray a weak neem mixture on the ground under the fruit trees. Spray once before the fruit starts to grow and then before it starts to ripen. This stops the fruit fly from changing from larvae (small worms) into flies. Read in natural pesticides later in this chapter for how to make a neem recipe.

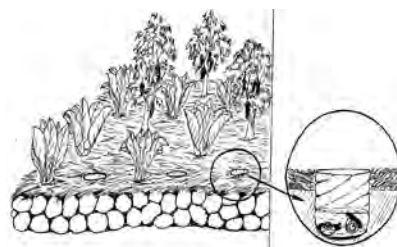


SMART IDEA:

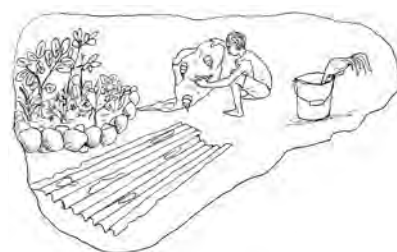
Fruit fly traps will work more successfully if neighbours also use traps.

Snail and Slug Traps

Snail traps can be placed around the vegetable growing areas to attract and kill snails. Simply place a bowl or container at ground level and half fill with liquid bait. The bait can be milk and water or beer. Small amounts of finely cut lettuce or cabbage can also be added. The snails and slugs will enter the trap and will get stuck in the water and not be able to leave. If you use beer the snails will be happy because they will die drunk!



Place pieces of old tin roofing or wet sacks on the ground near your vegetable plots. Snails and slugs like to live underneath and will be attracted to them. Check every few days. Fresh coffee waste (skins) or fresh sawdust placed on paths around the vegetable plots will help to prevent snails and slugs from entering. They don't like the rough surface.



Citrus skin traps

Citrus fruit includes jambua, orange, lemon and lime. Half skins with a little bit of fruit still left can be placed on the ground. They will attract pest insects, especially snails and slugs.

Hand Nets

Hand nets can be made to catch crickets and other flying and hopping insect pests. A simple frame of wood or bamboo with a net made from old fishing net or something similar works well. A fun game can be made for children to see who can catch the most insects, but be careful of damaging crops.

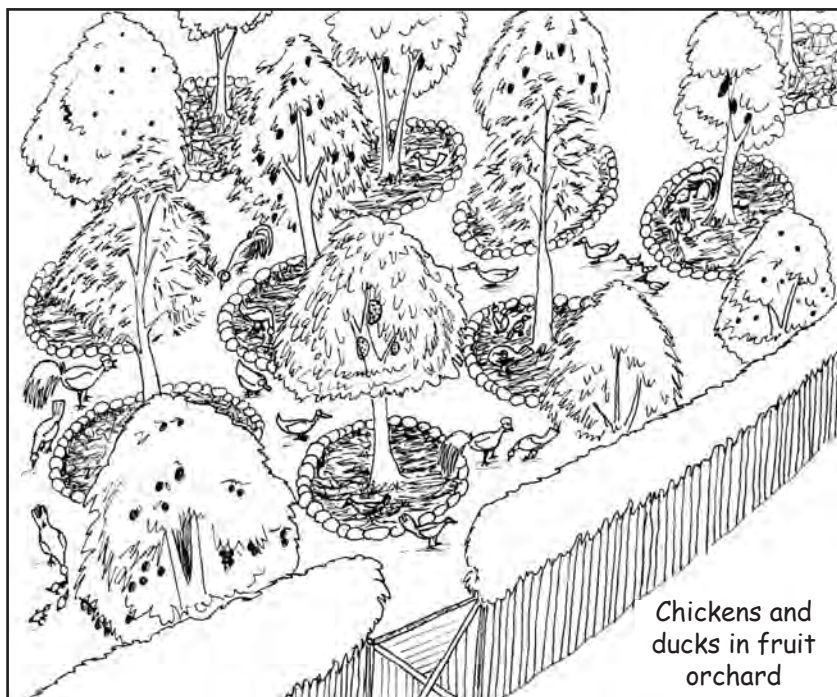


9. Use of animals in pest control

Chickens and ducks are very happy to do a lot of your pest control work for you!

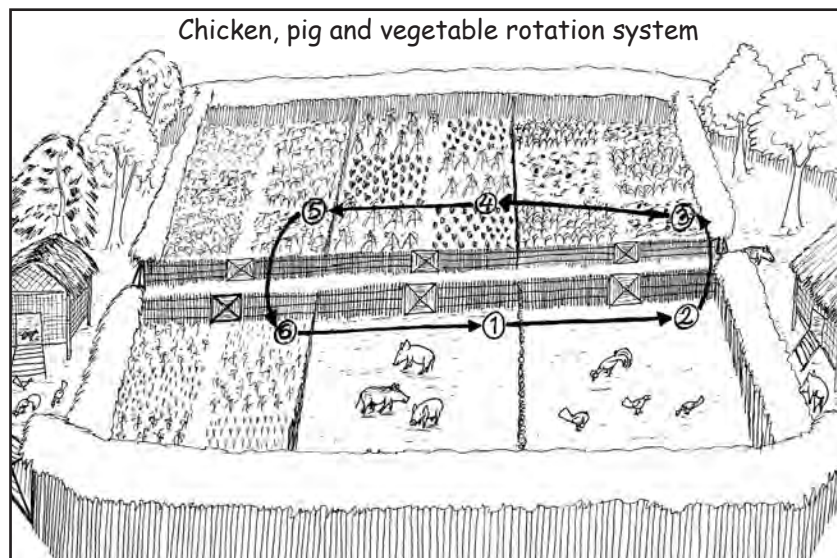
Techniques for animal pest control:

1. Part of a fruit tree crop system. If chickens or ducks are kept in one area they will clean under the trees and eat the larvae and insects on and in the ground that would damage the tree. Your pest problem therefore becomes animal food.



Chickens and ducks in fruit orchard

2. Part of a crop system. If chickens or ducks are kept on cropland after a crop has finished, they will eat many pests in the ground that would eat the next crops. E.g. snails, insect eggs and larvae. At the same time the animals are providing fertilizer for the next crops. This can be in a chicken or duck "tractor" or can be part of an animal/agriculture rotation system.



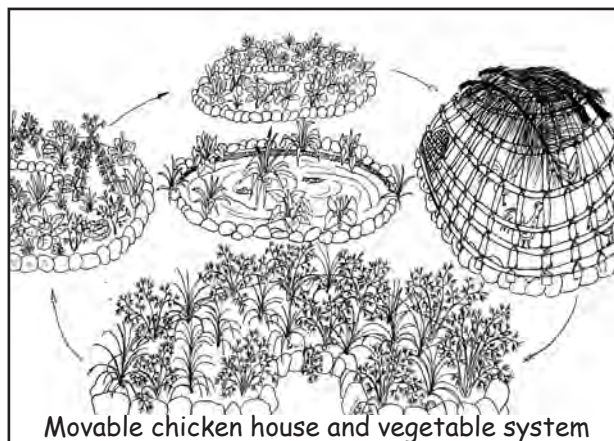
Chicken, pig and vegetable rotation system

3. Feeding insects to the animals. When pest infested plants are removed and fed to animals it provides food as well as reducing insect numbers.

Read the chicken and duck sections in the Animal Systems Chapter (CH 12) for more details on how to make and maintain animal systems.



Feeding insects to chickens



Movable chicken house and vegetable system

10. Making and using natural pesticides

Natural pesticides are a short-term solution to immediate problems.

They need to be part of a system of pest management and should be used only when necessary.

DO NOT use natural pesticides if there are no pests and no crop damage.

Even a small amount of crop damage is OK. Take time to observe if pest predators are eating the pests and if the pests are spreading quickly or slowly.

Some natural insecticides are very strong and will kill all insects, good and bad. Be careful because most insects will not harm your crops and killing them will create problems in the future.

How to apply natural pesticides

You can use traditional broom or a tree branch. These work but sometimes don't spread the natural pesticide evenly. Also there is more chance of getting the natural pesticide on your skin.



For home gardens and small pest problems a plastic hand sprayer can be used and are effective. An aqua bottle with small holes in the lid makes a very easy and cheap sprayer.

A hand made bamboo sprayer can be used and is explained later in this chapter.

The best way to spray is using a spray pack, but these are expensive and require maintenance. One could be bought by a group or as part of a community tool bank.

Bamboo sprayers, spray packs and plastic hand sprayers **MUST** be cleaned with water after every use.



Always wear long pants, long shirt, gloves, shoes and a cloth over your nose and mouth, especially for stronger natural pesticides.

Glasses are also good.

Some natural pesticides can cause skin problems and make you sick if you get too much on your skin or in your mouth, nose or eyes.

Natural pesticides

SMART IDEAS FOR ALL NATURAL INSECTICIDES & FUNGICIDES:



- Stop using at least 2 weeks before harvest. **VERY IMPORTANT.** This will prevent food from containing pesticides that can also make people sick.
- Rotate sprays to stop the insects becoming resistant to one type of insecticide.
- Some will work better than others. Experiment for yourself.
- Only spray early morning or late afternoon to prevent burning from the hot sun.
- In the wet season try to spray at least 3 hours before any rain so that the spray can work properly.



Hand Picking

Hands are an excellent natural insecticide! Many pest problems can be controlled by continual observation and hand removal of pests.

Insect sprays (Biological spray)

Insect sprays are a simple and effective pest control.

Take a handful of the insect pests that are eating your plants, crush them and mix them in a small bucket of water.

Leave for 2 days.

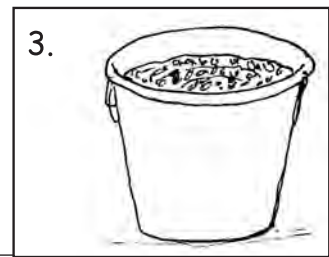
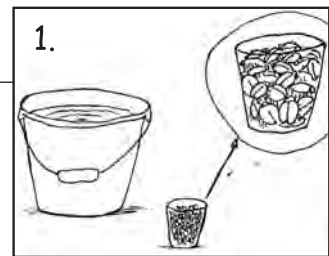
Strain the liquid and spray the affected crops.

Pests that are the same as the pests in the spray will be repelled.

The remaining insect bodies can be put in containers and placed around the crops.

The smell will continue to repel the pests.

This spray is effective for worms, caterpillars, slugs, snails and various bugs but less effective for grasshoppers.



Traditional East Timorese Sprays

Information and techniques provided by Gaspar Xavier from Legumao Organization in Luro, Halarae Foundation, Xisto Martins and USC East Timor.

Plants that can be used:

- Gadung – use the leaves
- Ai Riti – leaves
- Al kalik – leaves
- Mindi – leaves
- Laos – tuber
- Ai hanek – leaves
- Tuha – root and bark
- Suren – leaves
- Siri – leaves
- Sirsak – leaves
- Kenikar – leaves
- Sumer – leaves
- Kuankout – root
- Maek – root
- Babotek – leaves
- Urine
- Tobacco – leaves



Method:

1. Collect as many plants as possible.
2. Crush 1 large handful of dry leaves if using leaves or grate 1 small handful of root.
3. Mix in a large bucket of water.
4. Leave for 1 day and 1 night.
5. Mix 3 water caps of pesticide for each spray pack of water. Be careful because it is very strong.



ALWAYS wear gloves and face protection when making the natural pesticides and when spraying them. Many of the leaves and plants can cause skin problems and many are poisonous and will cause sickness from prolonged direct contact. These sprays can be used on rice, corn and vegetables. They are mostly used to stop worms and caterpillars. Use only when worms and caterpillars are causing problems with the crops.



SMART IDEAS:

- It is wise to change the type of natural insecticide that you use each time. Try different combinations to find out what works best. But only use them when you have to.
- Only use the Tuha root in the spray if the insects are a big problem and other sprays haven't worked. Tuha is very strong and will also kill many beneficial insects.

Each community has their own knowledge of medicine and poison plants. Apply this knowledge and experiment on small area. But be careful and try a weak recipe first.



Neem spray

The neem tree can be used to make a safe and effective natural insecticide spray. It comes from India but grows in East Timor. Neem can be used on almost all insects, including mosquitoes. It works in different ways with different insects. Sometimes it can take a few weeks to show the effects because with some insects it breaks the breeding cycle. It is one of the best plants to use because it is safe for people and it is much less problem for beneficial insects, especially pest predators. In some conditions it even increases beneficial earthworm production! Snails, nematodes, beetles, pest worms, moths, leafminers, flies and grasshoppers are some of the insects controlled.

Methods:

1. Crush neem seed and put in a cloth bag. Place the bag in a bucket or drum of water overnight. Use 500grams of seed for every 10litres of water. Use as a spray on the pest insects and affected plants. This method is more effective than leaves.
2. Take a large handful of fresh leaves, break them up and put into a bucket of water. Leave for 2 days then remove the leaves and use as a spray.
3. Dry a large handful of leaves, crush them and add to water. Leave for 2 days, strain and then spray on plants.
4. Neem can also be made from soaking crushed seeds in alcohol (ethanol), or making oil from neem seeds using an oil press. These methods are more costly but produce a much stronger product.

Look in the reference chapter for where to find more information about producing and using neem products.



Chilli / Garlic spray

1. Cut up 3 bulbs of garlic with a large handful of chillies and put in a pot of water. Bring to boil then add 1/4 block of soap. Stir well then leave for a day.
2. Strain the liquid, and then add 2 cups for each bucket or spray pack of water.

Garlic is an insecticide, fungicide and repellent. Chilli is an insecticide and repellent. The soap helps the spray to stick to the plant and insects. Use for aphids, worms, caterpillars and moths.



SMART IDEA:

- Garlic and Chilli plants naturally repel many insects. Plant them around fruit trees and other vegetable crops to reduce insect problems.
- Garlic and chilli can also be used separately as sprays.



Papaya Spray

Papaya spray can be used for aphids, termites, bugs and caterpillars. Method: Collect 1kg of papaya leaves. (About 1big plastic bag.) Cut finely and add to 1 litre of water. Mix well and leave for 1 hour. Remove leaves then add another 4 litres of water and one large spoon of soap. Spray onto insects. For termites crush young unripe fruit and collect the juice. Spray directly onto termites and damaged wood.

Ginger Juice



Grate 1 small handful of ginger (root) into a bucket of water. Leave for 1 day. Spray onto damaged plants to control larvae of worms and caterpillars.

Taro leaf spray



Taro leaves contain lysollic acid. When insects eat them it feels like eating broken glass!

1. Crush 10 Taro leaves and put into 5 litres of water (1/2 bucket)
2. Mix well
3. Splash onto crops using a branch of leaves. Make sure each plant is well covered to give good protection.

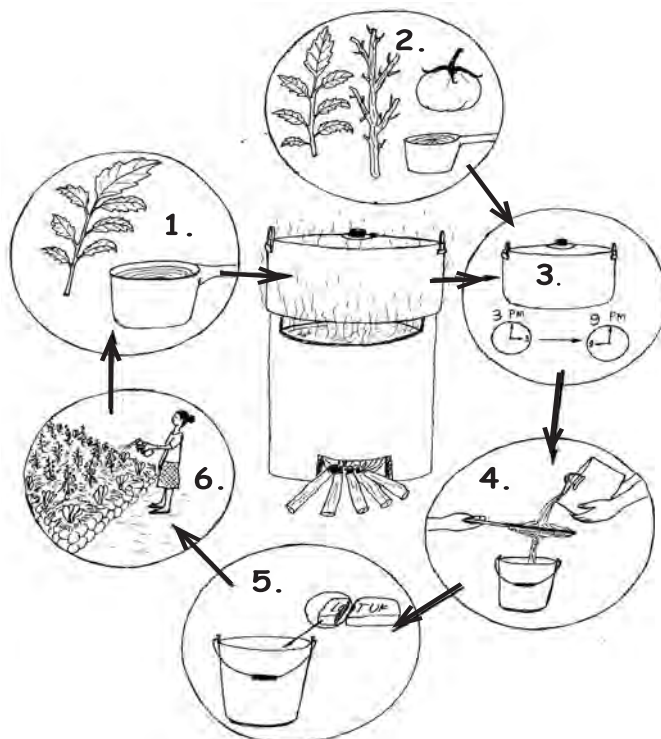


Tomato leaf spray

Tomato leaves are a natural insecticide, a repellent and a mild fungicide. It can be used on aphids, ants, worms, caterpillars, insect eggs, grasshoppers, some moths, nematodes, whitefly, fungi and bacterial rot.

1. Gently cook 1kg of leaves in 2 litres of water for 30 minutes.
2. Finely cut 2 handfuls of leaves, stem and fruit and add to 2 litres of water.
3. Mix together then leave for 6 hrs (1/2 day).
4. Strain solids from the liquid.
5. Add 1/4 block of soap.
6. Spray every 2 days when insects, especially moths are in large numbers.

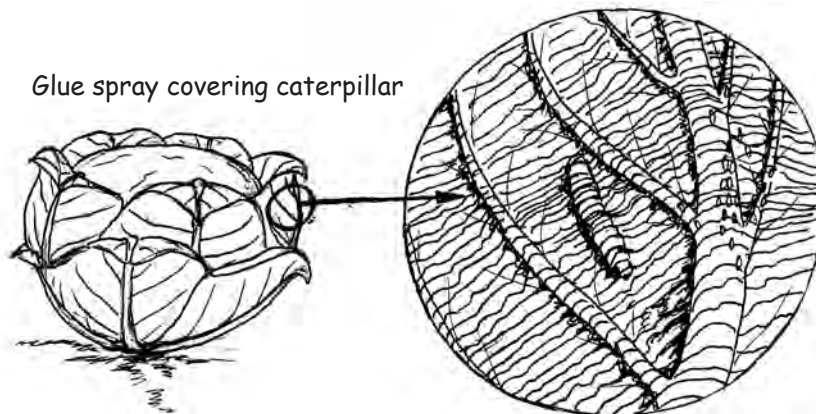
WARNING: Tomato leaves when used as an insecticide are poisonous for humans. This is because the chemicals in the leaves become much more concentrated. Use gloves and protect nose and mouth at all times.



Glue sprays

A glue spray will stick to small insects and suffocate them. It is useful for aphids, caterpillars and whitefly but try on other small insects as well. It is made from the water left over from cooking cassava, taro or potatoes. Method: Mix some cooking water with more water to make a mixture. The strength will vary depending on the type of plant used. A good mixture will leave a thin coating on the plant when the mixture has dried.

Glue spray covering caterpillar



Soap spray

You can use the washing water from your dishes or clothes to make an effective pesticide for snails, slugs, aphids, caterpillars, small beetles and other leaf-eating insects. Method: Use 1 large spoon of soap powder or liquid per 1 litre of water. Spray only on the pests and damaged plants.

Betel nut juice

Betel nut spit has been found to be an effective poison for giant snails and other snails! Collect the spit from betel nut chewing in a bucket, mix with water and spray directly on snails. It could be the betel nut, or the lime powder, or the combination of both, but it works! Spray on the outside of your vegetable plots to deter the snails from entering. But it is NOT recommended to spray directly onto plants. Reapply regularly.



Tobacco leaf spray

Tobacco spray should only be used as a last option. Wear good protective clothing and protect hands and face when making and using tobacco spray. It is very poisonous and it will kill many useful insects as well. It can be used for most pest insects. **Method:**

a. Soak 1 kg (1 plastic bag) of crushed leaves in 15 litres of water for 1 day and 1 night. Add 2 big spoons of liquid or block soap and mix well. Remove leaves then use as a spray.

b. Dry leaves and grind them into a powder. Use the powder on aphids, slugs, snails, caterpillars and leaf curl virus.

Warning: DO NOT use on tomato, potato, eggplant, capsicum, chilli plants or roses.



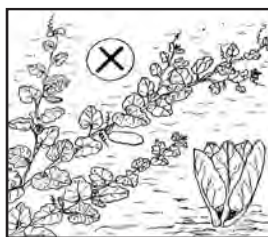
Ants

Cause problems in East Timor through their digging and removal of seeds. They can never be removed completely, but their effects can be lessened. Read in preventative measures for how to prevent ants damaging seeds, seedlings and trees. For root damage, try the following sprays: biological, chili, garlic, tomato or tobacco.

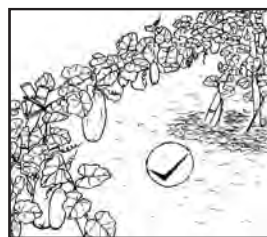
Natural Fungicides

What is fungus? Fungus is an organism that can live and grow on the surface of plants, animals, wood, people and even cement and other non-living surfaces. It lives much better in wet and moist conditions. It can cause

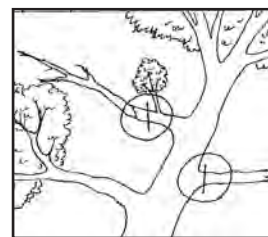
problems for plants by covering plant surfaces, causing rotting and preventing normal growth. The most important step for controlling fungus is to promote gentle winds, sunlight and air flow. Fungus is encouraged by dark and damp conditions and rotting materials. For trees, remove all dead wood and prune the trees to allow enough wind and light through. Only prune as much as needed. For vegetables, remove old and dead leaves and provide trellising for climbing plants like peas, beans and tomatoes. Any badly diseased plants should be removed and burned. Don't let mulch touch the trunks of trees or stems of vegetables.



No trellising



Trellising



Removing dead wood

Neem Spray

You can also use neem as a fungicide. Make a recipe from neem seed the same as for as a natural insecticide and spray on powdery mildew and rust mildew. It may work on other fungi as well but research is still being conducted. Experiment for yourself!

Seaweed tea

Collect some fresh seaweed, rinse with water to remove some of the salt then put into a bucket with water. Leave for 2 weeks, and then spray on affected plants.



Garlic

Dry bulbs of garlic and crush into a powder. Mix 1 big spoon of powder with 1 litre of water and use on mildews and tomato and bean funguses.

Papaya

The papaya spray that can be used on insects can also be used as a mild fungicide for coffee rust, powdery mildew, and rice brown leaf spot.



Sweet potato

Cut up and soak 3 large handfuls of sweet potato leaves in a bucket of water. Leave for 1 day then use as a spray on fungus, especially on rice fungus diseases.

Diluted urine

Mix 1 part human urine to 4 parts water. Spray onto plants or trees damaged by fungus diseases like powdery mildew, vine mildew and other similar fungus.

Milk powder

Powdered or fresh milk can be used. Mix 1 litre of milk with 10 litres of water. Spray once every 10 days onto vegetables or trees that have fungus, mildew or mosaic virus.



Results

Results of any natural pesticide must be continuously observed.

- How well has it worked?
- Does it need to be re-sprayed?

If the pest problem is not stopped then you have a number of choices:

- Re-spray
- Try a different pesticide
- Try a stronger mix
- Mix different natural pesticides together

Asses the situation for other factors and solutions.

Natural Pesticide Sprayers

Information taken from “Liklik Buk”, a development book compiled by Liklik Buk information center, Lae, Papua New Guinea.

Materials

- A bamboo tube adult arm length long between nodes, and 3-4cm wide
- A wooden rod, about 1m long, longer than the bamboo that will fit into the bamboo. A hard wood is best
- Nails for making holes
- A hammer
- A saw
- A strip of cloth, about 1m long and finger length wide
- Small length of wire or strong grass

Method

1. Cut the bamboo tube so that one end has the node closed and the other end is open. There cannot be any other nodes between the ends. Use the hammer and nail to make many small holes in the end with the node. Wrap the wire or strong grass around the other end to stop it from splitting.
2. Wrap the strip of cloth around one end of the hard wooden rod until it is thick enough to be used as a valve. (Fits tightly inside the bamboo tube). Wrap and tie the material with string or wire to secure it. Make a handle and a stopper at the other end of the wooden rod. The stopper will stop you from pushing the rod through the node.

How to Use

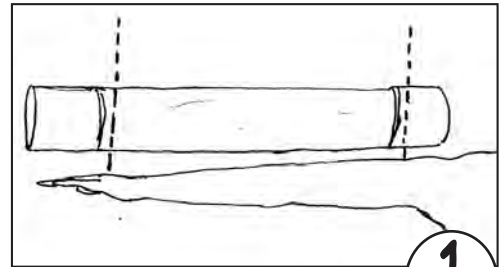
The sprayer is used like a simple pump or syringe.

- Push the rod into the tube up to the stopper.
- Dip the node end of the sprayer into the liquid, and then pull the rod back to its full length. The tube will fill with liquid as you pull back. Be careful not to pull the rod out of the tube.
- When you want to spray simply push the rod back in.



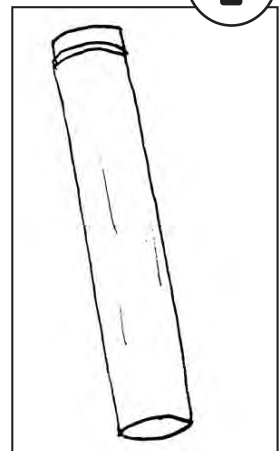
SMART IDEAS:

- Even with natural pesticides, always use protective clothing, plastic gloves and face protection.
- Natural sprayers can also be made from metal or plastic pipes.



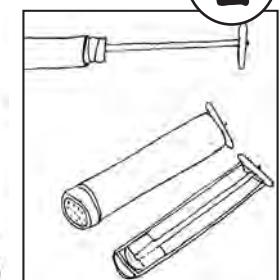
Method

1



Method

2



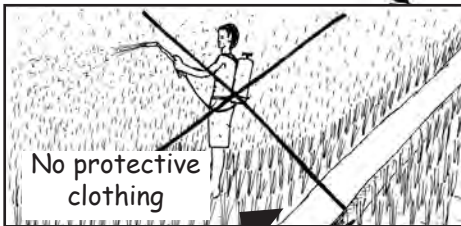
11. Biological control

Insect (biological) sprays are one form of biological control. Another common method is the introduction of a pest predator or control technique into an area that has a large pest problem. The pest could be an insect, plant, animal or bird. The result is that the pest problem is stopped, most times, without the need for using pesticides. Usually biological controls are released by the government or can be bought from them.

Danger

chemical pesticides & herbicides

Chemical pesticides and herbicides provide short-term solutions to pest problems but will cause many long-term environmental and other problems.



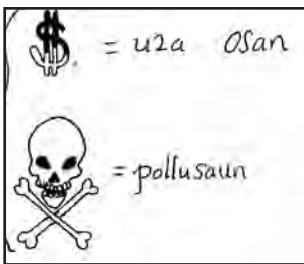
* Pesticides will kill not only the pests damaging your crops but many other good insects as well. Insects that improve your soil, pollinate your plants and eat the pests are also killed. The result is that your land is less productive and when more pests come there is no predators to eat them. Therefore you will need to use the pesticides again and again and again.

* Pesticides and herbicides are very expensive, too expensive for most farmers.

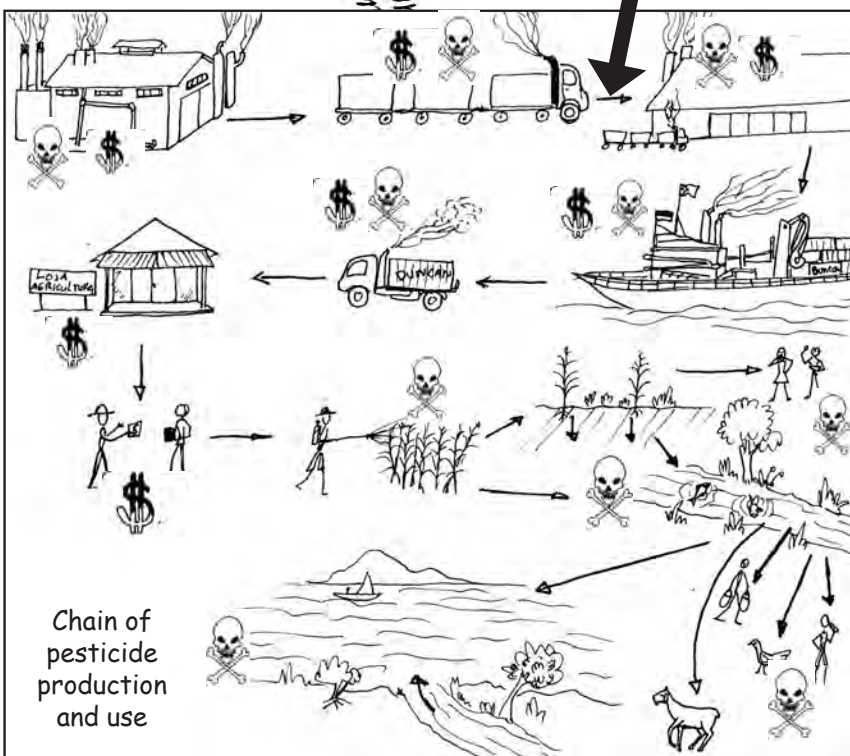
* Pesticides will damage and kill a lot of soil (animals) biota and bacteria. The biota and bacteria are essential for quality, productive soil.

* Chemicals are very dangerous for people to use without protective clothes, gloves and mask. They can make people sick and cause bad health problems in the future. Unfortunately in East Timor most people using chemical pesticides are not wearing proper protection and have not been told about the dangers.

* A lot of damage to the environment is also caused when the pesticides are made and transported. Air pollution, ground pollution and water pollution are all created and all cause long term problems.



* The chemicals do not just disappear after they are used. They can end up in the water, rivers and the ocean and will cause a lot of damage to fish and water plants and will give health problems to people, animals and birds that drink the water and eat the plants and fish.



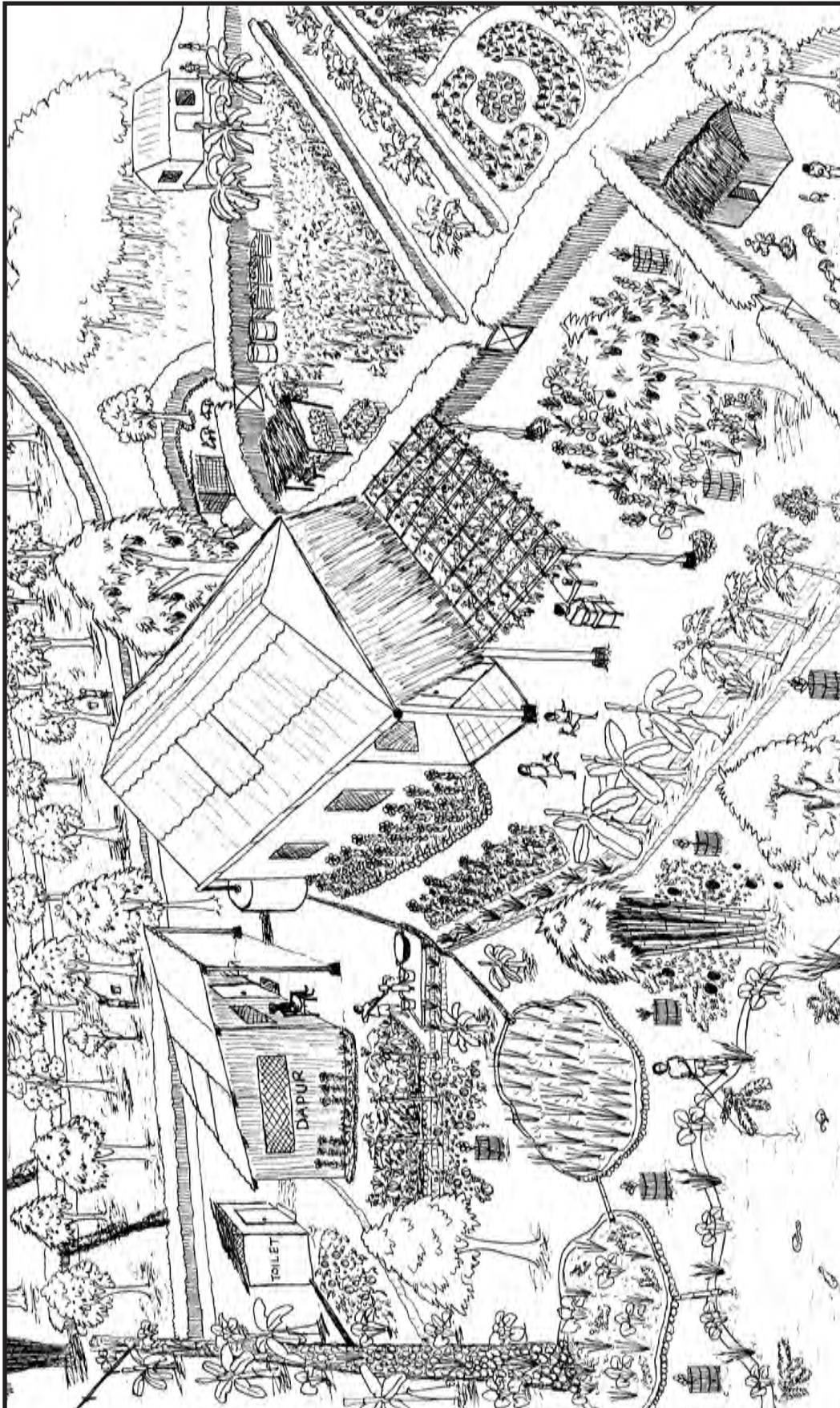
Chain of pesticide production and use

Remember that:

MOST INSECTS ARE NOT HARMFUL TO YOUR CROPS!!!

All insects have a role in the natural environment and are needed to have a balanced environment.

Even pests should exist in small numbers to provide food for the pest predators. To remove all pests will create more imbalances and a dependence on pesticides. IPM is a strategy that will improve your land and crops, especially for the future. The techniques naturally combine with other permaculture techniques to help create a strong and resilient farming system.

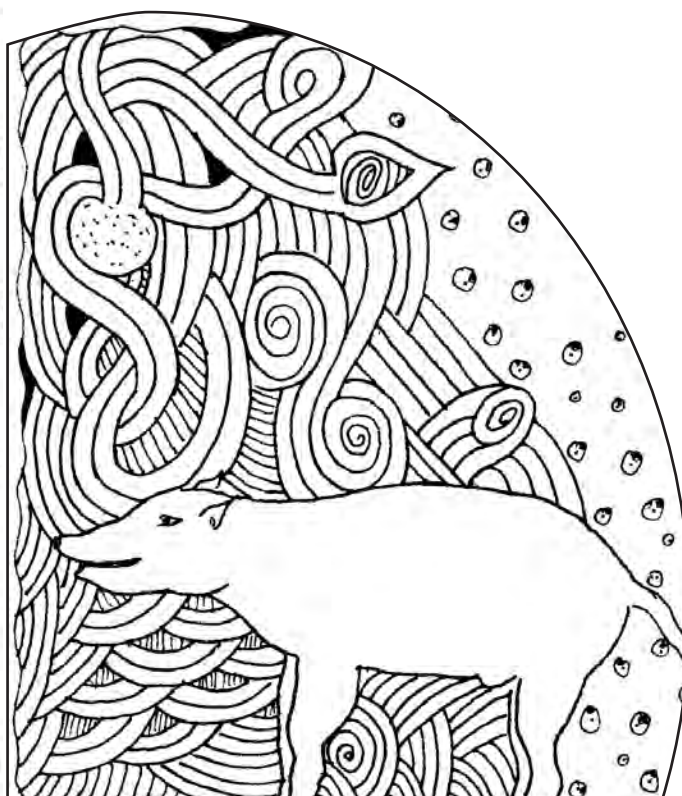


How many I.P.M. strategies can you find in this picture?





Animal Systems



CHAPTER

10

In East Timor animals are very important to the people and to the nation.

Animals represent:

- Food
- Health of a family and community
- A part of traditional culture and ceremony
- Labour
- Wealth



Many animals were slaughtered in 1999, leaving people without food and income. This was a huge problem and has made recovery and growth much slower. Animal numbers are now much higher and increasing and it is important to keep raising more. Animals are part of every household and farm. It is also important to manage them in a sustainable method, for now and for the future, and to maximize their uses and benefits. Most importantly, they must be well cared for.

The best medicine for your animals is to manage them well and maintain their good health. Good quality food, water and a clean, comfortable house will help a lot to prevent any diseases or problems.

In East Timor it is a common tradition to keep babies in the house for 40 days after birth to improve health. If a similar approach is used with animals, keeping them fed and watered in a secure animal house for a few weeks after birth then animal survival rates, size and health will improve A LOT.

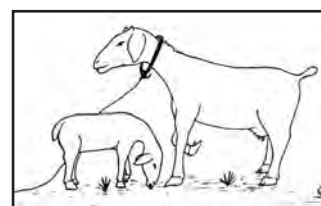
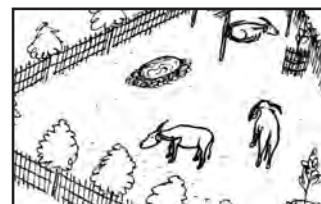
If the animals are healthy and happy and breeding well, they will produce more meat, eggs and babies. This will improve the lives and health of every Timorese person. Meat is an important part of East Timorese food, providing protein and other nutrients to help people grow and stay strong.

Whilst all animals are important in East Timor, breeding smaller animals provide more benefits here than larger animals.

This is because:

- Small animals breed more often.
- Small animals, including fish, produce more meat for less land, less food and less water than large animals.
- Small animals are MUCH better for the environment.
- The animals can be killed for meat as is needed, so no meat is wasted.
- Chickens and ducks also provide eggs.

This chapter looks at the different animals that are raised in East Timor. It looks at how to provide the food, housing and medicine needed for healthy animals using local and traditional materials and appropriate modern technology. This chapter also looks at different ways to integrate animals in agriculture and agro-forestry and how to use them as labour.



Pig house and yard

Chickens

In East Timor chickens usually go where they want to and nest in trees or in bushes. This system is easy because it requires very little maintenance. However, dogs, cats, rats and snakes eat many young chicks. Also, eggs are often hard to find and are also eaten by other animals. Chicken manure, a valuable fertilizer, cannot be collected and disease can spread more easily from chicken to chicken.

A chicken house will keep the chickens in one place so that eggs and fertilizer can be collected, young chickens can be protected and chickens can be fed extra food so that they grow faster and bigger.

Chicken houses can be part of a chicken yard, an integrated system or just used to keep the chickens at night. If you want to have more chickens and improve production then remember that the first 4 weeks of a chicken's life are the most important!

If the baby chickens are protected and fed, then you will have:

- Many more baby chickens that grow into adult chickens
- Healthier chickens
- Larger and faster growing chickens

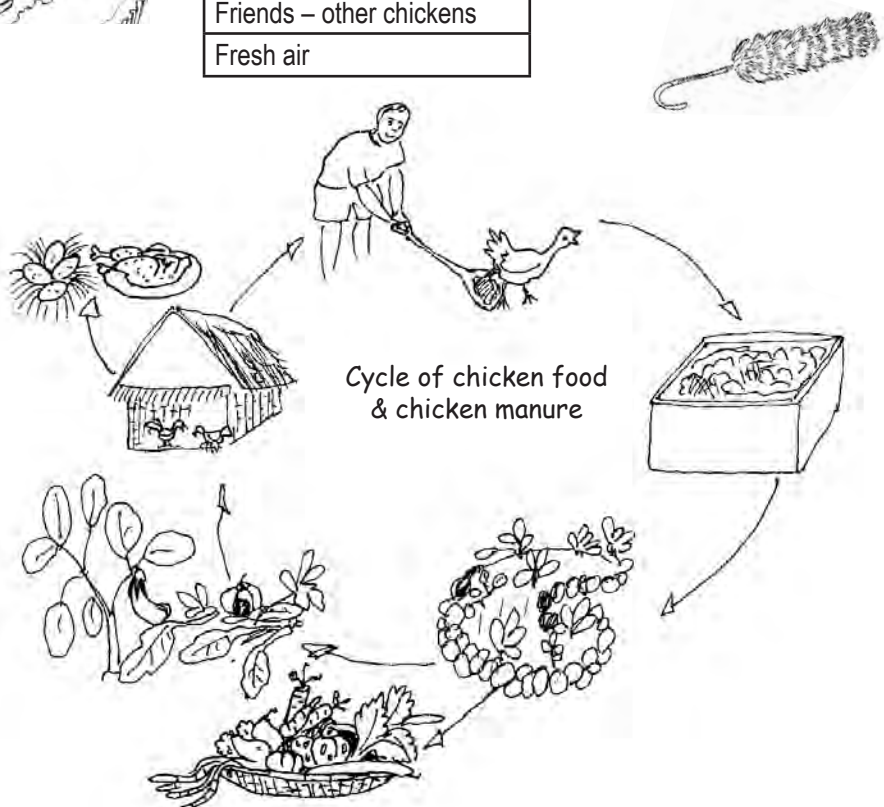
First of all, what do the chickens need and what products do they give?



CHICKEN NEEDS
Food
House
Water
Laying box
Protection from predators
Shade
Health
Dry earth
Friends – other chickens
Fresh air

CHICKEN PRODUCTS
Meat
Eggs
Manure
Money
Feathers
Work - weed control
Work - pest control

Chickens will provide for most of their own needs naturally, except sometimes for medicine and protection from predators. If you make a house for the chickens, you will need to provide some of their needs for them.



Chicken needs



Night house

A chicken house is much easier to manage if it is close to the house and close to water supply if possible. Sometimes roosting boxes are used to keep chickens at night. This is good for protection from predators and collecting eggs but not as easy to collect manure.



House : A chicken house needs to provide protection from rain and predators, places for chickens to roost and to lay eggs. The size and shape, and building materials used depend on what you want. Local materials are cheaper and easier to use. Train the chickens to come back each night by giving them some rice or crushed corn in the house. Don't let the chickens out until they lay their eggs in the house. This is usually by mid morning to midday.

The floor can be made from cement, which is easier to clean and more hygienic, or it can be dirt. The dirt must stay dry or the chickens might become sick. A layer of grass can be added on the dirt floor. The grass will collect the manure. The grass and manure can be removed once every month and used in composts or liquid composts. It is very strong and very high quality.

Important - The house must be strong enough to stop other animals like pigs and dogs from entering the house looking for food.

Water: Healthy chickens need a continual supply of fresh water.

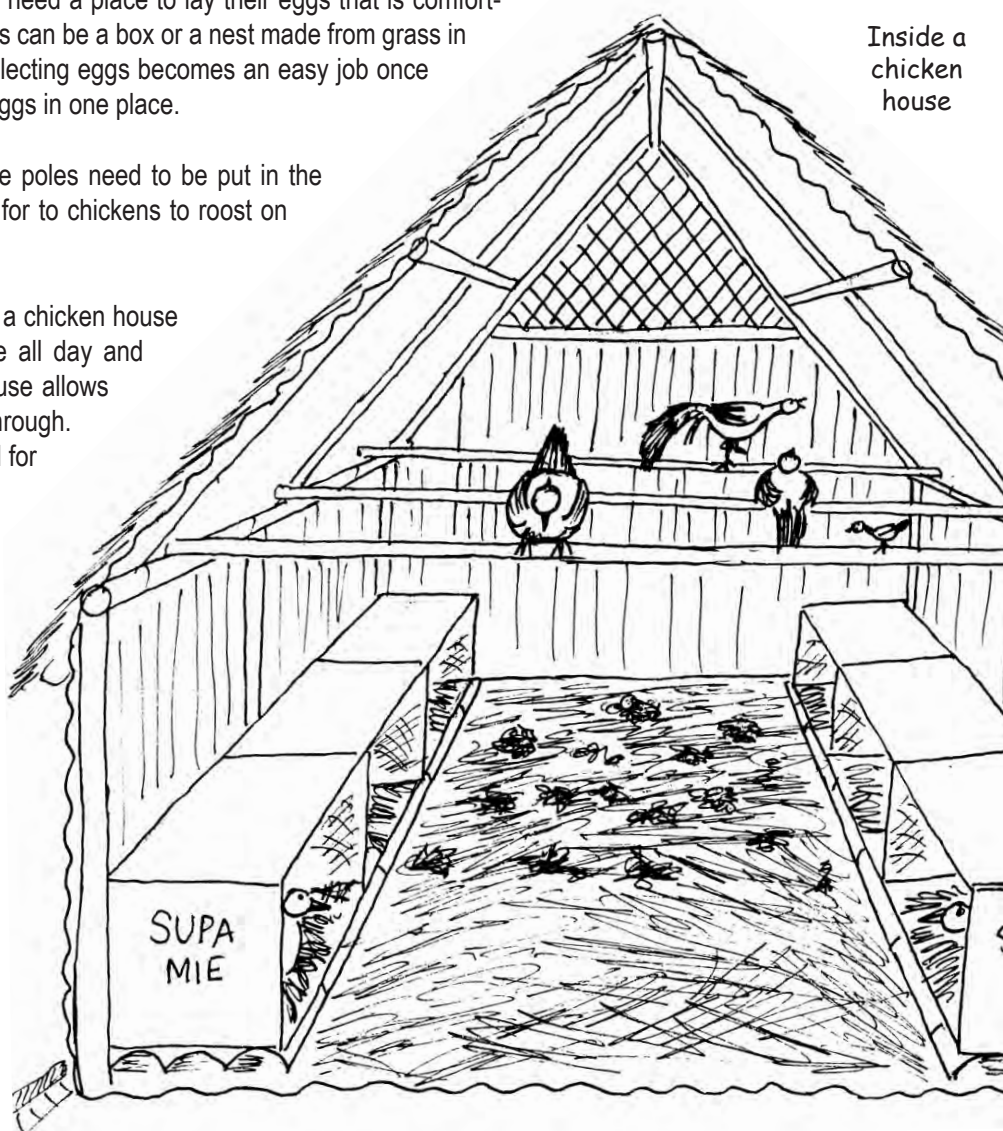
Laying Box: Chickens need a place to lay their eggs that is comfortable and protected. This can be a box or a nest made from grass in the chicken house. Collecting eggs becomes an easy job once the chickens lay their eggs in one place.

Roosting Poles: Some poles need to be put in the house, off the ground, for the chickens to roost on at night.

Fresh air: If you make a chicken house don't keep them inside all day and make sure that the house allows some wind and air through. No fresh air is very bad for their health.

Benefits

- A night house for the chickens is a good one because the chickens are free to eat during the day, and you can still collect eggs and manure.
- It can also improve feeding, which will increase the amount of meat on each chicken.



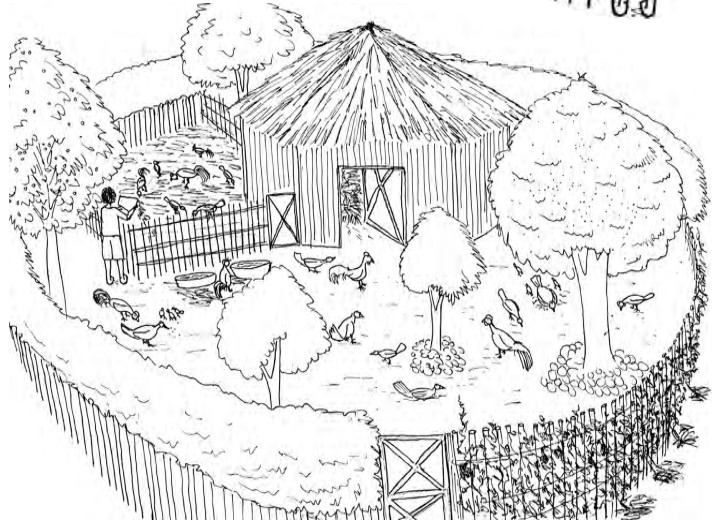
Permanent chicken area

This is a chicken yard that the chickens never leave. All their needs are provided. It includes a house and a feeding area. A permanent chicken area is better for controlling chickens and provides many more benefits than a night house. A night house can be built first and, after time, can be augmented to make a permanent chicken area. Plant fruit and chicken food trees around and in the chicken yard. Mulberries are best; wax jambu, loquats, mangoes, moringa, sesbania and acacias are good. Bananas and citrus are good around the outside of the yard. Bamboo also provides shade and wind protection, and many products. Vines are also excellent to grow. E.g. passionfruit, choko, beans, luffas, cucumbers, gourds.



A multifunctional chicken area provides many benefits:

- It will stop chickens from damaging your crops
- The trees provide shade and food for chickens and people.
- A lot of manure and excellent soil can be continually collected.
- Fruit and vegetables grown outside the area or on the fences will benefit from the nutrients from the chicken manure.
- You can put weeds and weed seeds for the chickens to eat. This helps to reduce the number of weeds in your garden.



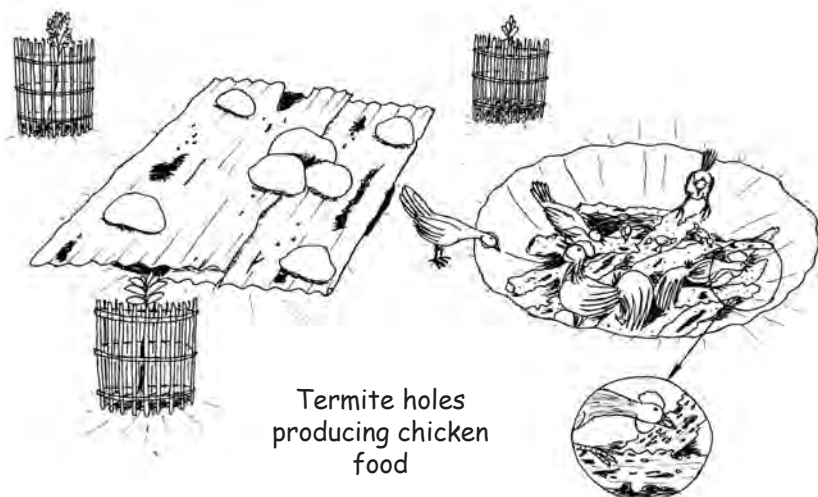
Chicken yard with house, tall fence, scratching area and shade trees

Food must be given to the chickens each day.

Food

- Kitchen food waste, weeds, rotten fruit and vegetables are all excellent chicken food.
- Chickens need some grains as well. Soak the grains and let them grow for 1 – 2 days. The grains will have much more nutrient and protein for the chickens. Approximately 1 large handful for every 10 chickens each day is good.
- Most importantly chickens need to be able to scratch for insects and worms. This can be provided easily by covering an area with rice husks, coffee husks, grass or weeds. The insects live underneath the grass and weeds and the chickens will scratch through it and eat them. After 1 –2 months the grass and weed are broken up and also collect lots of chicken manure. It can be removed and used as very high quality compost fertilizer. A yard for chicken food scratching and compost making can be made next to a night house as well.

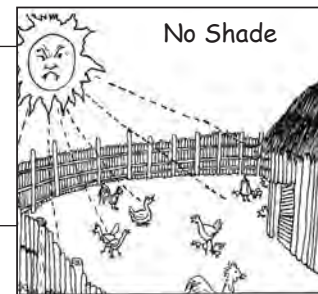
- You can also grow termites for chicken food. Dig a hole in the ground inside the chicken yard. Place rotting wood in the hole. Cover it up and leave for 1 month. Then uncover and let the chickens eat all the termites. Repeat. If you have room this method works even better with 2, 3 or 4 holes with wood. Rotate between the holes to provide food more often. This method can also be used without needing a permanent chicken area. The ground around the holes will become nutrient rich, and the remains from the holes is excellent fertilizer.



Termite holes producing chicken food

Shade

Chickens need shade.
Their ancestors come from the forest and they need some shade to be healthy.



Fence

A fence is needed to keep the chickens in one area. The fence can also provide shade, food for chickens and people, space for vines, windbreaks, bamboo or wooden poles and more. Think multifunctional.

The fence needs to be high enough to stop chickens from flying away. Or make a simple roof using palm leaves or split bamboo.



Friends

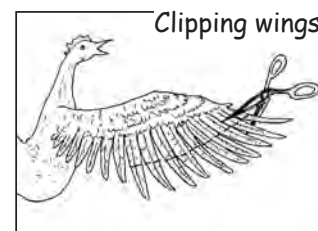
Chickens always live in flocks (families). Too few chickens or too many chickens in a small space is not good. If they live free they will work out the flock size.

If you keep the chicken in a house you will do this for them. 1 rooster for every 10 – 15 hens works well. When the young chickens become males or females the males can be separated or eaten.

Clipped wings

Another way to keep chickens in a fenced area is to clip (cut) the feathers on one wing.

Method: Cut the long outside feathers on 1 wing in half. This upsets the chickens balance and prevents flight. This works for 3 months for young chickens, and for up to 1 year for older chickens.



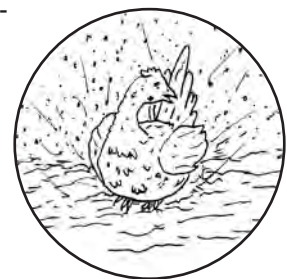
Health

In East Timor chickens are generally healthy animals that will care for themselves. Preventing disease is helped by keeping the chicken house dry and cleaning it regularly.

Separate any sick chickens until they are cured to stop disease from spreading. If your chickens mix with other chickens in the area then there is more chance of diseases spreading.

Dry Earth: Chickens dig holes in dry earth and shake the dirt through their feathers to remove lice from their bodies. This is VERY important for their good health.

If chickens are free they will find dry earth by themselves, if they are in a yard you must provide it for them in the wet season. Put some neem leaves in the holes. They are a natural pesticide that does not affect animal health will help reduce lice even more.



Worms: 2 good natural treatments are papaya seeds and mulberry leaves. Chickens like eating them, especially seeds from green papaya. Feed it to them regularly to help prevent problems.

Chickens also like eating chillies and garlic, which will help them to fight off minor sicknesses. Occasionally add small amounts to their other food.

Crushed eggshells, crushed seashells and sand are good to provide to the chickens. They will naturally eat a small amount with other food. It helps their digestion and helps them produce eggs with strong shells.

Vaccination: There is a disease that kills many chickens in East Timor and many other countries called Newcastle's Disease. It spreads very quickly and easily and occurs every year, usually at the end of the dry season. The only effective control is vaccination. The vaccination must be given when the chicken is young, and must be given to all the chickens in a community for it to be effective. The government agriculture department and some NGOs are running vaccination programs. Contact government agriculture workers for more information.



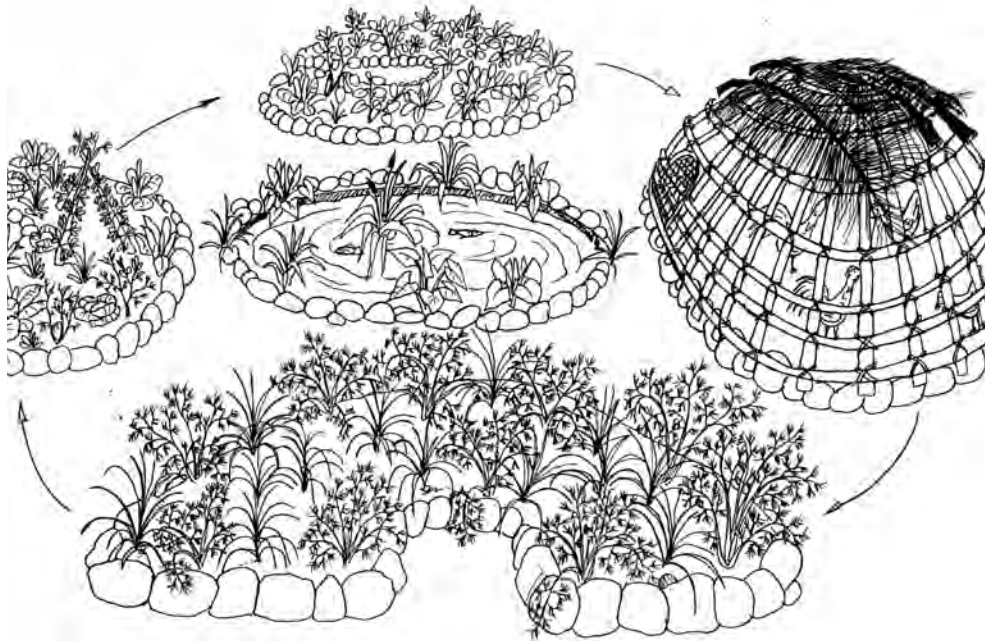
Chicken products

Chicken Labour

Chickens can also provide pest and weed control. There are many different ways of using the chickens to work for you.

Moveable Chicken House

The chicken house can be moved from one garden plot to another. A good system is to have 6 – 12 different plots all the same size and move the chicken house from plot to plot once every month.



Cross section of moveable chicken house

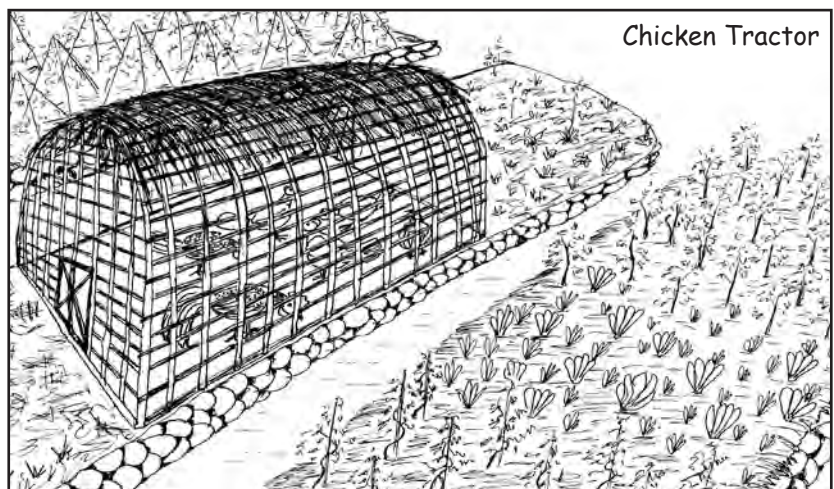
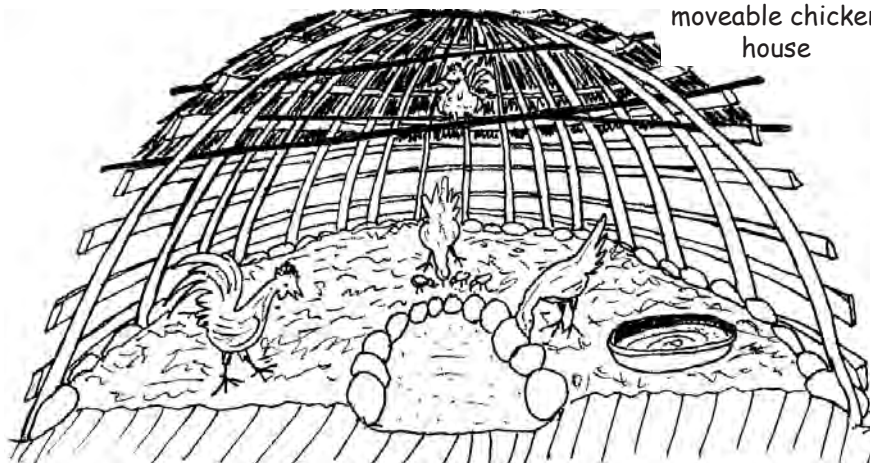
Chicken tractors

A chicken tractor is a small moveable chicken cage with no bottom that you can put the chickens in during the day. 6 chickens in a cage 2m x 1m is good.

A chicken tractor can be used to:

- Scratch up and fertilize soil before planting.
- Remove pests and insects from the soil.
- Remove weeds.

The movable chicken house and chicken tractor are good for keeping mothers and baby chickens. Try to build it as light as possible to make it easier to move. Treated bamboo is a good material to build from.

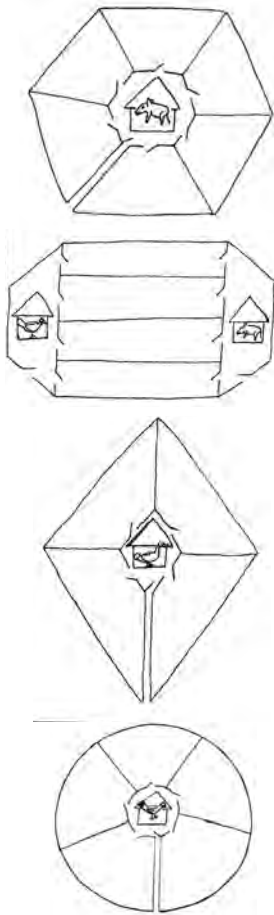


Chicken Tractor

Chicken systems

Chicken & vegetable systems

Chickens can help in the vegetable garden.

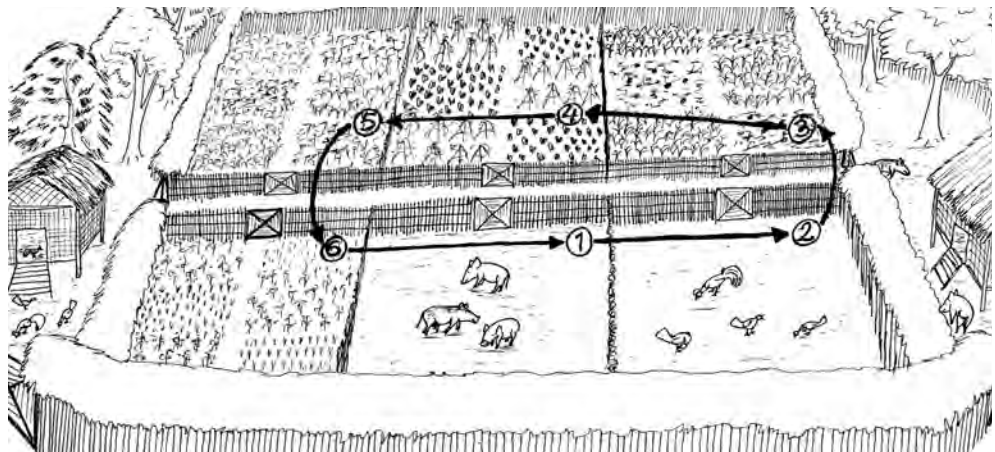


Divide the garden into sections. Approximately 5metres x 5metres is good, but it can be smaller or bigger. Each section must have a tall fence around it or a temporary roof made from palm leaves to stop the chickens escaping. Or you can clip a wing on each chicken.

Let the chickens into one section and grow vegetables in the other sections. When a crop is finished you can let the chicken in to eat the stalks, weeds and insects. As you provide food for the animals, they are working for you, cleaning and fertilizing the area for the next crop and providing important pest control. Move the chickens from one area to another, as you need them. Keep the chickens in a chicken house at night.

Pigs can also be a part of this system. This works even better. Use the pigs first, between 1 and 4 pigs depending on the size of the area. For a 5m x 5m area, 2 or 3 pigs is good. Add a layer of dry grass. The pigs will dig up the ground, eat out the weeds and turn the dry grass into the soil. Then follow with the chickens. They will scratch around and eat the insect pests and weed seeds. Both will add manure. Usually 1 or 2 months for each animal is enough.

If there is no shade, provide a small amount using palm leaves.



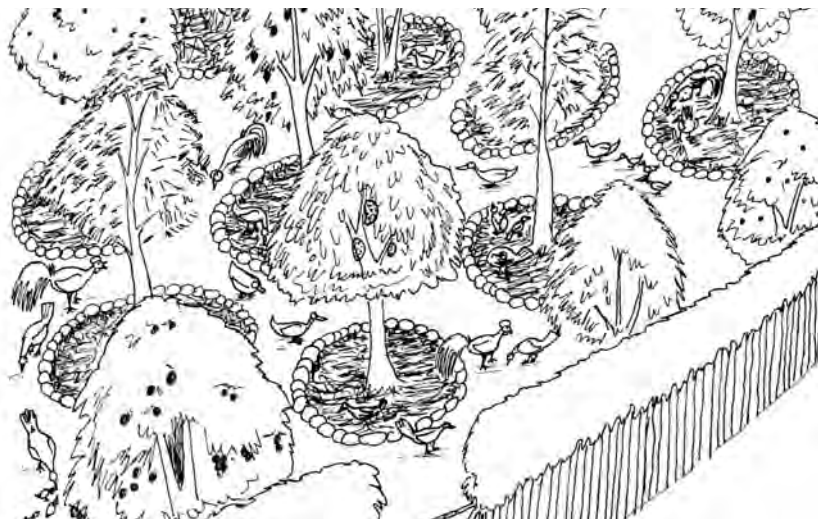
Chickens and fruit trees

Chickens are excellent for managing around fruit trees. About 50 chickens for an area 50m x 50m will eat the weeds and fertilize the trees. Make sure that the fruit trees are 1 year old before using the chickens. Make a stone ring around each tree, 1- 2m from the trunk and place lots of compost and mulch inside the ring. The chickens will scratch around but the stones will keep the compost and mulch near the trees.

Plant legume trees for a living fence and between the fruit trees. You can cut the legume trees to feed to the chickens and provide nitrogen to the fruit trees. Read in the Aquaculture Chapter (CH 11) about Chicken and fish systems.

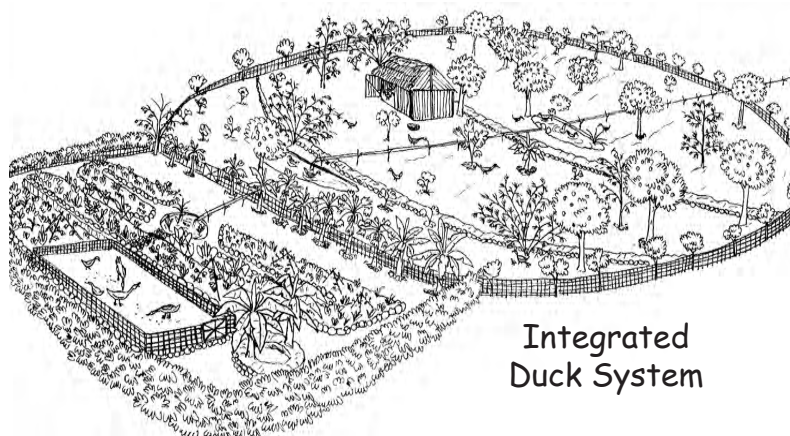


SMART IDEA:
Choose from the techniques you like best, combine different techniques or try your own.



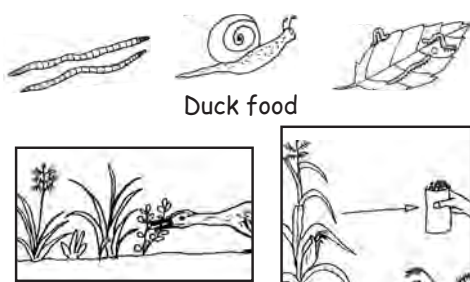
Ducks

Ducks are a very good animal for East Timor. Ducks are easy to breed and provide many different products and income. They do not get sick very often and do not suffer from Newcastle's Disease, which kills many chickens each year. They can be easily integrated with agriculture production already practiced in East Timor, like rice production, vegetable production and fruit trees. Ducks need food, water, shade and shelter to be healthy and happy.



Integrated Duck System

The first 4 weeks of a ducks life are the most important. If they are given good food and water in this time it will help them to grow faster and bigger, and they will get sick less often. This is also when they are most likely to be killed by predators. A little bit more work during this time will result in a lot more benefits later on.



Duck food

Duck Needs
Water
Food
House
Shade
Protection from Predators
Health

Duck Products
Meat
Eggs
Money
Manure
Labour – Weed Control
Labour – Insect Control
Feathers

Ducks Needs

Water

Ducks need a continuous supply of water. They need a container or small hole filled with water that they can drink when they eat. Ducks need the water to help swallow and digest their food. Ducks also like water to swim and look for food in. This is not essential, but is good for their health and the pond will be an excellent source of liquid fertilizer. Ducks can also be combined with water plants if the pond or ponds are big enough.

Food

Ducks like a mix of insects, worms, fresh grass, fresh leaves and grains (rice, corn, millet).

- They will hunt for insects and worms in the soil, on the edges of ponds and under mulch and leaves. It is much easier for them to find insects and worms if the soil is wet.
- Ducks like grass and leaves if they eat it from the plant or it has just been picked. Be careful because they love vegetable seedlings!
- It is good to give the ducks some grains each day. Like for chickens, if you soak the grains in water overnight and let them grow for 1 or 2 days it will improve the quality of the grains. 1 big handful for 5 ducks is enough. Grains will help the ducks to grow faster and bigger.

Duck House

Because ducks cannot roost in trees like chickens, they will always need a house. This provides a place for them to lay eggs and protection at night from dogs, cats, snakes and rats, especially for baby ducks. A duck house can be as big or small as you need it. 2m x 2m is a good size for 10 - 15 ducks, 3m x 3m for more ducks. Always have a thick layer of cut grass on the floor. Replace the grass every 1 or 2 months when it will be full of duck manure. This is excellent compost and fertilizer but be careful because it is strong. The ducks will also use the grass to make nests for their eggs. A water container inside the house is also important.



Shade

Ducks need some shade, especially in the middle of the day. Trees or a simple shade structure with palm leaves will work well.

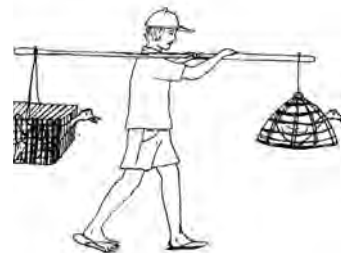
Health

Ducks don't often get sick, especially if they are healthy. Most problems can be prevented by providing clean water for them to drink everyday, providing food and cleaning their house regularly. Make sure they have some shade, especially during the middle of the day. Add some papaya seeds or mulberry leaves to their food regularly to reduce problems with worms. Separate any sick ducks until they are cured to stop disease from spreading.



Duck Products

Duck meat can be cooked and eaten in the same way as chicken meat and it is very tasty. Duck eggs are twice as big as chicken eggs and are very healthy and tasty to eat. Both the eggs and meat can be traded or sold. Duck manure is excellent fertilizer but it is strong. For vegetables it needs to be mixed into compost or liquid fertilizer before use.



The grass/manure that is collected from the duck house can be mixed with more grass, dried cow manure rice husks or coffee husks and then used as fertilizer.

Ducks can also be combined with rice and fruit trees and can be used for pest control and weed control. The following examples will explain how.



Duck Systems

Ducks need to be checked every day so it is better if they are close to the house. It is much easier if the duck house is close to a water supply too.

Night house

Ducks need a house at night but they can freely eat and roam during the day. This system is very low maintenance, but vegetable gardens must be protected from them. Ducks love seedlings and green-leaf vegetables and can eat a lot very quickly!

Duck house with fruit trees

An area for ducks is much easier to build and maintain than a chicken yard. The fence only needs to be small because the ducks don't jump fences like chickens and don't fly as high.

The ducks will control the grasses and weeds around the fruit trees, eat some pest insects and fertilize the trees at the same time. Ducks like to sit in the shade, and ducks will defecate where they sit. Therefore the fruit trees will be fertilized well! Citrus trees and ducks are a great combination because citrus trees like the strong manure and they have shallow roots that ducks won't dig up and disturb.



SMART IDEA:

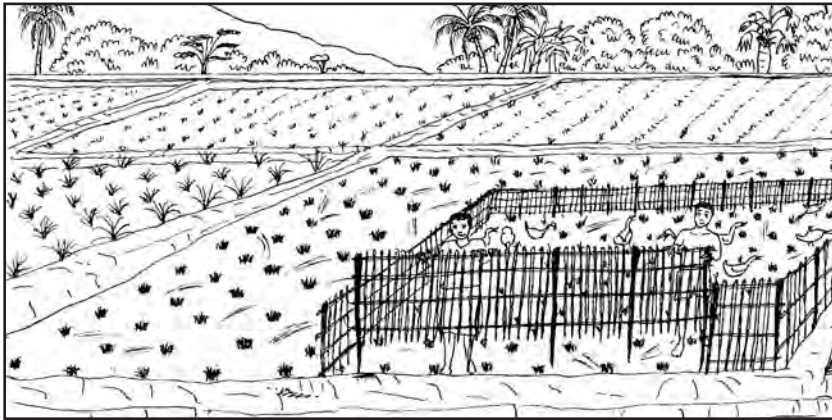
Plant some fast growing legume trees between the fruit trees, especially if the fruit trees are newly planted. The legume trees will provide shade quickly and can be pruned to provide nitrogen and mulch.



Ducks and orchards

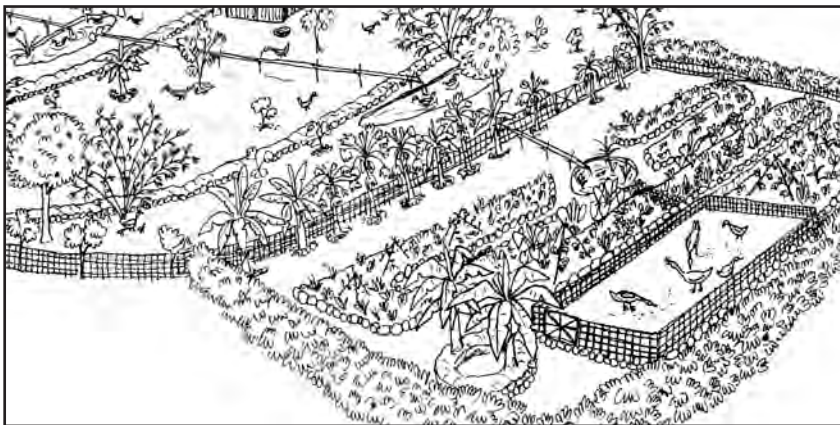
This is the same as for ducks and fruit trees but larger. Ducks will provide weed control, some insect control and provide fertilizer. They can work well with chickens but their houses MUST be kept separate. Ducks need a wet house area and chickens need a dry house area. If the chicken house area is wet the chickens can become sick.

Duck and rice paddies



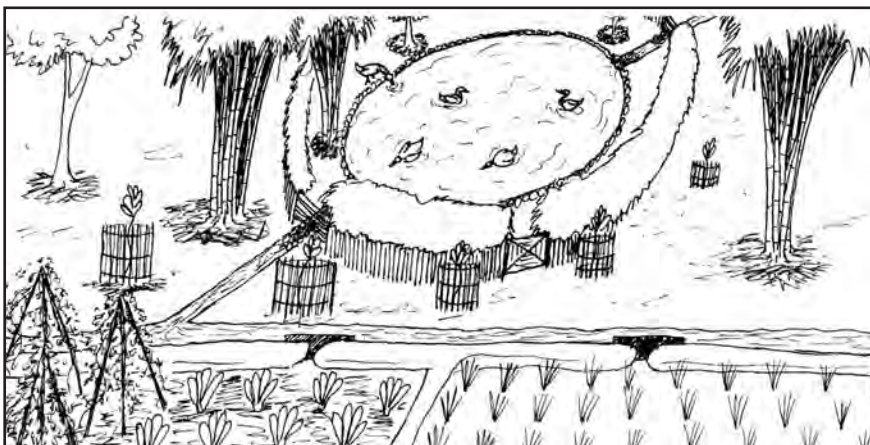
Ducks can be used to eat weeds and fertilize rice paddies after harvest. Use a small moveable fence to keep them where you want. It is best to move them back to a duck house each night to protect them from predators and collect the eggs.

Ducks and vegetable gardens



You can use a moveable fence to move ducks around a vegetable growing area. This is a good way to combine vegetables and ducks. By using a fence and keeping the ducks in one place, the ducks will eat weeds and insects and fertilize the soil before the next crop. Important: Provide some shade from the hot midday sun. Look in the Aquaculture Chapter (CH 11) for combining Ducks and fish production.

Ducks and irrigation water



A duck pond is a continual source of liquid fertilizer. It can be combined with irrigation to provide nutrients in the water for the plants. In the wet season especially there will be water that will run off from a duck pond. You can make swales or other water catchments below the pond to catch the water. It is nutrient rich water and will feed vegetables and trees that you plant.



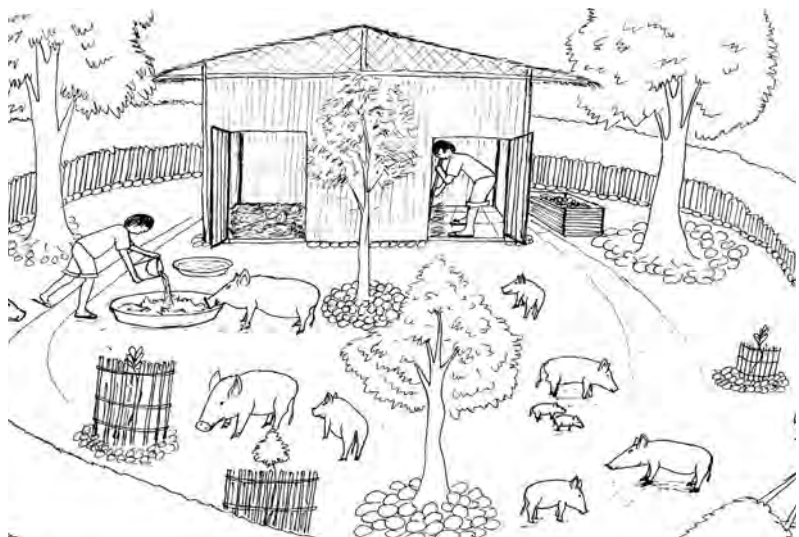
SMART IDEAS:

- Waste water from the kitchen and bathroom MUST NOT be used for duck water. It contains soaps and detergents and it will make them sick.
- A duck pond can be used for making liquid manure. Ducks will use the pond for drinking, swimming and food. After 1 – 2 months the water will have a lot of manure and can be used as liquid compost for fruit trees and vegetables.

Pigs

Pigs are an important source of income and meat, and are used a lot for traditional ceremonies. Often pigs are allowed to live free. This is very low maintenance and cheap. However, the pigs get sick more easily from bad food, diseases spread quickly, more young pigs die and there is more chance of your pigs being stolen.

Most importantly, pigs can cause a lot of damage to crops and young trees if they are not kept in a yard. A simple pig house and yard can improve pig health and productivity, and protect your crops and trees. Then you can also collect and use the pig manure and the pigs can be used for labour.



The practice of pigs eating human excrement is common in East Timor, but is very unhealthy. The pigs can become sick from disease from eating the excrement and diseases can be passed to humans who eat the pigs. A simple solution is to make a composting toilet that the pigs can't enter. Look in the Houses and Water Supply Chapter (CH 13) for how to make and use them.

Pig Needs
Food
Shelter/house
Water
Health
Earth to dig
Shade
Fence

Pig Products
Meat
Money
Manure
Labour – weed control
Labour – land clearing
Ceremonial needs
Leather



Simple needs

Simple Pig House

You can start with a simple system and then slowly develop the system over time.

Pigs need food and water everyday so it is easier if they are close to the house. The pig house is used to keep the pigs at night. 3metres x 3metres is a good size. The pig house must give shade and protection from rain and strong winds. If the pig house has no walls then a strong fence is necessary. A cement floor with a gentle slope is best for cleaning and good health. It can be lined with grass. The grass must be changed every week.

Use the grass and manure as fertilizer and mulch. The floor can also be made from wood or split bamboo. It must be raised off the ground and have thin cracks so that it can be cleaned out and doesn't rot.

Some trees planted next to the pig house will improve the living environment for the pigs. If they are happy they will be healthier and grow faster and larger. Plant fruit trees and trees that provide pig food. They will benefit from the pig manure.

During the day the pigs can be let out to feed or they can be tied to a stake. If they roam make sure that the vegetable gardens are fenced. If the pigs are tied to a stake, use the pigs to clear and fertilize land that you use for crops.

Food and water

The pigs must have water and food each day. A mix of leaves and roots cooked together makes good pig food. Sweet potato, cassava, yam, taro, sesbania, gamal, leuceana, pigeon pea and moringa are good to use. Other local trees can be used too. Rice powder and corn powder are also excellent pig food. Food waste from the kitchen is good to add. Beans are another vegetable that can be used. They provide important protein, which will improve growth. You can use the wild beans but make sure they are cooked properly.

Health

If you keep the pig house clean and give them enough food and water then the pigs will be healthy and most sickness will be prevented. Add mulberry leaves or papaya seeds to the pig food regularly. They will treat worm problems, but if given regularly, about once a month, they will work as a preventative. Add 1 or 2 small handfuls of papaya seeds and/or 1 or 2 big handfuls of mulberry leaves to the cooked food after cooking.

During pregnancy, birth and for the first few weeks after birth, make sure that the mother is given more food. This will help her to produce healthier babies and provide plenty of milk for them. Also make sure she has a comfortable area that is protected from dogs. The result will be that more baby pigs survive, and they will be healthier and will grow better.

Separate any sick pigs until they are cured to stop disease from spreading.

Pig Yard

A fenced area for pigs will take time and labour to build but will save a lot of time and labour in the future. It will also make your land more productive. It is easiest to build the yard around the pig house. It is very important to build strong fences that will keep the pigs in. On the outside of the fence it is good to plant some trees or a living fence. This will provide some shade and pig food and will eventually become the fence. Place rocks on the inside of the fence to help prevent the pigs from digging holes and destroying it. A good idea is to divide the yard into 3 or 4 sections. Then the pigs can be moved from section to section. Vegetables can be grown in the sections that the pigs are not in. The pigs will still need to be given some extra food and water.



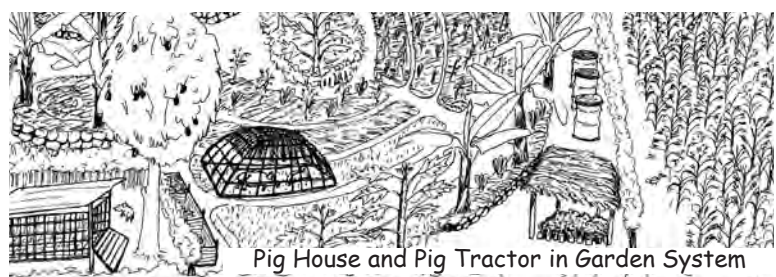
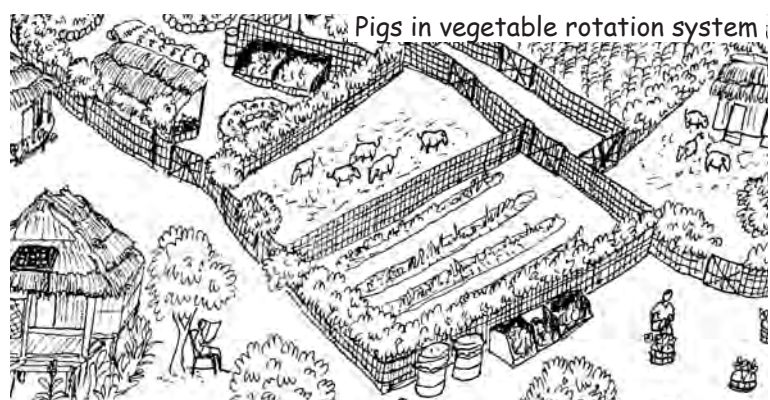
Pig products

Pig tractors

Pigs can be used as a tractor on your land! There are 3 ways to do this.

1. Tie the pigs with rope to a stick and let them clear weeds and fertilize land where you want to plant vegetables or trees.
2. Build a good fence around your vegetable land and put the pigs inside to clear the weeds and fertilize it in between crop rotations.
3. Make a moveable pig house for the pigs during the day. 4 steps long and 2 steps wide is big enough for 3 pigs. The house has no floor and palm leaves for the roof to give some shade. The pigs inside will clear weeds and fertilize the soil. Move the house to a new place when the land is clean.

Look in the Aquaculture Chapter (CH 11) for Pig and fish Systems. Look in the chicken section of this chapter for more ideas about animal labour systems and combining pigs with chickens.





Goats

There are a lot of goats in East Timor. They are very tough and adaptable animals. They give many different products, including milk, and they can be used as labour for weed control and land clearing. But they can also be very destructive to plants and to the land. They must be well managed to prevent these problems

In an established permaculture system, goats can be productive, but it is recommended that small numbers of goats is more productive overall than high numbers. Fish, chickens, ducks and pigs are all more productive and work better with other production such as vegetables and fruit trees. But for very dry areas goats are the most suitable animals.

Goat Needs
Food
Shelter/House
Water
Health
Shade
Fence or rope

Goat Products
Meat
Money
Milk
Manure
Leather
Labour – Weed Control
Labour – Land Clearing



Goat needs

A simple goat system will improve the health and size of your goats and make your land more productive.

You can start with a goat house and then start to create a goat forage area.

A plan for the future is very important. Then you can create a productive area that provides food and local medicine for the goats and some food and resources for people too.

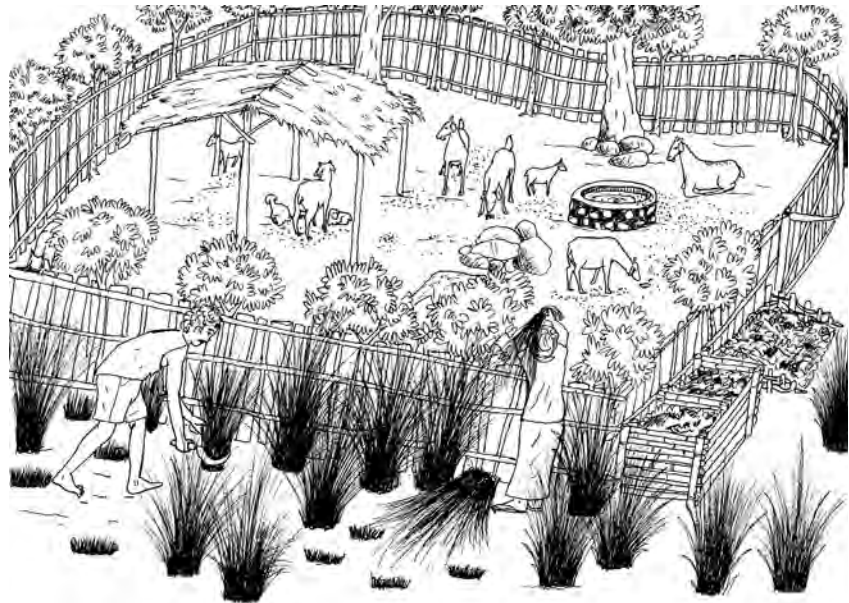
Sheep (Bibi Malae) can be taken care of in a similar way to goats.

Simple Goat House

A goat house is used to keep the goats at night.

It needs to provide shelter from rain and strong winds. A place for water and feed is also necessary.

The goat house floor must stay dry in the wet season, and be easy to clean. It can be dirt, or a split bamboo floor raised off the ground. Add dry grass for the goats to lie on. Change the grass about once a month in the dry season. In the wet season change the grass about once a week, and sweep out the area every 2 days to reduce disease risk. When the grass is removed it contains a lot of goat manure so it makes excellent mulch and fertilizer.



The goat house can be made with walls, or no walls but with a strong fence surrounding the house.

Plant some trees and grasses around the goat house to give some shade and provide some food for the goats.

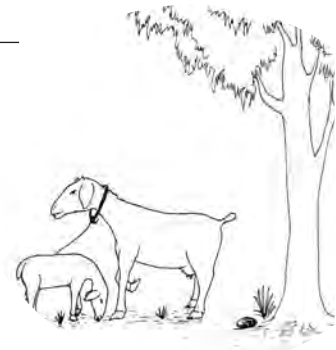
And provide a water container with continual fresh water.

Food

Goats are easy to feed because they eat almost any plant. Often in East Timor goats are allowed to roam around looking for food, often in large numbers. This makes other agriculture very hard because the goats will eat almost anything.

Some solutions are:

- To put fences around all vegetable areas and trees
- Fence an area for the goats to stay in
- Tie the goats with rope to sticks and move them when needed.



Use a solution that is best for you. Or use a combination of techniques. In the long-term it is best to make an area for goats to stay in. This will allow you to make the rest of the land more productive. But the goats **MUST** be fed every day, approximately 10kg for each goat.

Some fresh leaves given to the goats each day will improve the goats' size and health. Goats will eat most leaves but some are more nutritious than others. Leucaena, Moringa, Calliandra, Sesbania, Gamal, Tamarind and Mulberry all provide excellent food with a range of nutrients.

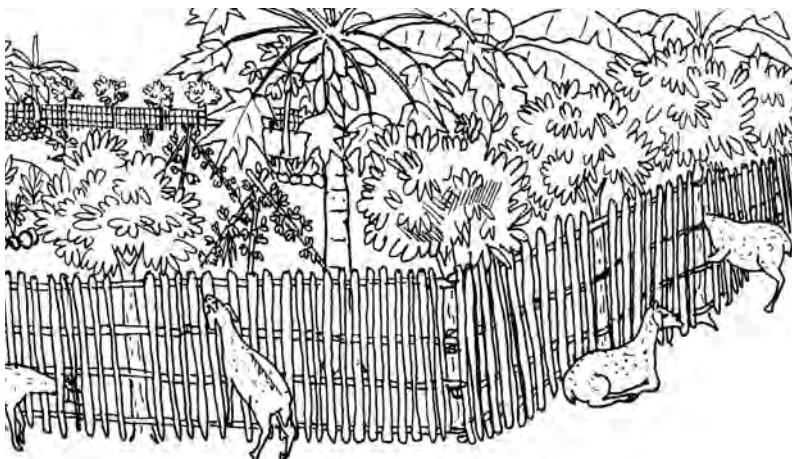
It is also very important to plant many trees to provide goat food, medicine and shade. Some trees can also be used as fences.

Food Rotation

A rotation system is a good way to manage goats because it doesn't put too much stress on any one area. The size and shape of each area depends on the number of goats and the size and shape of the land.

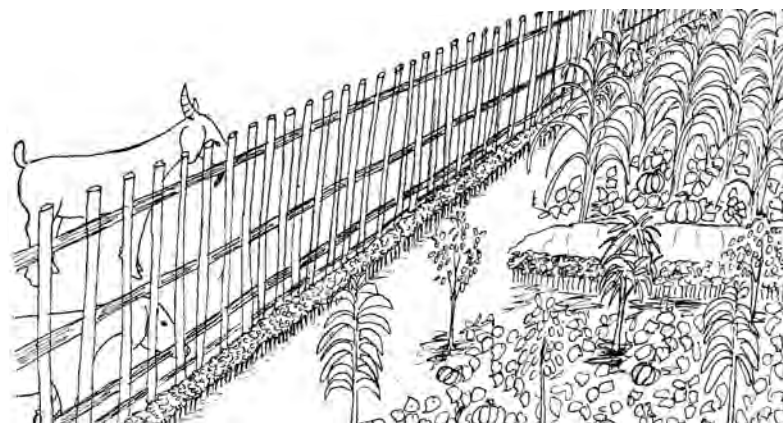
The number of goats per hectare will vary depending on what they eat:

- Good quality grass: 3 or 4 per hectare
- Rice paddies after rice harvest: 2 per hectare
- Poor quality grass or weeds: 1 per hectare



If you also provide food from trees you will increase the growth rate of the goats. Therefore they will have much more meat over the same time period. If you increase the quality of grass and add ground cover legumes you can increase the number of goats per hectare. (Up to 4 per hectare is the maximum recommended.)

Living fences or fences can be made.



Living fences are better because they can also provide food. However, the goats will eat them if they are introduced too early. A good solution is to make a fence, then a living fence on the outside. The fence will last for a few years. After that the living fence is established and can be used instead. Or a living fence can be established using trees that goats don't eat.

Benefits:

- Goats can be moved from one area to another before they eat all the grass and vegetation. This allows it to grow again.
- They can be used to control weeds.
- Fruit trees and other production trees can be planted within these areas if they are very well protected from the goats. The goats will then help to weed and fertilize around the trees.
- The goats won't damage any other crops or land.



SMART IDEA:

Collect and spread seeds of native legumes: ground covers, beans, clovers and other small plants. (But not the poisonous beans!) This will improve the soil and help the grasses to grow better and provide high quality feed for the goats.

Health

Sea salt is very important for their health. If you put a small basket of sea salt in the goat house the goats will lick it when they want. Add papaya seeds and mulberry leaves regularly to the goat's food. They will help to control worms. Keep mothers and newborn babies in a house or yard that is protected from rain and wind. It will help more babies to survive after birth and reduce chances of sickness for mothers and the babies.

One of the main diseases that affects goats in East Timor, and all over the world is Coccidia. It is a type of worm that the goats carry usually without problem, but if living conditions are unhealthy and the weather is bad, it can kill them. Usually in East Timor this is at the end of the wet season when there are strong winds. The best cure for Coccidia is prevention.

This can be achieved by:

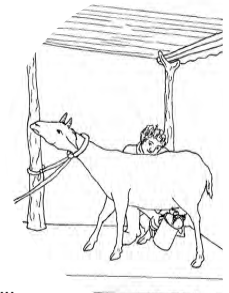
- Don't stock too many goats in the yard.
- Clean out the goat house regularly in the wet season –every day or two. Wet goat manure increases the disease problem.
- Put some dry grass on the ground in the goat house and burn it. This will kill Coccidia and worms living in the soil. Once or twice each wet season will help, but be careful if you have a grass roof!
- Use clean water containers that don't have goat manure in them.
- Protect from strong winds in the goat house, and by using wind breaks to slow the wind.

Separate any sick goats until they are cured to stop disease from spreading.



Goat products

Goat milk



Female goats produce milk that is very good and healthy for people to drink, especially children. It is good for people with asthma. The milk can be produced all year. Cheese and yogurt can be made from the milk.

Goat milk is valuable product that is rarely collected. Because there are many goats in East Timor there is potentially a lot of goat milk that could add to the diets of East Timorese. However, goat milking is a process that must be done properly and carefully or the goats can be permanently hurt. People need to be trained to milk the goats properly. And the goats ALSO need training to get used to the milking process.

For milking you need a milking room, some equipment and the goats require milking every day. The milking room and equipment must be kept clean and sanitary. The goats require a good supply of food to produce the milk every day. Growing trees for goat food is essential. If the milking is done properly it can be very worthwhile, providing milk for drinking, trading or even selling. For more information on techniques and materials needed please ask at Hasatil and read in the reference chapter.

Manure

A goat house will provide you with a lot of manure that can be added to liquid compost and composts. It can also be dried and spread around corn, cassava and other crops to improve production.

Land clearing

Goat can be used to clear areas of land that you want to use to grow crops or trees. They are very good labour that doesn't need to be paid. Just make sure they don't clear your neighbour's land too!

Cows

Cows are very important to East Timor's culture, economy and diet. The cow population, very much reduced in 1999, is increasing again, and with good management and breeding they can help to greatly improve the situation here.

Cows need a large area of land, a lot of food and water.

More cows can be raised on the same amount of land if you improve the grass quality, grow ground cover legumes for the cows and create windbreaks. The cows will also be healthier, larger and grow faster. Tree leaves will also improve their growth.

Food trees; Leucaena, Gamal, Sesbania, Calliandra, Moringa etc. They can also be planted as fences. A windbreak will improve the growth and quality of grass for cattle feed, reduce the stress and energy used by the cow and provide shade. Read about how to create windbreaks in the Large Scale Agriculture Chapter (CH 9).

Cow Needs	Cow Products
Food	Meat
Water	Money
Shelter/House	Manure
Health	Leather
Shade	Labour – grass control
Fence or rope	Ceremonial needs
	Milk



Cow Needs

Food

Cows mostly eat grass and legume ground covers. They can also be fed tree leaves like Leucaena, Gamal, Sesbania, Calliandra or Moringa. Cows need a large area of land for feeding.

Grasses and Legume ground covers

Good quality grass and legumes will result in larger, healthier cows. Land that is used for feeding cows can be managed to improve the quality and types of grasses and legume ground covers.

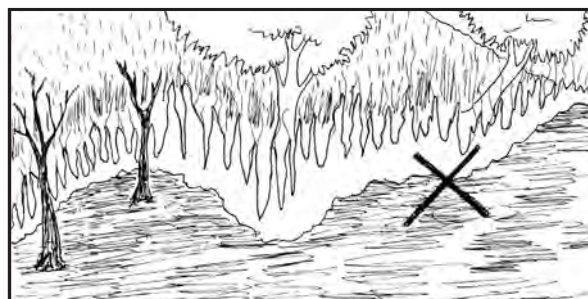
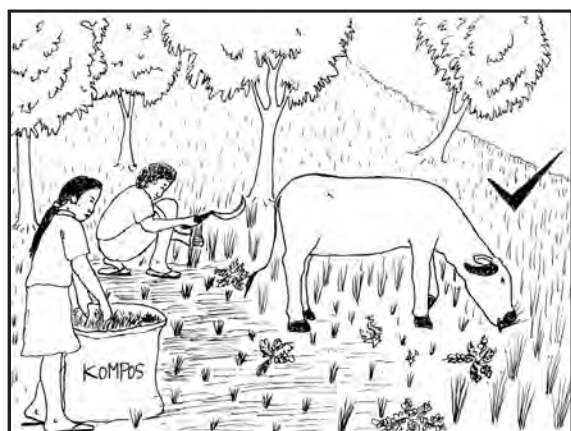
Techniques for good management:

- **Collect and spread seeds of legume ground covers.** New legume plants such as clovers can be introduced but local legumes are more likely to grow well. Legume plants are important to mix with grasses because they provide food containing important proteins and minerals. They also add nitrogen to the ground that helps the grasses to grow better.



- **Stocking rate:** The "stocking rate" which means the number of cows per feeding area, usually 1 hectare, is very important. If there are too many cows they will eat the grasses faster than the grasses can grow. This will eventually kill the grasses. Weeds that the cows can't eat will grow instead. The average stocking rate for East Timor is 1 cow per 2 hectares for good feeding land. It can be approximate but the important thing is that the cows have enough feeding area or are moved on before the grass is eaten too low.
- **New Growth:** Introduce cows after grass/legumes have a "blaze" of growth. This occurs after the grass/legumes are cut, eaten by animals or burned. (Preferably don't burn at all.) Move the cows on after first "cut". The first "cut" is the most nutritious for the cows, and if the cows are then moved, the grass is not damaged.

- **Cow rotation:** Use an order for feeding rotation, mothers and calves first, then other cows after. This is because the mothers and calves need the best food to grow well and stay healthy.
- **Burning:** Burning is a big problem because it increases low-quality grasses and weeds and decreases high-quality grasses and legumes. This is because the low-quality grasses and weeds grow back faster after burning. Burning too often will weaken the grasses and eventually kill them. Legume ground covers will die. Burning in the middle of the dry season is especially bad. Burning at the beginning of the wet season is much smarter. The ash will stay and not be blown away, and the grasses will grow back quickly. Areas where cows eat regularly should not be burned regularly.



- **Fertilizing:** Any type of fertilizing will improve animal feeding land. However, fertilizing a large area of land is either expensive or takes a lot of time.

Improving soil quality through good animal and land management is the best long-term solution. But some smart fertilizing at the beginning of the wet season will improve the amount and quality of food for the animals. This will increase the amount of meat on each animal, which will more than make up for the cost or time used for the fertilizing.

If possible, natural fertilizers are best and will provide much better results in the long term.

- **Weed Control:** Weeds are a big problem in East Timor and reduce the amount of land that is productive.

Techniques to reduce weed problems:

1. Mulching with cut grass and weeds.
2. Selective removal of weeds BEFORE seeding time. Any weed removal must be followed with planting good grass and legume seed.
3. Improving soil quality.
4. Some have been explained already. Using correct stocking rates. No burning. Rotating feeding land for cows.

Dry grasses are also valuable cow food.

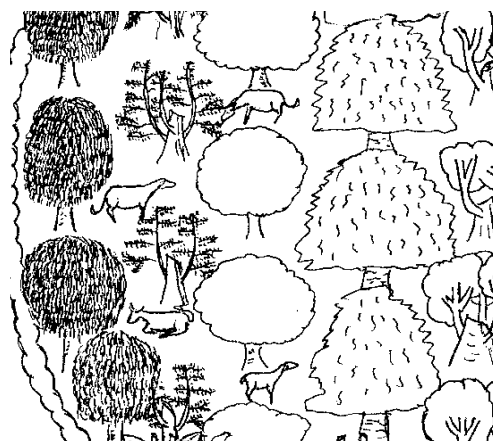
They are not as good as fresh grass but still provide feed. They are destroyed from burning. The dry grasses also protect the soil from erosion and wind in the dry season. Dry grass is better for the cows to eat than no grass!

Trees for feed

Grow and use trees to provide feed for the cows. In a well planned system the trees will provide feed, shade, wind protection, fencing, soil improvement and more. Trees will help to increase the stocking rate and improve the living conditions for the cows.

Water

Cows need a daily supply of water. If they don't drink enough water they will be smaller, weak and can become sick easily. Provide a continuous supply of fresh water in the yard.



Cow Yard

It is a small fenced area to keep your cows in at night. The size depends on the number of cows you have. The cow yard can be built close to where the cows feed. Make sure the yard is made on ground that dries quickly in the wet season. It will provide you with lots of manure for your crops and fruit trees. Cows don't need shelter but build the yard under some large trees if possible to provide some shade and protection from rain. A simple roof or large trees will keep the ground drier in the wet season, improving the cows' health.



SMART IDEA:

- Use a living fence to make the yard. The fence can be cut back to provide cow food.
- Make a compost area next to the cow yard. The manure can then be mixed immediately with grasses, rice husks and other compost materials to make compost.
- We strongly recommend to never keep cows permanently in very small yards. Cows need to walk around. If they are kept in yards with little or no grass, the cows **MUST** be fed at least 10% of their bodyweight in feed EVERY DAY.



Shade

Cows need shade to be cool and happy. Too much sun is not good for them. Remember, a happy cow is a healthy cow!

Health

- Keep cows away from wet, swampy areas.
- Clean their yard regularly to prevent disease from spreading.
- Treat any sores on the cows quickly to stop infections and worms.
- Give mulberry leaves and papaya seeds regularly to prevent and control worms.
- Keep mothers and newborn babies in a house or yard that is protected from rain and wind. It will help more babies to survive after birth and reduce chances of sickness for mothers and the babies.
- Cows also need to have sea salt. Provide a small basket and they will lick it as they need it.
- Separate any sick cows until they are cured to stop disease from spreading.



Cow Products

Manure

Cow manure is excellent for vegetables and fruit trees. Be careful with fresh manure because it can burn plants, especially young plants. It is better if it is dried or made into compost or liquid compost before it is used. See soils chapter for different compost methods. A cow yard will make manure collection much easier.



Cow systems

Rope and stake

A very simple method for a small number of cows that is good for keeping the cows where you want them. Move the cows often to give them fresh new grass, to prevent overeating and reduce soil compaction. Make sure they have access to water.

Alley farming

Alley farming is a strategy for combining cow and animal feeding with rows of productive trees and crops such as corn, cassava and taro.

Living fences help to divide up the land into rows and keep the cows (and goats, sheep and buffaloes as well) away from trees and crops.

It is important to plant the trees on contour with the shape of the land. On sloped land use swales or tree terraces to improve the system and stop erosion. The feeding rows should be between 5 and 10 metres wide.

See the Reafforestation Chapter (CH 7) for techniques on making tree terraces and swales. The alleys that are created can also be rotated between cows and growing crops when the fences are established. Don't introduce cows into the rows until after the tree leaves are above eating height. Alley farming creates high quality feeding land for cows. The living fences and trees between the rows can provide cow food, fruit, nuts, wood, bamboo and many other products.

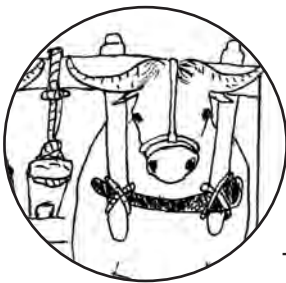


SMART IDEAS:

- Plant animal medicine trees too, to provide traditional medicines if an animal becomes sick.
- Be very careful not to let cows eat too often on land that you want to use for growing crops. Because they are very heavy they will make the soil very hard when walking on it often. This makes digging a lot harder and will reduce the size of your crop.

Wild legume paddy rotation

Read in the buffalo section about this technique. Cows can be used as well as buffaloes.



Buffalo

Like cows, buffalos are very important to East Timorese culture, economy and diet. And like cows they need a large area of land and a lot of food and water. Buffalos are good animals for wet, muddy conditions and can eat where cows can't.

The biggest benefit from buffalos is that they can be used for ploughing rice paddies and fields. Growth rate, size and health of the buffalo can be improved by providing high-quality grasses and food, growing food and shade trees and creating windbreaks where the wind is strong. These ideas will also increase the number of buffalos that can be kept in an area.

Buffalo Needs
Food
Water
Shelter/House
Shade
Water hole
Fence or rope
Health

Buffalo Products
Meat
Money
Manure
Leather
Labour – ploughing paddies and fields
Labour – grass control
Horns
Ceremonial needs
Milk

Buffalo yard



Buffalo needs

Food

Buffalos eat similar food as cows but they can live on land that is much wetter than cows can. Read the cow food section for different types of feed and land management techniques.

Water

Buffalo need to drink daily to be healthy.

Health

Buffalo, like goats and cows, need sea salt for good health. Provide a small basket for them to lick as they need to. Most important for the good health of a buffalo is shade and a water hole.

Keep their yard clean and provide good food and water. Treat any sores quickly to stop infections, especially cuts from the buffalo being used for ploughing. Use cloth or other pads to prevent cuts. Feed the buffaloes mulberry leaves and papaya seed regularly to reduce worm problems.

Keep mothers and newborn babies in a house or yard that is protected from rain and wind. It will help more babies to survive after birth and reduce chances of sickness for mothers and the babies.

Separate any sick buffalo until they are cured to stop disease from spreading.

Buffalo yard and shade

Buffalos don't need shelter at night but need shade during the day. However a simple shelter will improve their health.

If you keep the buffalos in a fenced area each night then you can collect and use the manure as fertilizer for your crops and fruit trees.

Place the yard in a dry area if possible to help maintain good health.

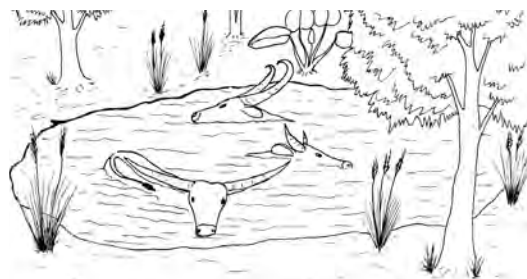


SMART IDEAS:

- Use a living fence to make the yard from trees that can provide food for the buffalo.
- Place the fenced area under some large trees to provide shade. Some food trees can be planted as well next to the fenced area.

Water hole

Buffalos need a water hole to keep cool during the day. If not then they suffer a lot from the heat and sun.



Buffalo products

Labour

Buffalos can be trained to plough fields and rice paddies.

Buffalos are excellent for this work because:

- Once a buffalo has been trained it can be used for many years
- They are A LOT less cost than a tractor
- They are A LOT less maintenance than a tractor
- They can be used in areas where tractors cannot get
- Almost anyone can learn how to use a buffalo
- They can plough steep land that tractors cannot plough

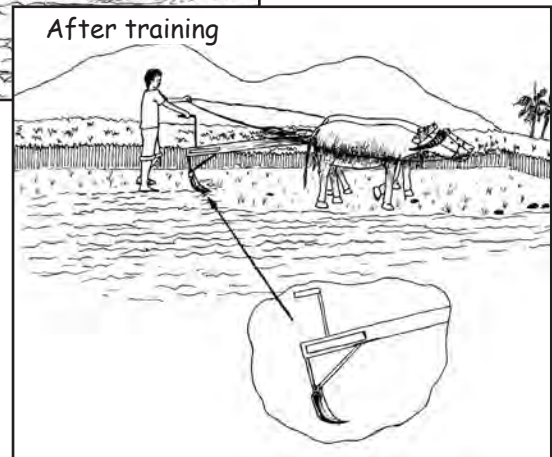
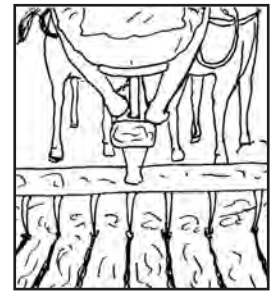
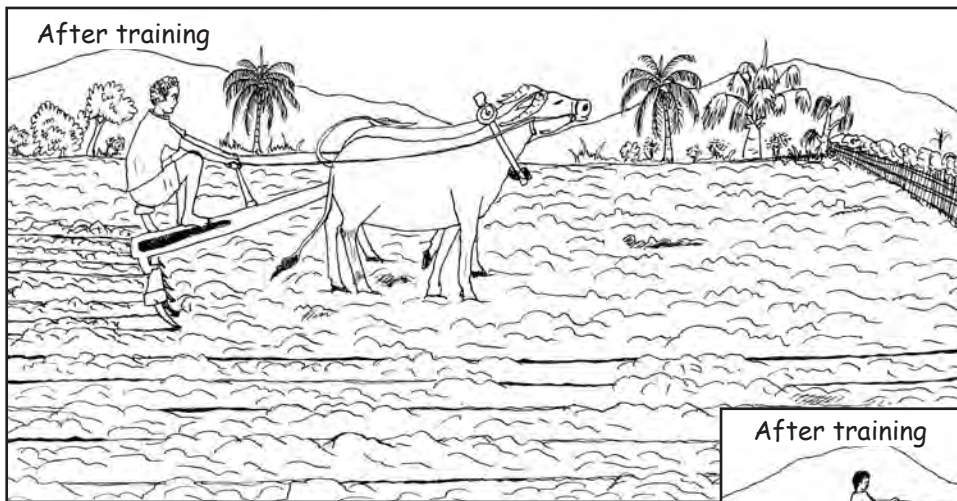
A Guide to Buffalo Training

Adapted from LikLik Buk, a guide book from Papua New Guinea. These notes are a guide only and any attempt at training Buffalo should be with trainers or experienced buffalo plough workers.



1. The first lesson is for the animal to untangle itself from it's own rope. This usually takes a week or two. Tie the rope around the horns or neck first, through the nose later.
2. It is good to have someone handling the animal everyday. Preferably it is the same person, who becomes a "friend".
3. It is better not to train the buffalo to work by having a person lead it from the front. But if you do, remember that the buffalo must learn to work with the person behind. Be patient.
4. For direction training (go left or go right), the person who trains should always be on the left and at the rear. The usual sign is a steady pull on the rope to go left and a gentle tug to go right.
5. After some direction training the buffalo can also learn to carry a person on it's back.
6. First hitch the animal to a small cart. This is easiest. Then use a plough, and finally a large cart. Slowly get the buffalo used to pulling and its skin will get tougher.
7. Incentives are very important. Let untrained or difficult buffalo train around other familiar buffalo, especially during direction training. Train animals when they are "partly" hungry, then after their work give them a bath, some salt and good grass.
8. The buffalo will always try to be rebellious at first but the person has control and the buffalo has to accept it. Treat it firmly but fairly, don't use force unless you have to.
9. Buffalo need shade when they are very hot and lots of water for drinking and bathing.

Bali cows (Karau mean) can be used instead and sometimes with better results.



Manure

Buffalos will provide you with a lot of manure. It is very easy to collect if you put them in a yard at night. The manure can be

- Put in compost or liquid compost.
- Dried and used straight on fields.
- Put around fruit trees.

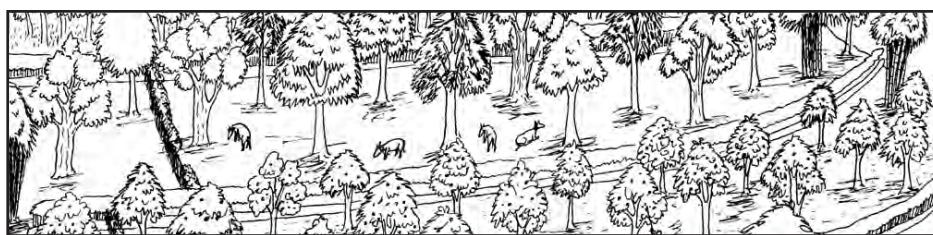
Buffalo Systems

Rope and stick

Tying a buffalo to a stick is an easy method if you want them to eat in one area. They must be moved often to provide the buffalo with new grass, and to make sure that it doesn't eat the grass down too much. Access to a water hole is also needed.

Alley farming

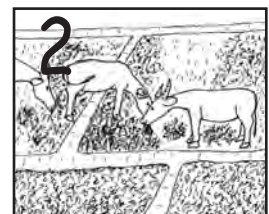
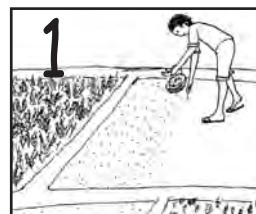
The same strategies can be used for buffalo as for cows. Look in the cow section and Reafforestation Chapter (CH 7) for techniques. Remember that buffalos can eat in wet areas that cows cannot. Therefore buffalos can eat in wetter areas with water loving trees, and cows can eat in drier areas.

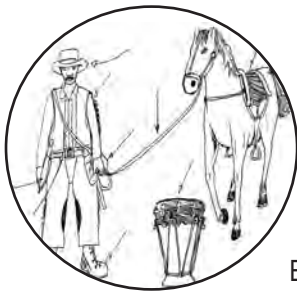


Rice paddies

After harvest of the rice, if there is water available, the empty rice paddies can be planted with native legume ground covers and beans. (Not poisonous beans) There are many of these plants growing all over East Timor. Collect and spread the seeds over the rice paddies. There is no need to burn first. Then flood the paddies once to wet the soil and start the plants growing. The plants can be watered again in a few weeks time if there is enough water. When the plants are about 1 – 2 months old, just starting to flower, let the buffaloes onto the paddies to eat the legumes. Benefits:

- Providing food for the buffalo.
- The legumes will improve the soil in the rice paddies and provide nitrogen.
- The buffalo will provide manure for the rice paddies.

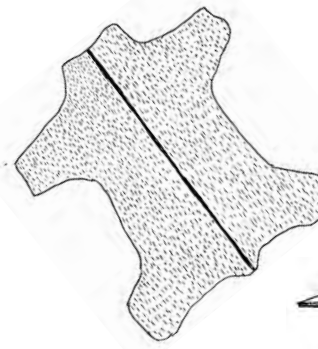




Leather

Leather can be made from the skin of many different animals. In East Timor buffalos and cows are used but goats, pigs and bibi rusa can also produce good quality leather.

Each type of animal leather has different uses because of the differences in thickness, toughness and weight. Some products and uses are bags, belts, clothing, shoes, horse straps, machete and knife handles and machete holders.



How to cure leather

Curing leather will make it last much longer and be much easier to work with. There are many methods for curing leather. The following method is simple and uses ingredients that are natural and cheap.

1. Soak in Water

Soak hides in water for 2 days.

2. Lime solution

Helps to soften and clean the skin and loosens the hair. Add 1 kilogram of lime powder for every 30 litres of water. Mix well. Soak the skin for approximately 3 – 4 days. Cover the bucket or drum to protect from animals.

The leather is ready to remove if the hair pulls out easily when the skin is rubbed. You can use less lime powder and leave the leather in the solution for longer. Check how easily the hair removes to find out when it is ready.

3. Wash

After the hair is removed wash the leather very well with water to remove the lime solution.

4. Tannin Solution

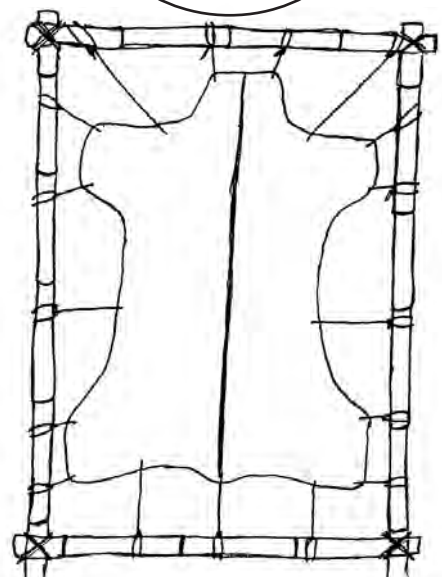
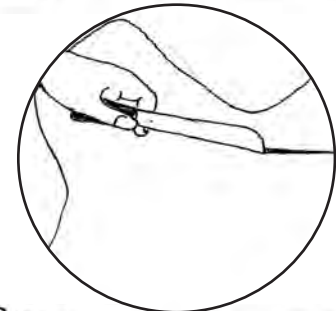
Tannin is a natural chemical that comes from many plants. Use the bark from Casurina trees, Cashew Trees, Indian Jube Jube Trees, Eucalypt trees or Acacia trees to get the tannin for the leather. The tannin preserves and protects the leather, making it last for much longer.

Make 2 different solutions. First make a solution using 1 kilogram of tree bark for every 5 litres of water. Soak the leather for 2 – 3 days. Then make a solution using 1 kilogram of bark for every 10 litres of water. Soak the leather for approximately 12 days, until the colour is fully changed.

To check when the leather is ready, make a cut in the leather 3cm from the edge. If the leather is the same colour all the way through, then the leather is ready. You can use less bark and leave the leather for longer, or use more bark and soak it for less time. You can also use tea leaves in the solution to add more tannin.

5. Dry

Wash very well with water then hang up to dry. Stretch the leather with rope between wooden poles to improve the smoothness and quality. Don't let the leather dry completely. When it is almost dry, place the leather on a flat surface and rub oil on it. Start from the center and rub outwards. Then hang again to dry.

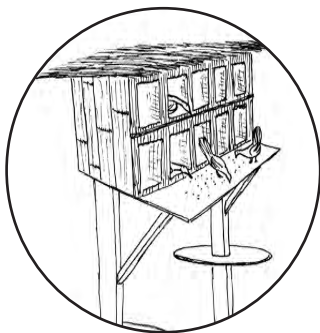


Pigeons

Pigeons are very easy to keep and breed. They are a good source of meat.

Pigeon houses are placed close to the house. The pigeons need to be protected from predators and rats.

Their house can be made from cheaply from mostly local materials. Pigeons will find most of their food but it is important to feed them some extra grains, like broken rice or crushed corn. Some natural food and water sources are ponds, trees and flowers. They need a supply of water as well.



Bees

Bees provide honey, which is a valuable product for eating, for health and for income. Honey provides lots of natural energy. Honey is a natural antibiotic and antifungal. It is sometimes used to stop infections on cuts and sores. Many people in East Timor also eat the honeycomb, with the bee eggs inside. This is also a valuable food source containing many vitamins and minerals. However, much of the goodness is lost if it is fried.

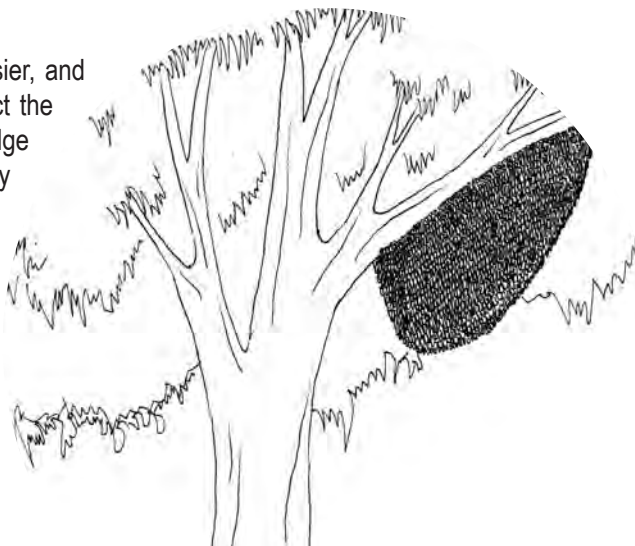
Honey in East Timor is collected from wild native bees.

Hasatil has information on making beehives (homes for bees) for the native bees. Native bees are then brought from the wild and introduced to their new homes.

Making a beehive will make collecting honey much easier, and more honey can be collected. But it isn't easy to collect the bees! Also, beehives require maintenance and knowledge to work well, and protective clothing for the workers. They can be very dangerous if not managed correctly.

East Timor's native bees and their very unique tasting honey **MUST** be protected. It is a valuable product.

If bees are introduced from other countries, they probably will also bring diseases and would compete with native bees for food.

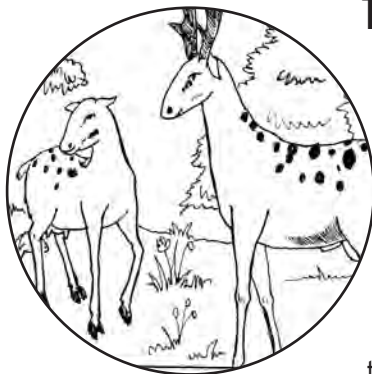


Timorese ponies

Timorese ponies are very important to East Timorese people and for the economy, especially in the mountainous areas.

They need to be treated well and they will return the service.

- Provide good quality grass to eat and water every day.
- Use old clothing or padding to prevent the ropes from cutting the skin.
- Treat any cuts or sores quickly to prevent infections and worms.
- Feed them mulberry leaves and papaya seeds sometimes (once every 3 months) to help prevent worm problems.
- Provide them some sea salt regularly for their health.



Timorese deer - Bibi rusa

Timorese Deer still live wild in some forests in East Timor. It is very important to protect and even expand the forest that they live in to ensure the survival of the deer and the many other forest animals and birds. Some people have caught deer to raise and even to breed.

In some parts of East Timor, mostly the southern half, they would be easier to raise than goats because they are much less destructive. The deer come from a forest system where they have lots of shade and water. Provide similar conditions for them to help keep them healthy and comfortable and to maximize their growth. If they are stressed they will be unhealthy, small and will produce less babies.

Living fences could be used to help feed them and keep them, and fruit trees and timber trees would combine well in a deer raising area.



Dogs

Dogs are a very common animal in East Timor. They are often used as guards to prevent thieves and are often eaten. But they are rarely well looked after. Dogs are loyal animals and good companions and if they are treated well they will be much more loyal and protective and will be much healthier.

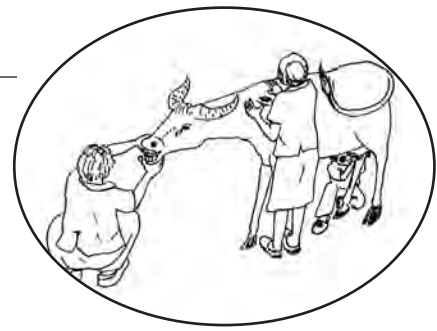
Some simple ideas:

- Let the baby dogs stay with their mother until 6 weeks old. This will greatly reduce disease problems.
- Any scrap food given will help their health and their size. Fish scraps, meat scraps, rice, vegetable scraps, etc.
- Give the mother dogs more food while they have puppies so that they can provide more milk.
- Add papaya seeds to their food sometimes to help reduce worm problems.

Working together with communities

Working together with neighbours and communities makes animal management easier and cheaper. It improves the wealth and health of the whole community. This already happens a lot in East Timor e.g. animal feeding land.

There are many ways to improve animal management by working together.



Health

Disease prevention through good animal health and clean animal yards is most important. However, when diseases do occur, it is important to work with government agriculture workers and the community to prevent diseases spreading.

This involves:

1. Identifying diseases
2. Separating diseased animals from other animals
3. Treating the disease quickly

Use traditional medicines if possible, but if you need to buy medicines, this is also cheaper to do in a community group.

Take care not to spread diseases in a community and from one community to another.

Some animal diseases can be prevented by vaccination. For example Newcastle's disease for chickens, Anthrax for pigs. It is the same as when children are vaccinated for Tuberculosis and measles. Vaccination **MUST** be performed in the whole community to work properly. And it is much easier to organize vaccinations through community groups or local NGOs. Government Agriculture Workers and some NGOs have vaccinations programs in some districts.

Community Animal Breeding

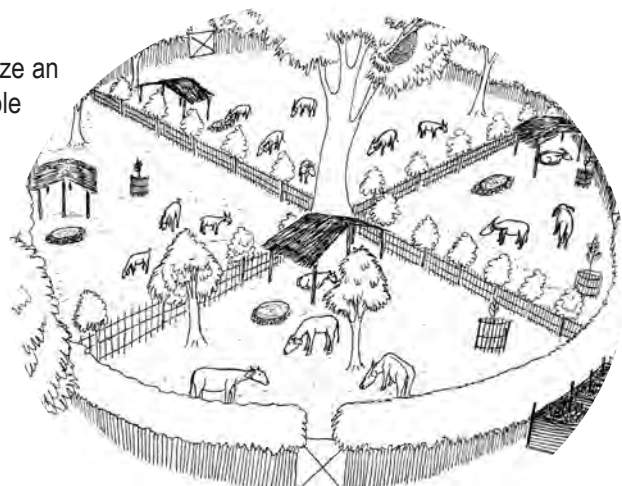
It is important to try to use the healthiest males for breeding. This is much easier to do if the animals are in a fenced area. The healthiest male animals, e.g. bull, can be chosen from a community to breed with the female cows. This will produce healthier babies and will improve the quality and health of the animals.

A breeding system can work when a community group buys some breeding animals. The community group looks after the animals and the families in the group divide the young.

- **Example 1:** A community group is formed that buys 3 pigs, 1 male and 2 female. One family in the group keeps and feeds the pigs. When the females have babies, the babies become the property of the family. When the young pigs are old enough, the 3 original pigs are given to another family in the group. And so on.
- **Example 2:** A community group buys 3 female ducks and 1 male duck. The group builds a duck house and yard. The work and feeding is divided between the group members. When baby ducks are born they are shared between the group to keep for themselves. Or the young and eggs stay in the community duck house and the extra ducks and eggs are eaten or sold by the group.

These are only 2 examples. There are many ways to organize an animal bank. It is important to plan from the start. For example

- What happens if the animals get sick or die?
- Are there rules for taking care of the animals to prevent sickness?
- How are the young animals divided between the families?
- Who supplies the feed? Each family or as a community group?
- Who does the work and supplies the building materials?



Community land animal feeding

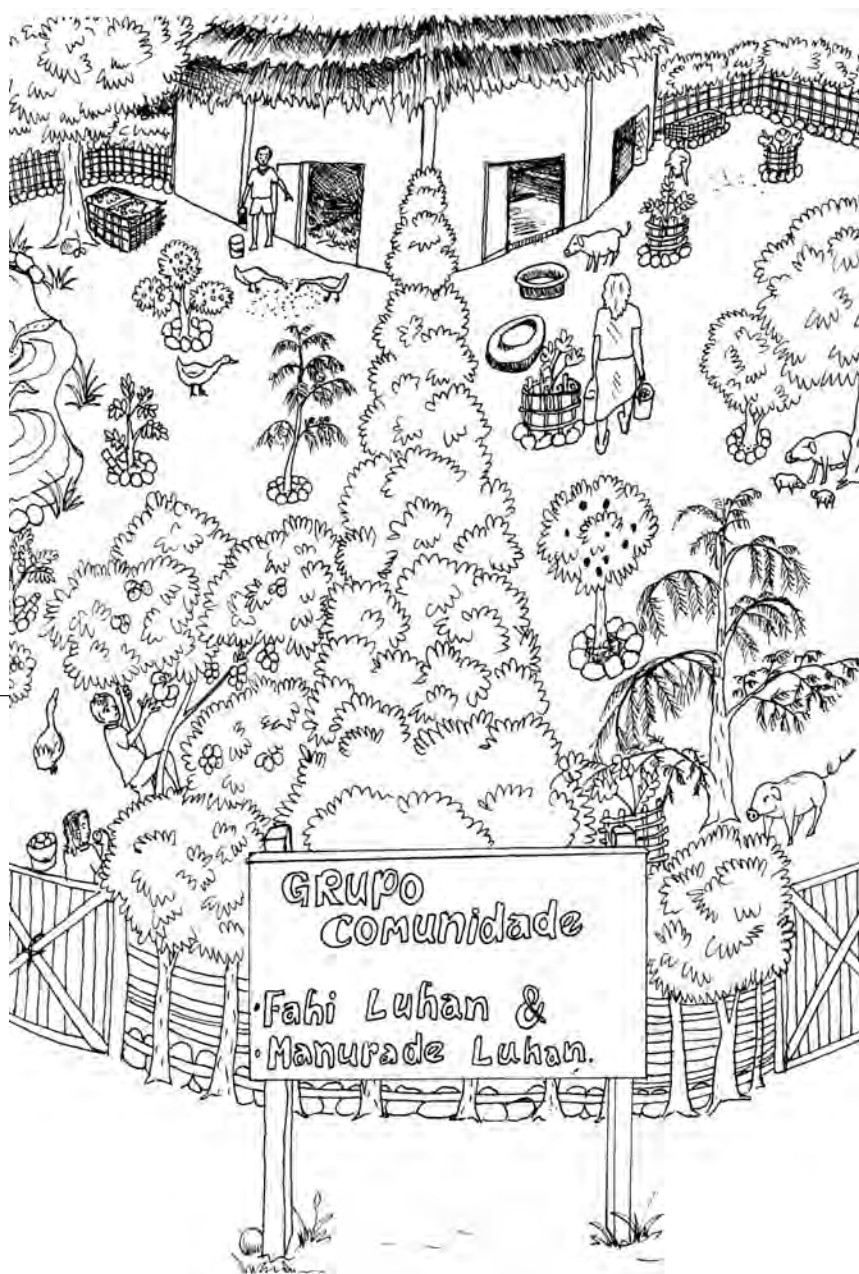
This already happens a lot in East Timor. It is important that it grows. Labour time is reduced and resources can be shared. E.g. water supply. Factors for community land feeding:

- Move animals regularly to prevent over-eating of the land.
- Tree crops can be mixed with feeding land, e.g. alley farming, and can improve animal production if managed well.
- Take care not to let animals eat young trees and crops.

Community animal yards and houses

A community animal yard or house can be built on community land. Neighbours can also share an animal house or fenced yard. It is best if it is built near community or shared feeding land and under some shade trees. A good water supply is also needed. A feeding yard can also be made. The feeding yard can be used to fatten animals before eating or selling them. It will provide many benefits:

- Less labour and resources to build 1 big shelter than many small shelters.
- A lot of manure can be easily collected for fertilizer, trading or selling.
- Easier for providing feed and water.
- Better for marketing and selling animals.



Stopping animal damage to crops and trees

Animals can destroy crops and small trees very quickly. The best way to prevent this is by working with your community to understand the problem and make an agreement. Community meetings are a good way for everyone to come together to find a solution. This can include:

- Long-term plan for animal feeding, crop and tree areas.
- Community and individual fences.
- Where animals can and cannot feed – this will change at different times in the year.
- Penalties for animals eating crops or trees.

Land, River and Spring Protection

This is very important for the future of East Timor. Rivers and springs must be protected and erosion must be controlled and prevented if East Timor is to grow. It is a family, community, district and national concern. Therefore solutions must be found for all these levels.

Springs will be damaged or destroyed and spring water made dirty if animals are allowed to drink directly from them.

River damage from animals comes from:

- Animals, especially cows and buffalo damaging the river edge
- Animals eating river edge plants
- Animals walking in the rivers

Erosion from animal feeding comes from:

- Removing too many trees from sloped land.
- Removal of grasses through overeating.
- Burning
- Not protecting the soil.

Solutions - Family and Community

Animals need water but where they drink from can be controlled.

Springs

- Make a drinking water hole down from the spring via a trench and fence around the spring to stop animals drinking from it.
- Make a water storage tank or cemented area where the spring water comes out and use taps, pipes or overflow trenches to provide water for people and animals.



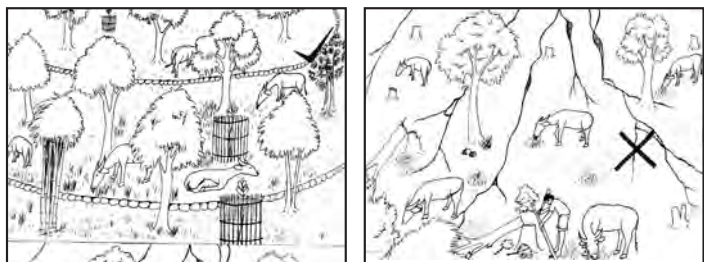
Rivers

Keep the vegetation on the river edge. The vegetation stops the animals and stops the soil from going into the river. Use fences to allow animals to drink from only a few places to keep damage minimal. In mountain areas this is very important.



Erosion

- Swales, tree terraces or small rock mounds on the contour of the land will hold the soil and prevent erosion. Or plant rows of trees. These trees will catch the soil and slowly create terraces. See the Reafforestation Chapter (CH 7) for techniques.
- Leave some large trees on animal feeding land because the roots hold the soil.
- If animals eat all the grass back to the ground in an area, then the grass will not grow back. Move them to a new area before the grasses are fully eaten so that the old grasses can re-grow. If not, the soil will erode.
- Stop burning!



District and National

District and National governments can work together with NGOs and community groups:

- a. To identify needs like spring protection or erosion and mudslide prevention
- b. To make a long-term plan to solve the problem
- c. To apply step by step solutions

Marketing

Marketing animals is an essential part of animal production. In communities animals can be easily traded or sold. But if the animals are to be sold at the district towns or in Dili then transport and a good holding/selling yard become important. An example is the area at Manleuana in Dili where Oecussi farmers bring their cows and goats to sell. The farmers keep their animals there until they sell them. Many different issues must be addressed when setting up a holding/selling yard, including:

- Manure sales/trading. Compost making and selling can happen as well. This could help pay for transport or feed
- Diseases. Controls and preventative measures can reduce chances of diseases starting or spreading
- Animal shelters
- Market days
- Prices
- Animal feed
- Transport

Drying and storing meats

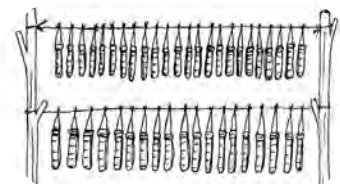
Meat becomes rotten very quickly in East Timor's hot and humid climate. Animal meat is wasted if it is not used quickly. There are some simple methods to make fresh meat last much longer. This is very important to improve people's diets because you can eat meat more often.

Drying Meat



1. Meat can be cut into small pieces and dried using a solar drier. The solar drier must be used because it protect the meat from flies, insects and animals, and makes the meat dry much faster. First rub the meat with salt to help to preserve the meat for longer. Look in the Appropriate Technology Chapter (CH 14) for how to make and use a solar drier.

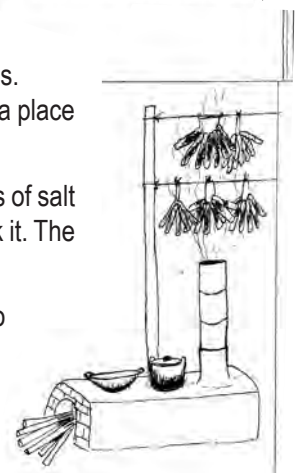
2. Dried salted meat. Use any type of meat. Cut the meat with the grain into strips 3 cm wide and 1cm thick. They can be any length. Make a solution of 7 litres of water and 1kg of salt.



The solution (brine) should be salty enough to be able to float a raw egg in its shell. Soak the meat strips in the brine solution for 2 days. Remove and wipe dry. Then hang the strips from thin rope or wire in the sun. Tie and hold the meat with grass. Protect from flies if possible. When dry the meat strips can be smoked or just stored in a place with good air flow and preferably free from insects.

3. Smoking meat. It is best to soak the meat in a brine solution (same as above) or rub lots of salt on it first. The meat will then last much longer. The idea is to dry the meat but not to cook it. The smoke adds to the flavour and preserves the meat.

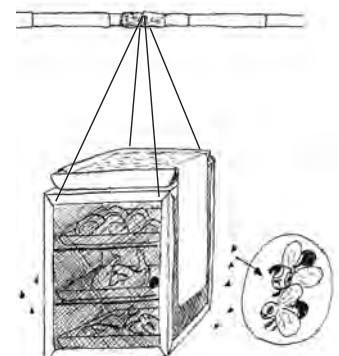
Use a wood which will add a good flavour. Eucalypt wood is not good because it is too strong and bitter. A clay stove with a chimney pipe is the best way to direct the smoke onto the meat. Hang the meat strips above the chimney pipe. After smoking store in a place free from insects with good air flow.



Storing meat

Always store meat so that it is protected from flies, insects and animals. Good air flow is also important.

If you have specific containers to store meat only use them for meat not for vegetables, breads or other foods. The bacteria from the meat will make the other food go rotten much faster. A "Koolgardie Safe" is a wire box that keeps produce cooler and protected. It can be used for both fresh and dried meat. Read in the appropriate technology chapter for making and using these containers.



Animal Rights

Animals are living beings that deserve respect, same as people.

It takes no more effort to treat animals kindly than badly. Animals react to kindness or meanness in the same way as humans, and this directly affects their health and behavior.

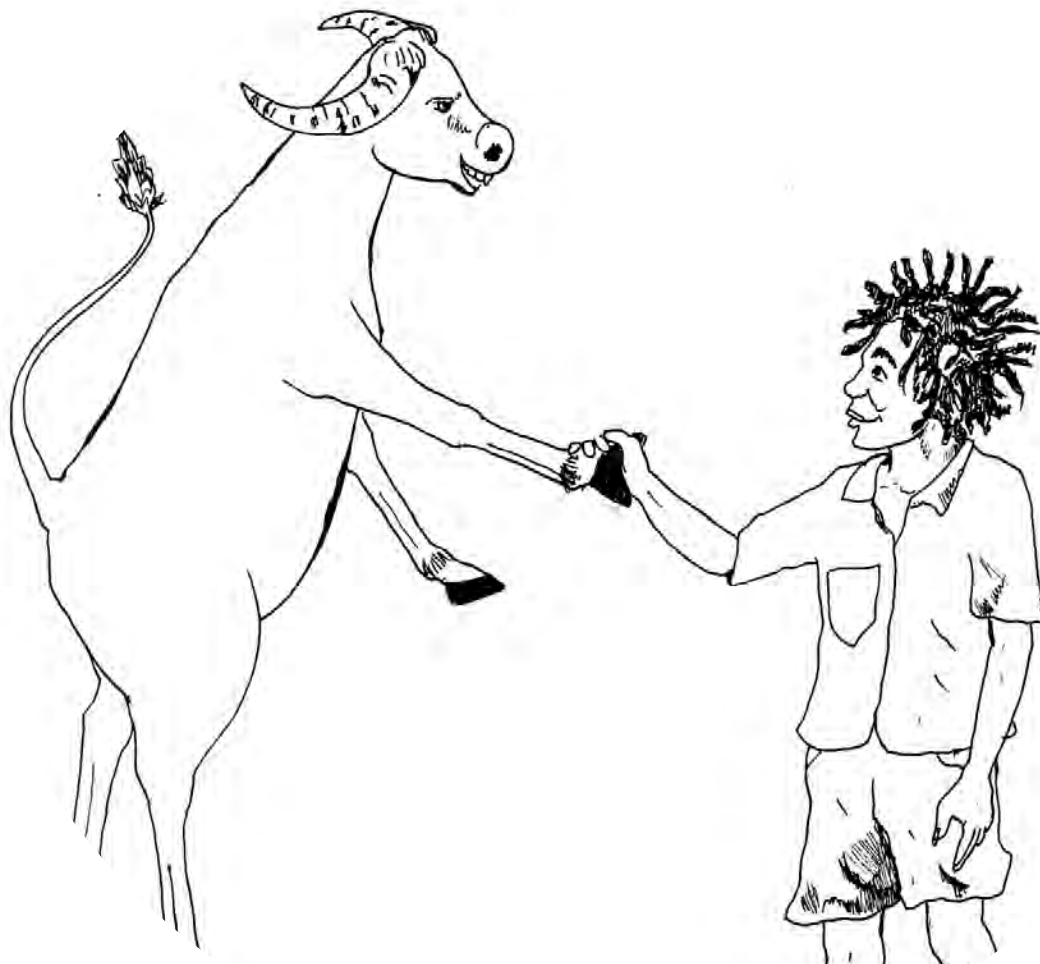
Violence and cruelty towards animals is completely unnecessary and only leads to scared, unhappy and unproductive animals.

Also, killing animals slowly and painfully is very cruel, disgusting and disrespectful! If they are killed slowly they will also be very stressed. Because of the stress the meat is, contrary to some beliefs here, much tougher and less tasty. It is also important to look after them well because you get many benefits in return. If they are looked after badly they will be unhappy, less productive, much less healthy and have less meat.

If animals are looked after well they will:

- **Be happy**
- **Be more productive**
- **Be much more healthy**
- **Have more meat**
- **Live longer**
- **Produce more babies and healthier babies**

A happy animal is a productive animal!





Aquaculture



CHAPTER

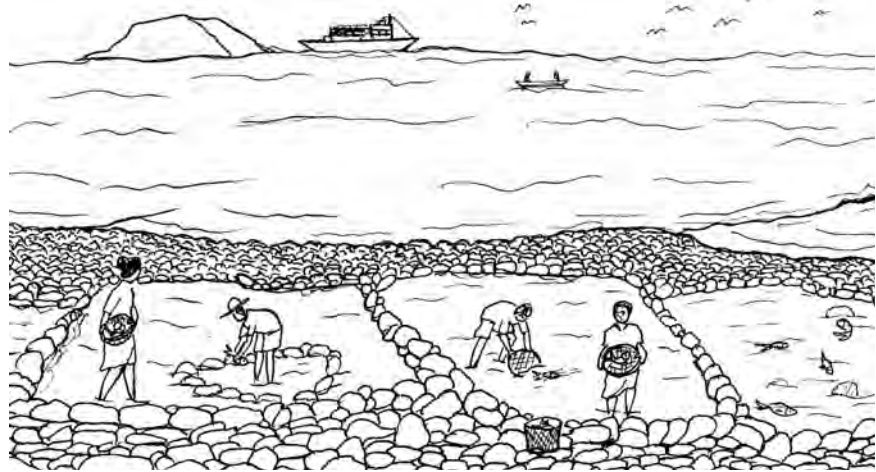
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Aquaculture is the name for any type of water, pond or wetland area where water animals (fish, eels, crayfish, prawns) and plants are grown. East Timorese are very reliant on the sea and it's resources. Fishing, including trapping fish in rock pools, is part of East Timorese tradition and culture. Fish is an important part of the diet and a good source of income.

In East Timor inland aquaculture (fishponds) has also been practiced for many years. Fishponds can provide fresh fish, and other products for food and income:

- Fish, prawns and eels can be raised for eating or selling.
- Kang kong, watercress, taro, bullrushes and lotus are some of the many plants that can be grown for food.
- Bamboo, fruit trees, vegetables and other plants can be grown around the edges of the fishponds.



Breeding fish is only one part of a healthy aquaculture system. There are many other factors that help keep the system healthy and productive. Plants, bacteria, insects, trees and other animals all have important roles.

There are also many more valuable products and uses for an aquaculture system. Additional animal and food production can be integrated as well. There are examples at the end of this chapter.

Why is aquaculture important?



1. Fish and other water animals are an excellent source of protein and nutrition. Even a small pond can provide enough fish to greatly improve diets and health, especially for children. The meat can be eaten fresh, as it is needed. Fish can also be traded, sold or dried for later use.



2. An aquaculture system will provide more meat for the same area of land than any other animal. It is the most efficient way to produce high quality meat with lots of protein.

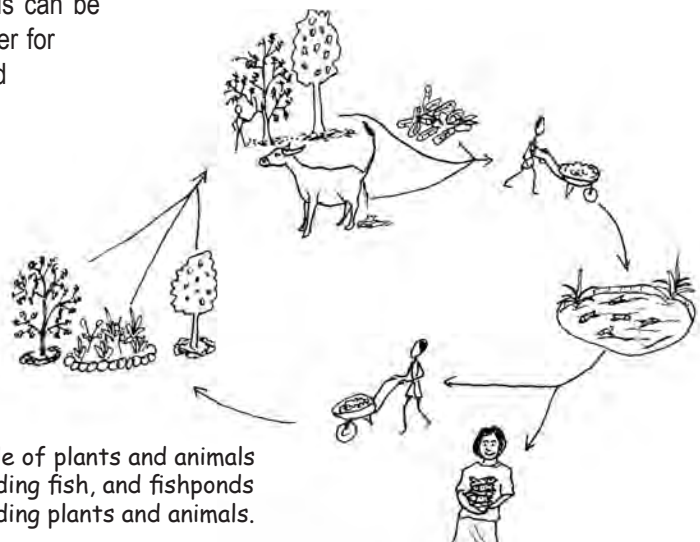


3. Aquaculture has proven to provide income to families and communities in the districts, especially in the inland mountain areas.



4. After fish are harvested the ponds can be cleaned to provide high quality fertilizer for plants. Be careful because it is strong and will be very high in nitrogen. If using for vegetables, mix a small amount with water, the same as liquid fertilizer, Pond water is also good low strength fertilizer. If the ponds are close to the vegetable garden it will reduce the heavy work of carrying water.

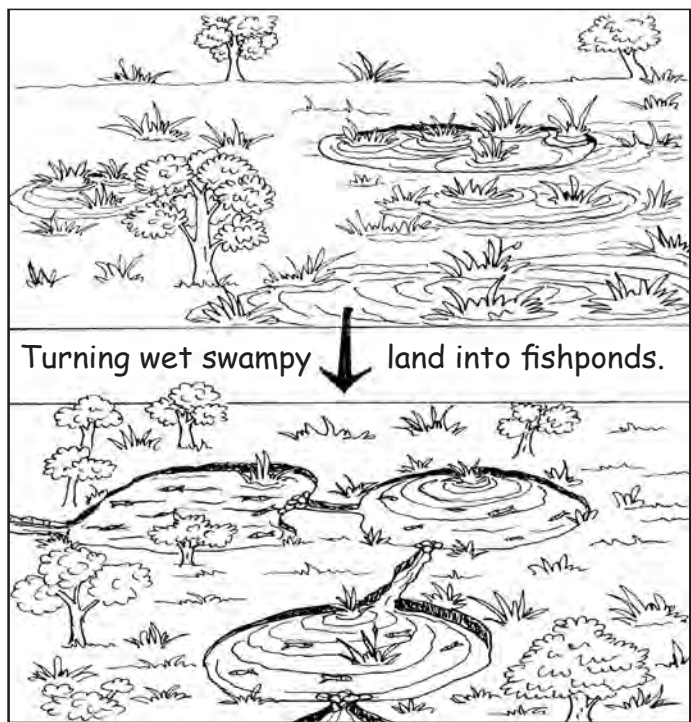
5. Aquaculture systems are a great way to turn animal waste and plant waste into food for fish and water plants.



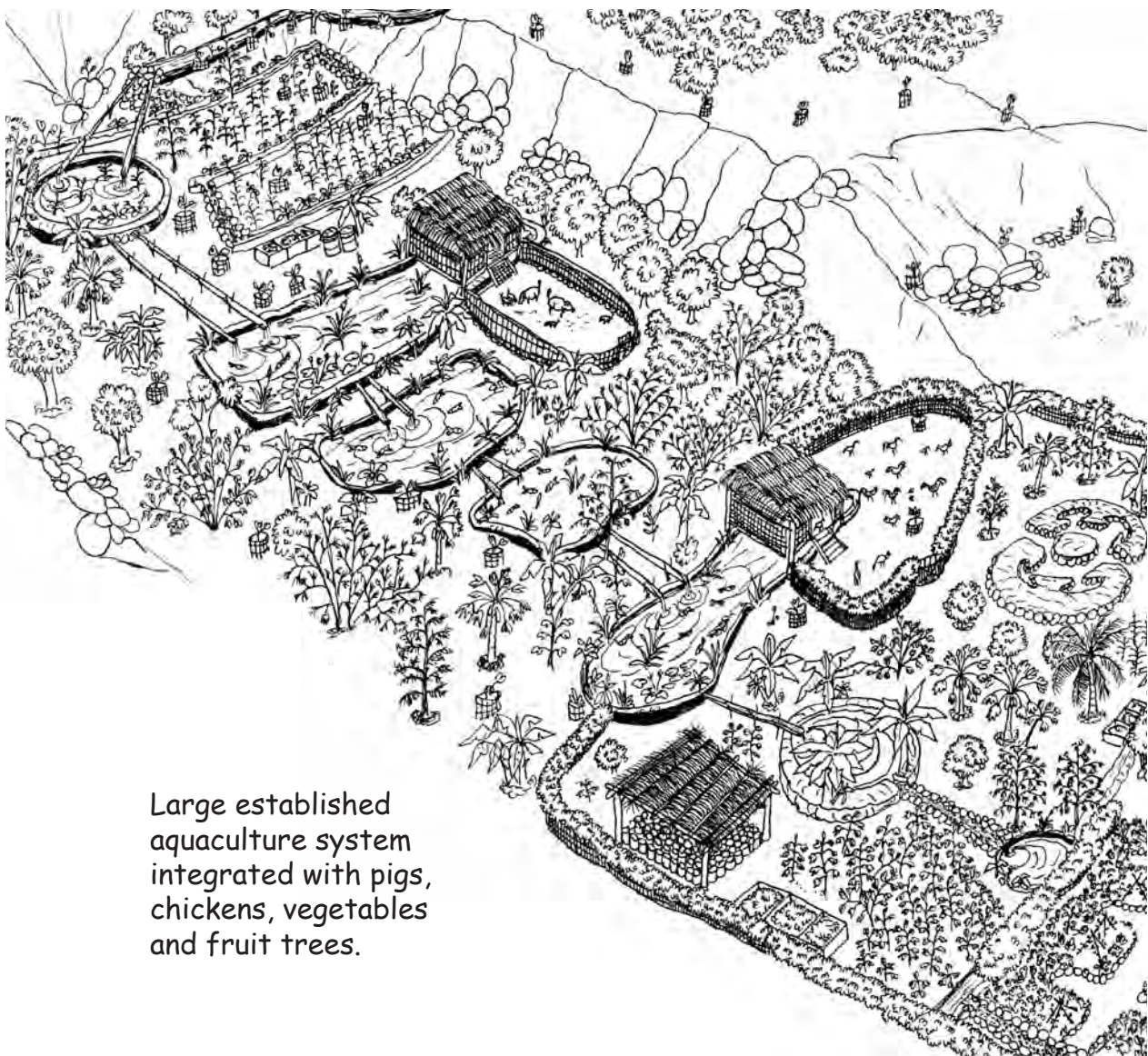
Cycle of plants and animals feeding fish, and fishponds feeding plants and animals.

6. Aquaculture systems can be made on land that has low productivity or cannot be used for other plants and animals, especially swamp land. Therefore, overall production, food and income from your land will be improved.
7. Rice, chicken, pig and duck production can all be combined with aquaculture to improve production in both systems. It can also be integrated with terraces, swales and other water catchments.
8. Aquaculture systems assist water flow and drainage in the wet season. In the dry season they provide a store of water that can be used for animal water.
9. Aquaculture systems change and modify the climate. They make the surrounding temperature less hot or cold therefore making it a more comfortable climate.

This is beneficial for trees and crops and for house areas as well.



This chapter will explain how to make and manage an aquaculture system, how to use all the extra benefits, and how to integrate it with other animal and plant production.



Large established aquaculture system integrated with pigs, chickens, vegetables and fruit trees.

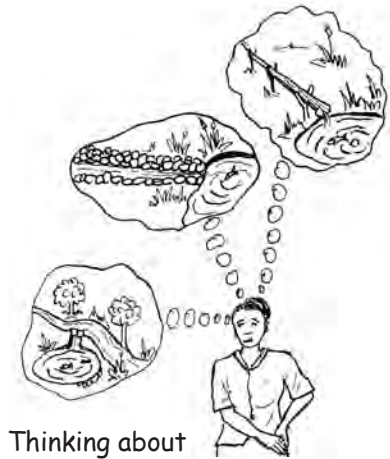
Step by Step Aquaculture Systems

An aquaculture system, whether large or small, will be easier to build and maintain if the community works together.

Objectives

- To create a pond or ponds that are productive, healthy and are as self-maintaining as possible.
- To create ponds with as much edge as possible. More edge = more food = bigger, healthier fish.
- To produce many different foods and products from the same area.

Aquaculture System Needs	Aquaculture System Products
Construction materials	Fish, prawns, eels
Labour	Vegetables
Water	Fertilizer
Water Plants	Mulch
Land plants and trees	Better climate
Fish, prawns, eels	Prawns
Fish Food	Bamboo, Tree products
Oxygen in the water	Fruit



Thinking about water source and slope

Location

Fishponds need a continual supply of water. Therefore they need to be located near:

- An irrigation channel.
- A river or creek that runs all year. Be very careful not to choose a site that might become flooded in heavy rains. Pipes, bamboo or water channels can be used to direct water into the ponds.
- A spring.
- Pumped water, house water, or any other continual unpolluted water source.



Gently sloped land will make it easier for draining and cleaning fishponds and for running water into and out of the ponds. This is especially relevant if you want more than

one pond in an aquaculture system. Flat land is still good but requires a little bit more work for maintenance and water supply. Steep sloped land is more difficult to work with and requires more maintenance.



Sun

For most districts in East Timor a small amount of shade will be beneficial for the fishponds. The shade will reduce the water temperature – fish don't eat much in hot water and may die. Shade will also reduce the evaporation rate of water from the ponds. Bigger ponds don't change water temperature as much as small ponds and the shade is less important. Some shade can be provided by trees and by water plants that cover the surface. Use trees that provide only light shade and that can be cut back as needed. E.g. Moringa, Sesbania, Leucaena, wax jambu, Mulberry, Bamboo. For small ponds, a simple shade structure of bamboo and palm leaves will provide temporary shade until trees grow tall.



Careful

Too much shade is also a problem because fishponds do need direct sunlight for plants to grow and for the system to be healthy. At least 1/2 day of direct sun is good, morning sun is best. In the cooler mountain areas where it can get very cold at night the fishponds will need plenty of sun to warm the water during the day.



Size

It is better to have many smaller ponds than one or two very large ponds.

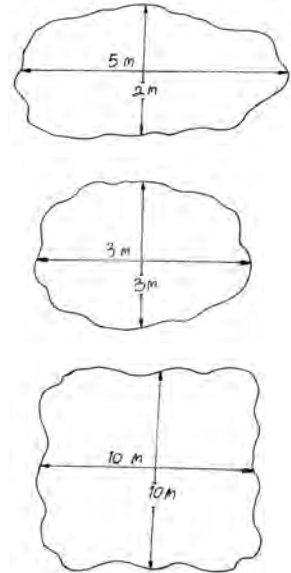
The size should be a minimum of 3m x 3m or 5m x 2m.
This is so the water can stay cool.

Approximately 5m x 5m (25m²) to 10m x 10m (100m²) is a good size for fishponds.

But remember, larger fishponds means a lot more digging!

Start smaller and if the pond goes well, build another one.

- Smaller fishponds are easier to manage, clean and harvest.
- If a problem occurs in a pond it will affect less fish.
- There will be more edge, therefore more food, therefore larger fish.
- The ponds can be harvested at different times.

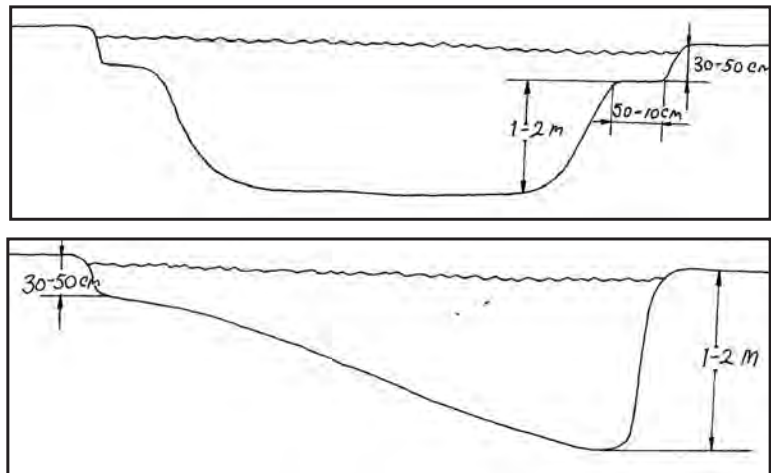


Depth

The ponds need to have a variety of depths to function properly.

A shelf around the edge and a deeper section in the middle is ideal. Or they can be deep at one end and shallow at the other end.

A shelf or shallow area provides a place for water plants that provide human and fish food, homes for small fish, and warmer temperature areas that promote plankton and pond animal growth (food for fish).



Some fish e.g. Tilapia, need a shallow area to breed.

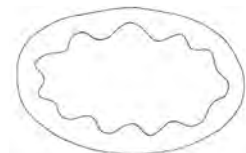
A good size shelf is about 30 –50 cm deep and 50 – 100cm wide.

Two shelves of different depths are even better. Shelves create edges in the water (more edge = more food = bigger, healthier fish), and are an essential part of a self-maintaining aquaculture system.

Most of the fishpond should be a minimum of 1 metre deep. About 2metres deep is better, especially for small ponds. This gives the fish a cool place to escape to on hot days. It is essential for producing fast growing good quality fish.

Shape

A fishpond can be whatever shape you want to make. More edge around the fishponds means more area for growing water plants and fish food and more area for growing plants and trees around the pond.



SMART IDEAS:

- Square and circle shapes are faster to dig but provide less edge. Dig a simple shape for the deep part of the pond – easier digging, then change the shape for the top shelf – more edge.
- When planning the shape of the fishponds always think of them as part of an aquaculture system that can also include vegetables, fruit trees and other animals.

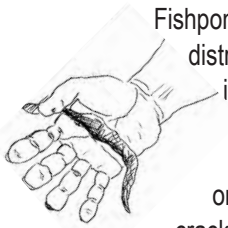
Construction

The construction of an aquaculture pond is hard work. People working together, especially when digging, will make the work much easier. **Work smart, not hard.**



- Start digging in the middle where the deepest part will be. Gradually move outward and don't dig too deep too fast.
- Wet the ground as you go to make the soil easier to dig.
- The clay or soil that is dug up can put around the edge of the pond to raise the height of the edge. This will greatly reduce the amount of digging!!!
- The extra clay or soil can also used to create an extra shelf to provide more plant production area.

Clay or cement?



Fishponds are cheaper and easier to make if they are made from clay but it depends if good clay is available. Most districts in East Timor have excellent clay for making fishponds. A good test is to wet a handful of clay and roll it into the shape of a snake approximately 1 cm wide. If the clay sticks together then it is good to use for a fishpond. Cement can be used for smaller ponds and for where there is no good clay available. Cement holds water much better than clay. Clay lining can be used if good clay is nearby. Make a layer 5cm thick or more. 10cm is much better if possible. Be careful that it doesn't dry out in the dry season or the pond will crack and leak. It may need to be resealed with fresh clay occasionally. Cement lining is usually less work.

Over-all, if clay is available, clay ponds are recommended because:

- * They are much cheaper and easier to make.
- * It is easier to grow water plants.
- * Less work providing fish food.
- * Plants and trees grown nearby will benefit from the water and nutrients in the soil.
- * They provide a healthier environment for the fish.
- * They work much better as a self-maintaining system.
- * The pond bottom can be used as vegetable gardens in the dry season.

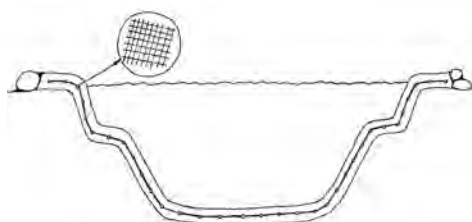


Clay pond techniques

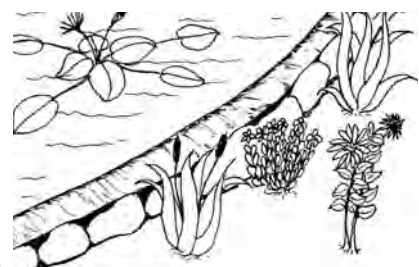
When the fishpond has been made to the desired size and shape the clay can be compacted and sealed to reduce water leaks. This will help a lot, especially if there is a limited water supply. A good method is to use cows, buffalo, goats or even people to walk in the ponds and make the clay compact. Fresh cow and buffalo manure also helps to seal the pond. Lime powder can also be used to help seal the pond. It will help to balance water PH levels as well. Use 2 – 3 kilograms for 100m² (10m x 10m).

Cement pond techniques

The amount of cement used in the cement mix needs to be more than for making bricks so that that cement is stronger. It is important to use wire mesh because it holds the cement together and stops cracking. A line of rocks around the top will help the cement to hold and looks good too. Keep the cement moist for as long as possible. If cracks appear, a final coating of cement and water painted on will help to seal them. Once the cement is dry, paint it with vinegar then fill it with water. Leave for 2 days, then empty the water and repeat the process. Empty the pond again then fill with water and empty one more time. This will make the cement safe for fish.



Cement cross section with wire mesh



Water for the Fishponds

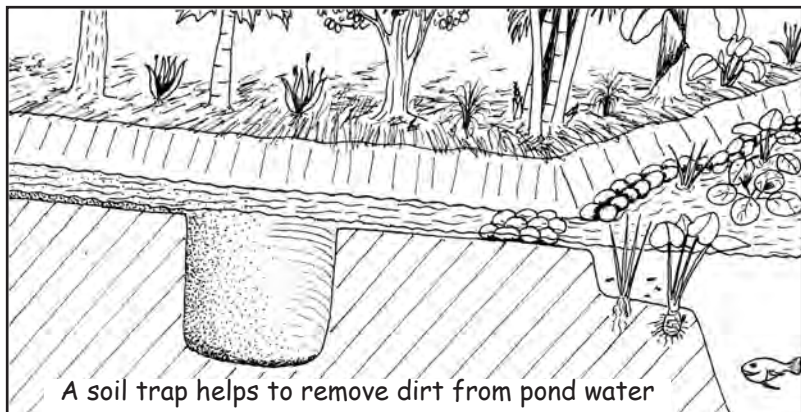
The water that flows into the fishponds must be kept as clean as possible to stop the fishpond from filling with soil. Water from rivers especially can contain a lot of soil, and must be cleaned first. Too much soil can create problems with natural food production and the fishponds will need to be cleaned much more often.

If you are going to use a water channel to collect water from a spring or a river:

- Line the channel with rocks or cement. Grasses or small plants planted either side of the channel will help to stop erosion as well.
- First run the water into a pond used only for growing water vegetables. This pond will catch the soil and clean the water before it enters the fishponds. Remove the soil from this pond as needed and use on vegetable gardens
- Or dig a “soil trap” in the trench before the water enters the fishpond. Soil will drop out of the water to the bottom of the soil trap as the water passes over it. Make it 1 metre deep if possible. The soil trap can be emptied whenever necessary. The soil that is collected is good quality soil and can be added to vegetable gardens.
- You can even use a water vegetable pond or a soil trap for piped water.



Water channel from spring to fishpond.



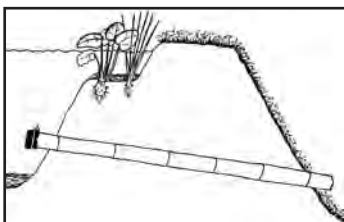
A soil trap helps to remove dirt from pond water



SMART IDEAS:

- If there is good water supply, line the water channel with rocks, so that some water will soak into the ground. This water can be used by planting fruit trees near the trench. (E.g. coffee, citrus, pineapple, papaya). This can be a highly productive area.
- If the amount of water that flows into the fishponds is small and needs to be increased, line some or all of the water channel with cement.

Drainage pipe



On sloped land a drainage pipe can be added during construction. The pipe can be made from bamboo, or can be plastic or metal pipe; whatever is available. Block the end of the pipe that is in the water to prevent leaks. The pipe is used to empty the pond when needed – it is much, much easier than using buckets!!!

You can also use a plastic hose to drain the pond. Fill it with

water, then place one end in the pond, and the other end below pond level and keep it closed. When ready, open the bottom end. The water will empty through the hose using gravity. This only works on sloped land and is good for clay ponds.

Don't forget to use the nutrient rich water as fertilizer.

Danger

Fish are very sensitive to pesticides and herbicides in the water. It can make them sick or kill them. Do not use them on land above your fishponds because it may enter the water supply. It is important to address this issue on a community level, as what other farmers do on land above you may affect your aquaculture system.

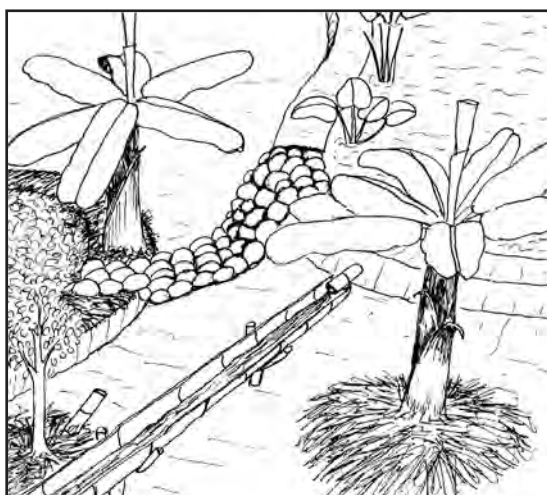
Water Overflow points

An overflow point is where the water will leave the pond.

It is needed to prevent pond wall damage and to direct the water where you want it to go. It should be large enough to cope with water from heavy rains. It can be a low point in the pond wall, secured with rocks and possibly even cement to stop erosion.

A piece of large bamboo placed in the wall will also work well. A piece of screen wire at the overflow point, or covering the end of the bamboo that is in the water will stop fish from escaping. It will also help to keep the overflow clean, which is important if the overflow water runs into another pond.

Try to run the overflow water into rice paddies, swales (read Reafforestation Chapter (CH 7) about swales), banana pits or other water catchments to make use of the nutrient rich water.

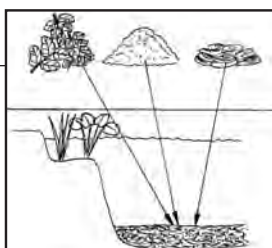


Draining a pond and making use of the nutrient rich water

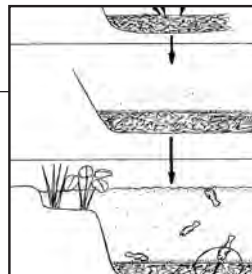
Fish production

To create a healthy, sustainable system and good fish production, all the different parts of a pond system need to be addressed. Plants, manure, bacteria, plankton, frogs, insects, leaves, fruit, trees, other animals and people all play their part in creating a good environment for raising healthy fish. A healthy fishpond will have water that is a light green colour. This means that there is plenty of plankton and other food for the fish. To achieve the light green colour, the fishponds need to be prepared and well managed.

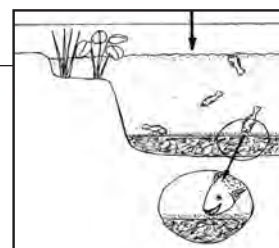
Creating plankton



1. Add leaves, manure & soil.



2. Plankton grows from the decomposing materials.



3. Fish eat the plankton.

STEP 1: Prepare the fishponds

Lime

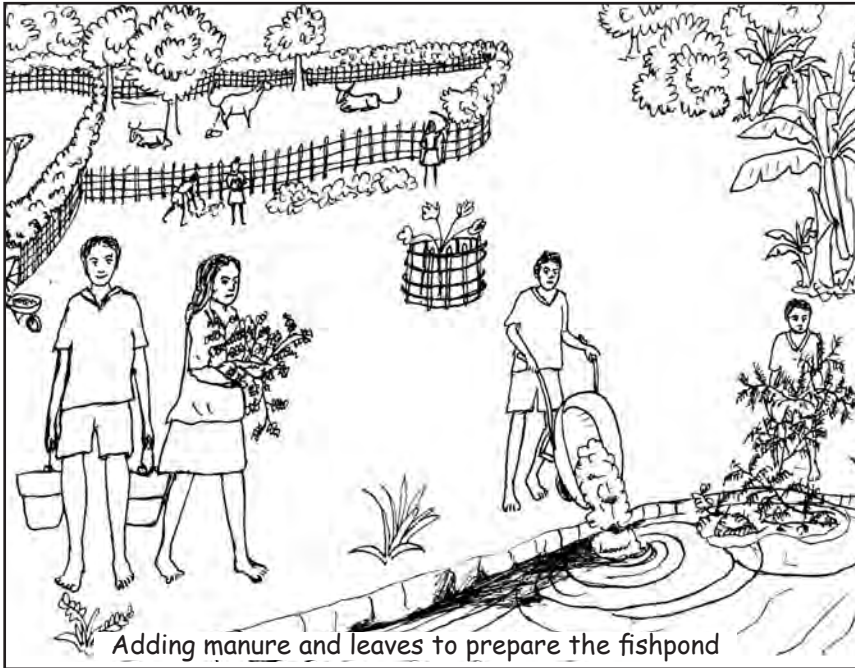
For new clay ponds, lime can be applied on the sides and bottom of the pond before adding water. The lime will balance any PH problems, especially acidic soil and water, and help the water to go clear. It will also help to control initial pest and disease problems.

Usually the PH conditions here in East Timor are neutral to alkaline and the water is reasonably clear. Also, pest and disease problems are minimal at present, so only small amounts of lime are needed. Apply about 2 – 3 kilograms per 100m² (10m x 10m). It is not essential but it will help a lot for new ponds.

Fill the ponds with water then leave them to settle for 3 days. Then other materials can be added. Lime is not needed for cement ponds.

Manure

A healthy fishpond starts with a layer of manure and soil on the bottom of the pond. Cow, buffalo, horse, pig, chicken and duck manure are all suitable. Fresh manure is better than dry manure because it has more bacteria. Use 30 – 50 kilograms of cow, horse, buffalo or pig manure per 100m² (10m x 10m or 15m x 7m or 20m x 5m etc). For a pond 25m² (5m x 5m or 8m x 3m or 10m x 2.5m etc) use 8 – 12 kilograms of manure. Chicken and duck manure is a lot stronger and can be applied at 6 kilograms per 100m² or 1.5 kilograms per 25m². If you mix chicken and duck manure with other manures only use half the amount.



E.g. for a 100m² pond use 3kg of chicken or duck manure and 15 – 25kg of other manures. 1 kilogram of fresh manure is approximately 2 large shovels full. 1 kilogram of dry manure is approximately 3 large shovels full.

Spread the manure over the whole pond bottom and sides. The manure promotes the growth of planktons, which are an important natural food source for fish. Water and soil from another already productive pond is also an excellent starter for a new pond because it will add lots of plankton and good bacteria. Add some of this soil as well as the manure.

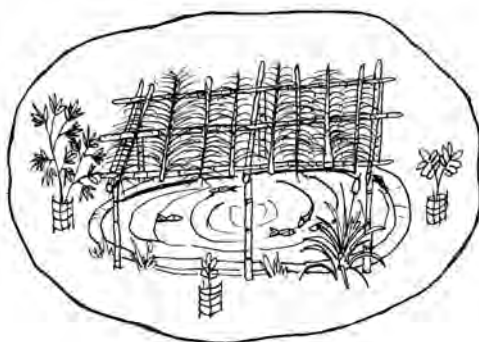
Plant material

Leaves and fruit are also important to add. Before adding fish, add a large amount of leaves and plant material. This will also promote bacteria and plankton and will provide fish food as well. Sesbania, Leucaena or Moringa are the best trees to use. Apply 40 – 50 kilograms of leaves and branches, tied in bundles, per 100m². (10 – 12 kilograms per 25m².) Place around the edges of the pond. Remove branches after 1 week and replace with new branches if the water has not turned green. The manure, soil, leaves and other organic matter provides food for plankton, bacteria, algae, insects and plants that all become fish food. This is especially important for cement ponds.

STEP 2: Provide shade if needed

The amount of sunlight and shade needed has been explained already in fishpond location earlier in the chapter. Some shade will keep the fishponds cooler and improve production. Sun is also important - at least half a day of sunlight is recommended, and morning sun is best.

Trees and water plants can provide some shade in the long-term. If there are no trees, you can provide some shade straight away by making a simple structure from bamboo or wood poles and palm leaves, or make a structure for growing vines like luffas, gourds and beans.



STEP 3: Add water plants and animals

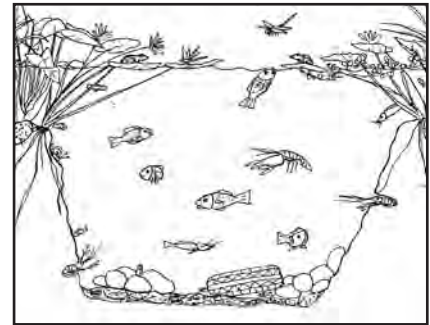
Water plants provide habitat for small fish, food for the fish and the rotting leaves help the plankton and bacteria (more fish food) to grow. They can also provide food for people. It is good to grow many different types of plants. Each type of plant provides different important functions that keep the ponds healthy. E.g. fish food, rotten leaves, habitat, shade. Plants that grow from the soil: taro, arrowroot, bulrushes, reeds, lotus, etc. Plants that grow from the soil and on top of the water: kang kong, watercress, etc. Plants that live on top of the water: Water Lilies, water hyacinth, etc

Many of these plants also act as water cleaners. They remove excess nutrients and help to remove any toxins. This helps to maintain a healthy pond environment.

Small aquaculture animals can be added now as well. Water snails and small prawns, frogs and other small animals are food for some larger fish like catfish and help to keep an aquaculture system healthy.

STEP 4: Provide homes for the fish

Small fish sometimes need protection from bigger fish, especially if the fish eat other fish. A place for fish to make their nests is also needed. All water animals are healthier if they have a good habitat. Piles of rocks, water plants, old tyres or old drink cans tied together all help to provide shelter, homes and habitat.



Tilapia need shallow water to make their nests. A shelf, already described in pond construction for growing water plants, will also provide a nesting area for these fish.

STEP 5: Plants around the pond edge

Clay Ponds: Plant around the edges of the pond immediately to hold the soil and protect from erosion. These edges make excellent production areas because the plants receive lots of water and nutrients.

Plants that can be grown are:

- Water plants: taro, arrowroot, kang kong, watercress, reeds, bulrushes – provide food and habitat for pond animals.
- Grasses – stabilize edges.
- Vegetables – small vegetable plots can be made around the edge of the pond.
- Small fruit trees: bananas, citrus, papaya – plant 1-2 metres from pond edge. They love lots of nutrients and won't give too much shade.
- Larger fruit trees: mulberry, wax jambu are best – pick trees that can be pruned and don't give too much shade. Plant 2 – 3 metres from the pond edge and don't plant too many. Bamboo is also very good.
- Legumes: Moringa, Sesbania, Leucaena, Acacia, Pigeon Pea – provide many functions including food for the fish. Can be pruned back as needed.

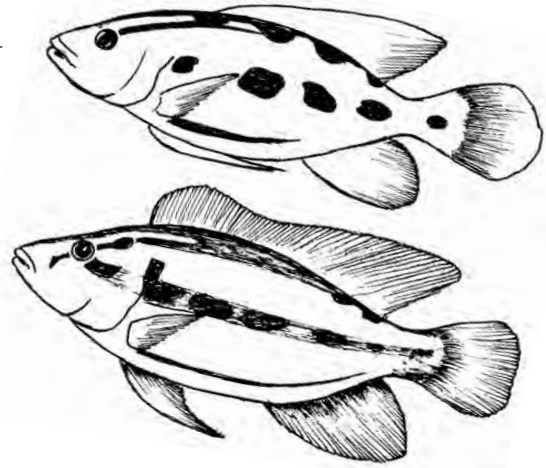


STEP 6: Add the Fish!!

In East Timor there are many types of fish that are grown.

- Carp - Ikan maas
- Ikan Mujair
- Tilapia - Ikan Nila
- Tilapia - Ikan Nila Gif
- Catfish - Ikan Lele
- Ikan Gurami

Prawns and eels can also be grown in fishponds.



Different types of fish together

Fish can be divided into three categories:

- Herbivores - Fish that only eat plants, planktons, leaves, grains etc. Example: carp.
- Carnivores - Fish that only eat meat or animals, including insects, small pond animals and other fish. Example: eels, catfish
- Omnivores - Fish that are herbivores but also eat, meat, insects and other very small pond animals as well. Examples: Tilapia, Ikan Gourami, Catfish, Ikan Mujair, Carp.

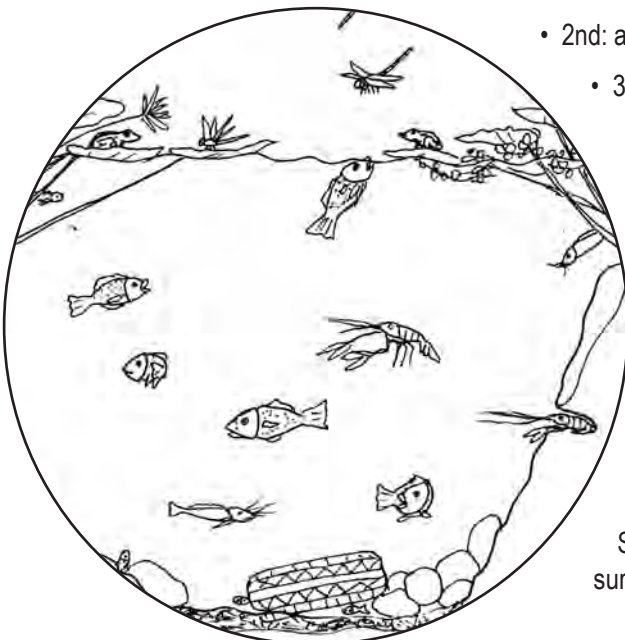
There are many different types of catfish in the world. Some are carnivores and some are omnivores. The common type of catfish in East Timor are omnivores.

There are also many types of carp, with some being herbivores and some being omnivores. In East Timor the carp that are raised are omnivores.

A healthy aquaculture system can contain different types of fish. The fish will create a balance between themselves. The different types of fish feed at different layers in the water and will maximize the use of food and space in the pond. They will also play different roles in keeping the pond healthy.

The fish that eat on the top and middle of the pond eat most of the fish food, and eat mosquito larvae and other insects. E.g. Tilapia. The bottom feeders will eat any food and plant material that drops to the bottom and will eat plankton and other fish food growing on the bottom. They help to keep the pond environment healthy. E.g. Carp, Ikan Mujair, Catfish. A larger pond is needed to have enough room for the different types of fish. 5m x 5m or bigger is recommended. If you want to have all three categories you must introduce them in the right order.

- 1st: herbivore fish
- 2nd: add omnivore fish when the herbivore fish are 3 months or older
- 3rd: add carnivores 3 months later



Most fish in East Timor are omnivores, but they will eat different foods. Catfish will eat other small fish, and therefore should be added last. The other omnivores usually won't.

Once established, the pond will mostly look after itself. Some food and general maintenance will be required. Continuously observe the health of the fish and the numbers of the different types of fish. The omnivores and carnivores will control the number of baby fish, eating many of them. This helps to prevent overstocking of the pond. But if they are introduced too early they might eat all the other fish! Some protection for small fish is needed so that some baby fish survive. (Rocks, water plants, old drink cans tied together.)



Established self-maintaining fishpond with different types of fish, fish homes, water plants and trees and plants for food, fish food and shade

Stocking rates

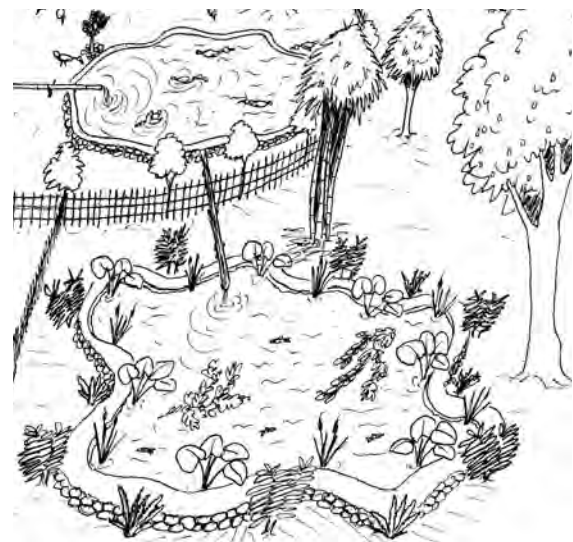
3 fish / 1m² is a good for most fishponds. For a 100m² pond, aim to stock 300 fish. This is for a fishpond that has manure and leaves added as well as some food. The number of fish can be increased to 5 fish/1m² with extra food and good management, but the amount of food must be given accurately and a good knowledge of fishpond maintenance is needed.

For the long term aim of sustainability and a self-maintaining fishpond, raising different types of fish together is the best method.

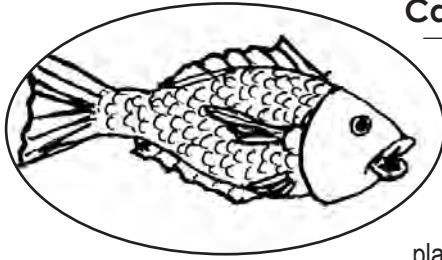
The following example of stocking rates is a good as a general guide.

- Approximately 30%(90) – Tilapia, Ikan Gourami
- Approximately 50% (150) – Carp, Ikan Mujair
- Approximately 20% (60) – Catfish

Raising eels together with other fish can create problems, especially in smaller ponds. The eels can reduce other fish stocks. Sometimes they will naturally enter fishponds from rivers or rice paddies. Try to keep their numbers low, and only introduce them if you are confident of managing them well. It is better to keep them separate.

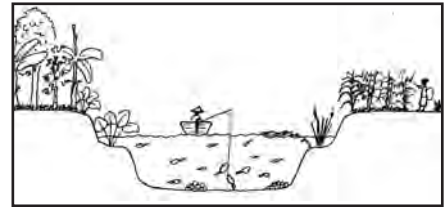


Types of Fish



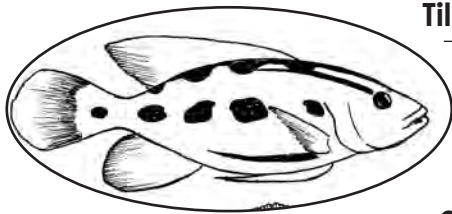
Carp

Carp are common in East Timor and are a tough, usually disease resistant fish.



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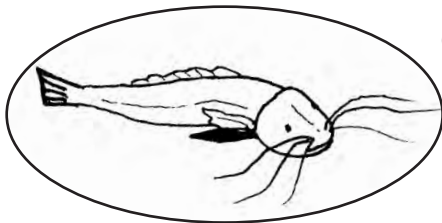
- **Growth** – Carp can grow up to 1/2kg in 6 months given good conditions and feed. Can be grown to 2kg or more if desired but they are tastier when younger.
- **Breeding** – A carp must be 8 – 12 months before it will lay eggs. Females lay their eggs all year round on vegetation in the pond. The eggs hatch in 2 – 6 days, and the baby fish start eating after 2 days.
- **Stocking Rates** – In a fishpond of 10metres x 10metres (100m²) you can stock 150 to 300 fish. In a fishpond of 5 metres x 5 metres (25m²) you can stock 40 to 75 fish. (approximately 2 – 3 per 1m²). The rates depend on the amount of food supplied. But if too many fish are put in a pond the fish will take a lot longer to grow, they won't grow to full size, and will be more likely to become sick.



Tilapia

• **Food** – Tilapia eat plankton, water plants and insects. They will grow well in a natural, healthy pond and all the food they need is provided. With extra feed of rice bran, crushed corn, cassava, etc they will grow much faster, and more can be stocked.

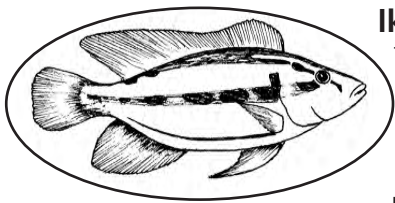
- **Growth** – They can grow to 200grams in 6 months with a good food supply.
- **Breeding** – They reach sexual maturity after 6 months and in good conditions they can breed 6 – 8 times a year. They will breed naturally in a healthy pond with shallow shelves or a shallow end. Remove the baby fish as soon as they come to the surface of the pond. The baby fish can then be raised in separate nets or cages or separate breeding ponds. This makes it much easier to sell the young fish and reduces overstocking problems.
- **Stocking rates** – the ideal rate is 3 fish per 1m². Tilapias are good fish to stock because they are easy to feed and because they will eat mosquito larvae that breed in the fishponds. Because they breed so often, problems can occur through overstocking. This will cause stunting (small fish). It can be solved by :
 - Removing the baby fish as soon as they come to the surface of the pond.
 - Adding some catfish to the system when the adult Tilapia are already mature. The catfish will feed on the young and keep their numbers low.



Catfish

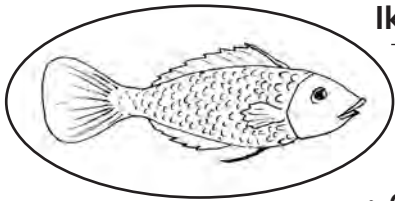
Catfish are a very good tasting fish that generally stay healthy.

- **Food** – The type of catfish that is raised in East Timor is an omnivore. Most food for catfish is provided in a healthy pond system. Extra feed can be provided. The feed must include some meat or animal remains.
- **Growth** – Catfish can be eaten after 6 months, but can take a year to 18 months to reach a good eating size.
- **Breeding** – Catfish will carry their eggs in their mouths until they hatch. They can produce many young. They are hard to breed so collecting young fish from rice paddies or rivers is easier.
- **Stocking Rates** – They can be stocked at a rate of 1 – 2 per 1m². If you want to stock more than a few catfish then you will need to provide extra feed. This is expensive for a lot of fish farmers. A good idea is to stock a small amount (about 1 per 2m²), and combine them with other types of fish.



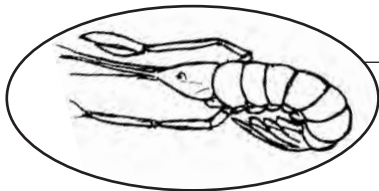
Ikan Gourami

- Food – Ikan Gourami are omnivores and will eat water plants, insects, plankton, soft fruit and more. Their growth rates will increase with extra feed.
- Growth – They can grow to 80 – 120grams in 6 months.
- Breeding – Will breed naturally but the survival rate of the baby fish is very low.
- Stocking Rate – They can be stocked at high densities of 5 – 10 fish/1m² if enough food is available. Ikan Gourami prefer ponds with a lot of vegetation in them. They are therefore good for raising together with water vegetables or rice production.



Ikan Mujair

- Ikan Mujair have similar behavior to Carp.
- **Food:** Use the same methods and food as for Carp.
 - **Growth:** They will grow to eating size in 4 to 6 months.
 - **Breeding:** Ikan Mujair will breed easily, and can breed 2 to 3 times a year.
 - **Stocking Rate:** They are smaller than carp so the stocking rates can be slightly higher, about 2 – 4 fish per 1m². E.g. 200 – 400 Fish per 100m² (10m x 10m).



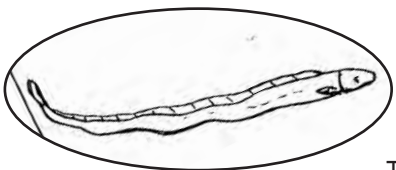
Freshwater prawns

Freshwater prawns grow naturally in rivers and ponds in many districts in East Timor.

They are very hard to raise from eggs or babies. Therefore a good method is to catch small ones and transfer them to the pond. The best time is when the young prawns have shed their last young skin and have just started growing into their adult skin. Before this time they need special attention, different water temperatures and different foods.

The benefit of growing prawns in a pond is that you can increase the amount of food they eat and grow more in a small area. They will grow faster and larger than prawns in the rivers. They can be sold or eaten.

Make sure that the prawns get lots of fresh water, and running water into the ponds if possible.



Eels

Eels live in many rivers and some rice paddy areas as well.

They can cause problems with stocks of other fish from eating them when they are small. But if the eels are introduced in small amounts when the other fish are large then they can be combined. Only experienced fish farmers should try.

It is easier to raise eels by themselves, but they are carnivores so food can be expensive. The following example is one method for raising eels. It works well for a pond approximately 3m x 5m. (15m²)

- First add a layer of mud and manure on the pond bottom.
- Then put a layer of cut banana stems, then a layer of grass and leaves.
- Repeat this process adding more soil, manure, then cut banana stems, then grass and leaves.
- Keep repeating this process until the pond is full.
- Then fill the pond with water, and wait until it becomes rotted, approximately 1 – 2 months.
- After this the eels can be added, approximately 100 – 150.
- The materials provide food and habitat for insects and small water animals. They are food for the eels.
- Extra food can be provided to increase production. E.g. Intestines, blood, bones, ground feathers, remains from animals, frogs, dead rats and mice, termites.

Breeding Fish

Proper breeding techniques for freshwater fish is very technical and often difficult.

Some fish, like Tilapia, will breed naturally but others need special techniques, conditions and specific equipment.

The methods are too long to include in this manual. However, people who are interested should look for more information. This is because breeding the fish will:

- Provide you with a continuous supply of baby fish and young fish.
- Improve production rates and quality.
- Provide young fish to sell.

One idea is for holding the baby fish. You can make containers from bamboo. Look in the reference section for where to find more information.



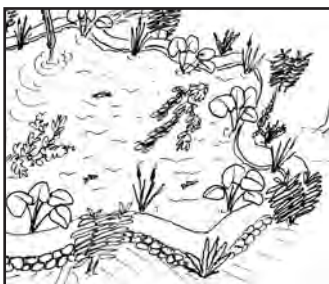
Water plant production



There are many different types of water plants that can be grown for food, trade and income in East Timor.

Taro, kang kong, water cress and arrowroot are all well known and used.

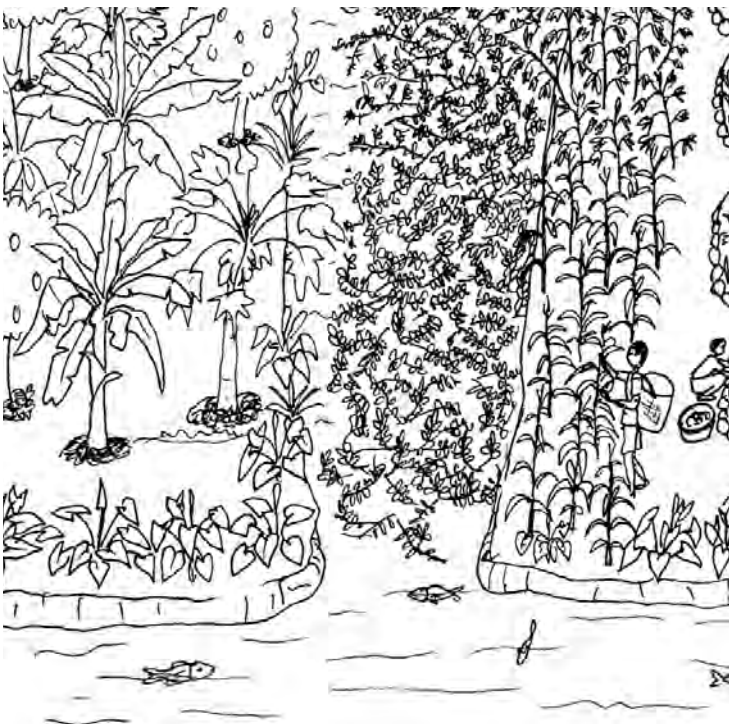
Lotus and bulrushes grow in East Timor and can also be eaten. The leaves, roots and young (unripe) seeds of lotus can be cooked and eaten and is very tasty food. The root of bulrushes can be cooked and eaten in the same way as taro.



Plant growth will be faster if you add a small amount of manure. All water plants need fresh water added from time to time to grow well.

Fish and water plants that produce food can easily be grown together.

The plants and fish help each other because the fish manure feeds the plants and the plants provide rotten leaves and habitat for the fish.



Be careful:

All water plants should be harvested and controlled as needed to stop them from growing over whole ponds.

Kang kong and water cress grow very fast. This can provide problems for the fish because they will take too much light and oxygen.

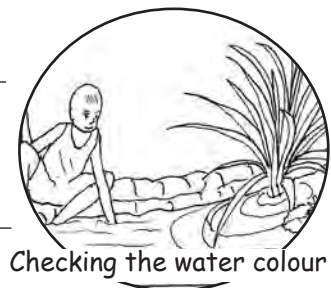
They should cover 1/4 of the pond at most. Less is better.

Plants that cannot be eaten, traded or sold can be used as mulch or in composts.

Pond Management

Fish Food

Food for Herbivore & Omnivore fish



Checking the water colour

Herbivores and omnivores are Carp, Tilapia, Ikan Gourami, Ikan Mujair, Catfish.

Food from pond maintenance: To provide ongoing food for the fish and to keep the pond environment healthy, continue to add manure and leaves. 1 week after the fish have been added, start adding more manure. 30 - 40 kilograms of cow, horse or pig manure per 100m² once every week. 8 - 10 kilograms per 25m². Or use 5kg of bird manure per 100m², 1 - 2kg per 25m².

For old fishponds that have clean, light green coloured water the amount can be reduced to 20 kilograms per 100m² per week of animal manure, or 3kg of bird manure.

For fishpond maintenance, animal manure is generally better. The quantity of manure that is added should be applied according to the colour of the water.

The water colour is very important because it shows how much food is available for the fish.

A good test is to place your hand 10 - 20cm underwater. If you can see your hand then the water is too clear.

- If the water colour is clear then the amount of manure added should be increased until the colour changes to light green.
- If the water colour is light green then the amount added can stay the same.
- If the water colour is dark green then the amount added needs to be reduced or stopped until the colour changes to light green.

Another sign of too much fertilizer is if the fish are at the surface of the water before dawn, acting abnormally. Also, if the fish do not move when scared. If these things happen, stop adding manure immediately. Add fresh water as well. Add leaves and rotten fruit occasionally as well, in small amounts.

If there are water plants growing then you don't need to add any more leaves. Other factors that can affect water colour include:

- Too much sun - can make water colour too dark.
- Too much shade - can make water colour too clear.
- Not enough fresh water - can make water colour too dark.

The amounts of manure and leaves recommended will keep your ponds healthy. A healthy pond will provide enough food for the fish to grow well and be healthy. And once the pond is harvested the manure can be re-used as plant fertilizer. Concrete fishpond systems or large-scale fish systems are the most likely to need extra fish food.

Extra feeding

Extra feed will help the fish to grow faster and will allow you to increase the number of fish in each pond. With good management, the number of fish can double or triple. To give maximum benefit the fish food needs to contain proteins, fats, carbohydrates, energy, minerals and vitamins.

- Feed the fish twice a day and at the same time each day.
- The amount that is given will increase, as the fish get bigger.
- The amount will vary from pond to pond. But as a general rule, almost all or all of the food should be eaten in about 10 minutes. Observe how much of the food is eaten each time. If all the food is eaten quickly then give a little more. If more than approximately 10% is uneaten then reduce the amount of food.
- Too much food will cause problems by reducing oxygen levels in the pond and building up too much on the bottom of the pond.





Types of natural feed for Herbivore & Omnivore fish

- Grains: These contain proteins, carbohydrates and fats. E.g. broken rice, rice bran, crushed corn, millet.
- Legumes: Leaves and seeds provide a lot of protein and minerals. The seeds must be cooked before feeding to fish. E.g. Beans, Sesbania, Moringa, Acacia, Mung Beans, Peanuts, Soybeans, pigeon pea.
- Leaves and Fruit: Can be used as feed or to keep the pond healthy. They supply a range of vitamins, mineral, carbohydrates and protein in small amounts. E.g. legume trees, cassava, sweet potato, vegetables, fruit trees, water plants.
- Root vegetables: These provide carbohydrates and energy. They must be cooked before feeding to fish. Only small amounts are needed. E.g. cassava, taro, sweet potato, yam, potato.
- Meat or animal remains: Supplies proteins, minerals, vitamins and more. E.g. Intestines, blood, bones, ground feathers, remains from animals that are not eaten by people, frogs, dead rats and mice, termites. It is good to cook the food first to reduce possible disease and worm problems. (Not the rats, mice, frogs or termites)
- Oil seeds: These provide protein and oils and are low in carbohydrates. E.g. Soybeans, Sunflower, Kapok, Candlenut, Coconut, Peanut.
- Kitchen food waste, which will contain all of the above, is a good source of food for fish.

Carp, Tilapia, Ikan Mujair and Ikan Gurami need very little or no meat in their food.

Catfish will grow better if you add some meat to their other foods.

Types of natural feed for Carnivore fish

Eels are carnivores, catfish are omnivores but eat more meat than the other omnivores. They will eat small fish, frogs, worms, insects, prawns, snails and other water animals.

Meat or animal remains can be used to provide the extra food. E.g. Intestines, blood, bones, ground feathers, remains from animals and fish that are not eaten by people, frogs, dead rats and mice, termites. It is good to cook the food first to reduce possible disease and worm problems. (Not the rats, mice, frogs or termites.)

Processed Feed – for all fish types

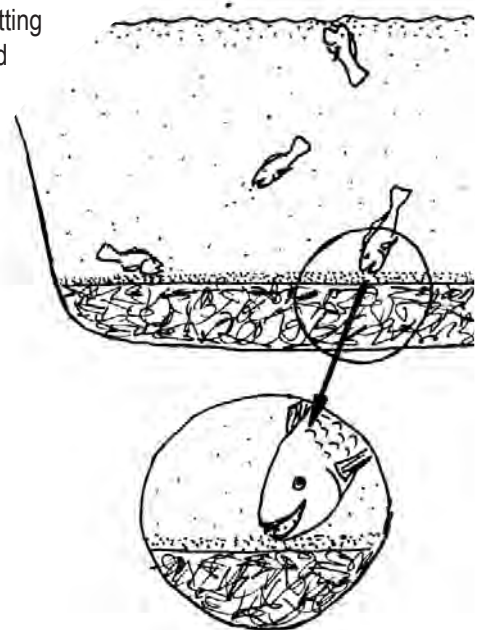
For some situations making food is a good way to make sure the fish are getting all the nutrients they need. For most fishponds in East Timor at present, and in the future, there is no need for making processed food. The fish can get all they need from a healthy pond and from natural feed. Processed feed can be used for:

- Large-scale fishpond production.
- Cooperatives of fish farmers who can make the feed as a group and then divide it between the farmers.

Processed food takes time and money, so it needs to be produced in large quantities to make it cheaper.

The food will also need to be stored properly.

If you are interested in producing processed fish food look in the reference section for where to find more information.



Fish Diseases and Pests

Treating a sick fish



Diseases

The main diseases to watch for are parasites and worms. Some symptoms are:

- Fish trying to scratch themselves on rocks, and moving slowly.
- Fish have swollen, fat bodies. (They are actually very thin but are full of worms)

Salt solutions can be used to treat parasites and worms. Salt solutions also help to clean fish gills and treat bacterial ulcers. If only a few fish are diseased, treat them using salt and water in a bucket. ALWAYS use water from the fishpond.

When treating the fish:

- Dissolve the salt in the water first
- Stir the water first to add oxygen
- Observe the fish constantly and remove immediately if they show signs of stress
- Use cooking salt or sea salt

Amounts of salt to use:

- 25g/1litre for 30seconds
- 10g/litre for 30-60minutes

This can also be used as a quarantine method of killing diseases before adding new fish to a pond. If many fish are diseased then you can treat the fishpond. Use 1.5kg/1m³ of water. E.g. 10x10m pond = approximately 100m³ if 1 metre deep or 150m³ if 2 metres deep in middle. This equals 150kg salt for 100m³ or 225kg salt for 150m³. ALWAYS dissolve the salt before adding it to the pond. After 1 day keep adding fresh water as usual. Continuous salt water is not good for water plants so watch for signs of stress. Add more fresh water to dilute the salt if necessary. Add salt to water at 2grams/litre to improve fish transportation.

Formalin can also be used if the fish are scratching and moving slowly, but try salt treatment first. Put 10 litres of water in a bucket and add 2ml of Formalin. Put the diseased fish into bucket for 15minutes, and then put them back in the pond. By adding lime to the empty pond after pond construction you will reduce the chances of worm diseases. See Step 1- Preparing the Fishponds, in fish production for details.

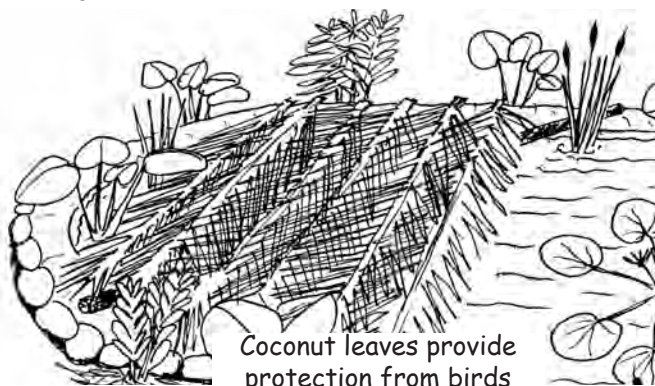
For any disease, especially after treatment, it is very important to add lots of fresh water, and if possible change the pond water completely. This will reduce the chances of the disease happening again, and add fresh oxygen to the fishpond.

Pests

The main pests are birds and humans. Snakes and crabs can sometimes be a small problem. These pests will always be around. If you attempt to kill the birds, snakes and crabs you will only solve the problem temporarily because more will come, especially birds. Also you will stop those animals from providing other important benefits – birds eat many pest insects as well, snakes eat mice and rats and they are all part of a healthy ecosystem. It is most important to prevent the problems if possible, and minimize any potential damage.

Birds

- Provide fish homes and protection in the water. E.g. rocks, water plants, old tyres, tin cans.
- Cover part of the pond with coconut palm leaves to stop the birds from diving in.
- Provide a deep area (2metres deep) in the pond that the fish can escape to.



Humans

- If the fishponds are set up as a community group then jealousy problems will be greatly reduced.
- Provide, exchange or sell knowledge, tools, plants and even baby fish to others in the community, or in other communities who want to start fishponds as well. This will also reduce jealousy problems.

Oxygen

Oxygen is essential for a healthy pond. It is in every drop of water. It is used by fish, water animals and insects, plants, algae and when rotting leaves turn into soil. There is less oxygen in warm or still water. The oxygen in the water **MUST** be replaced regularly. A lack of oxygen can be caused by:

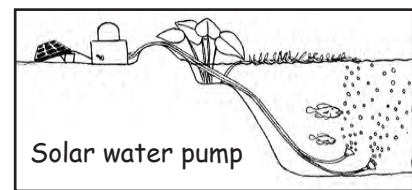
- Stocking too many fish
- Giving too much feed
- Not enough sunlight – caused by too many trees or water plants
- Not enough fresh water
- Adding too much fertilizer



If the fish are at the surface of the water in the early morning and are opening and closing their mouths and do not respond to a surprise then there is probably a lack of oxygen in the water. Fertilizer application and extra feeding must be stopped immediately. If there are too many water plants and shade giving trees then they must be cut back or removed as needed.

Oxygen can be replaced and increased by:

- **Running water:** the best way to add oxygen is to direct running water into the ponds. If there is a continual supply then only a small flow is needed.
- **Fresh water:** add regularly, every few days, especially for small ponds.
- **A deep pond will stay cooler than a shallow one.** Cold water holds more oxygen than warm water.
- **Wind:** wind moves the surface water and helps put oxygen back into the water.
- **Water pump:** a water pump is a pump that sits in the pond and creates water flow in the pond. The movement of the water adds oxygen.
- **Water wheel:** A water wheel is a small machine that spins in the water turning the water as it spins. It can be powered using electricity, petrol or solar power. They are common in South-East Asia.
- **Moving the water with a stick.**



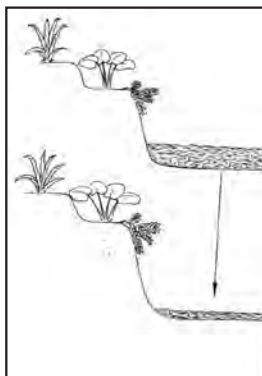
Cleaning the ponds

It is important to clean the pond to stop the pond from filling up with soil, rotten materials and fish manure.

The best time to clean the pond is after harvesting the fish. It can be cleaned after each harvest or every 2nd harvest. If a pond has younger and older fish and therefore never completely harvested, the fish can be caught in a net and stored in a separate pond or water until the pond is cleaned.

Leave a very thin layer of soil/manure on the bottom so that the good bacteria stays in the pond. The soil/ manure that is cleaned out is **EXCELLENT** fertilizer and very strong. Use it for:

- Fruit trees
- Adding to compost and liquid compost
- Vegetable gardens. Don't place close to young plants and don't apply too much at once. Add to the garden beds 2 weeks before planting. The compost trench system that is explained in the Soil Chapter (CH 4) is also a good way to use the manure



Potential Problems

Pollution

Pollution of your fishponds can cause big problems and even kill the fish.

Do not allow any water with chemicals, oil or petrol.

Water with washing powder also **MUST NOT** directly enter fishponds. It can **ONLY** enter fishponds if it is cleaned first in separate cleaning ponds.

Pesticides and herbicides are also dangerous.

To reduce the chances of pollution do not use them on land above your fishponds because it may enter the water supply.

Pollution in water can come from a long way away, especially if you are using river water. Work with the community to reduce the amount of chemicals put in the water. This will benefit everybody.

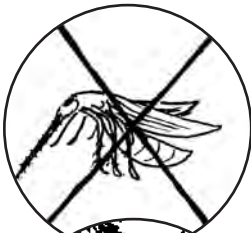


Over feeding

If you give the fish too much food, it will cause problems with the water quality and amount of oxygen for the fish.

Manure, leaves and rotten fruit need time to turn into food for the fish so be careful and continuously check the water colour.

If you are also feeding the fish, don't let uneaten fish food build up on the bottom of the pond. If the problem is bad an emergency solution is to change the water and clean the bottom of the pond.



Mosquitoes

Mosquitoes carry malaria, dengue fever and other sicknesses. They will lay their eggs in fishponds, and the young mosquito larvae live in them until they turn into flying adults. Some types of fish eat the eggs and young mosquitoes, therefore stopping the problem. E.g. Tilapia are best, but all the other types of fish will eat some as well. Frogs also eat the mosquito larvae.



Neem leaves

Neem leaves can be added to fishponds to stop mosquito problems. Add a large plastic bag of leaves twice a year, 2 or 3 bags for bigger ponds. Or you can spray the pond surface with neem oil mixed with water, 3 – 4ml of oil per litre of water. The neem will stop the mosquitoes from breeding but will not harm the fish. Do not attempt with other natural pesticides because they might harm the fish.

Other Fishpond Benefits

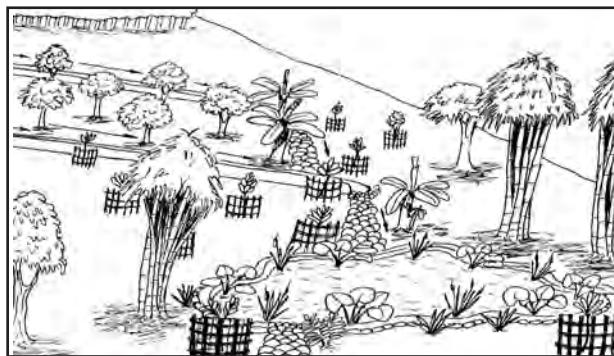
A healthy aquaculture system will be home to many frogs, lizards, pest predators and other helpful insects.

These animals will naturally reduce the number of pests in your garden. The water will attract birds, bees, and other small animals that will improve pollination of your fruits and vegetables. The water will make the temperature around it cooler and more comfortable. This benefits people, plants and animals.



Wet season fishponds

A wet season pond can be made where there is no or minimal water supply in the dry season. Wet season water must be regular; rains usually won't be enough, especially to keep the water fresh. Trenches, swales and irrigation pipes can be used to increase the water inflow. Soil traps that will keep the water clean need to be dug if you use swales or soil-lined trenches, or if the water comes from a river. The amount of oxygen in the water will be reduced if the water supply is not regular. You will be more likely to need to use different techniques to keep oxygen levels in the water at a suitable level.



SMART IDEAS:

- You will grow bigger size fish if you raise them for a month or two in separate container or water tank first, and then move them into the pond at the beginning of the wet season. In the dry season the pond is not used or, if there is a small water supply, the bottom of the pond can be used for growing vegetables.



- Cement pond: easier to maintain but more expensive and can't be used for growing vegetables in the dry season.
- Clay pond: will probably crack in the dry season. The cracks can be filled in with more clay once the first rains come.
- Both will last much longer if covered with palm leaves during the dry season.
- A wet season pond can also be used for growing water vegetables.
- Make long, narrow, shallow ponds specifically for growing wet season water vegetables. The ponds can also be used for vegetable growing in the dry season.

Salt water fishponds

Fishponds can be made using salt water as well. If a hole is dug close to the sea it will naturally fill with salt water. The land must be not much higher than sea level, or it will take a long time to reach the water! The best areas to make them are where the land already has salt water and water plants growing. (Swampy areas) By making a fishpond you will create a productive area on low productivity land. But be careful not to change the natural environment too much or damage the surrounding area because these areas are very important for keeping the coast and sea healthy. Create an area as natural as possible, using local plants. This is also important for providing fish food. The pond must be stocked with fish that like the salty water. E.g. bandin, boek, karapuk tikus The water plants must be able to grow in the salty conditions as well. E.g. bako.

Construction and Maintenance

- Use the same ideas for pond size and shape as for normal fishponds.
- However the level of the water will rise and fall as the seawater rises and falls with the tides. The pond must be made deep enough so that it still has enough water for the fish at very low tides.
- Rocks and plants around the edges are important to protect them and stop erosion especially if the soil is mostly sand.
- Rocks and other fish protection must be provided to give protection from birds.
- Some shade is essential to help to keep the water cool, especially during the middle of the day.
- A fence may be needed to protect the pond and plants from goats.
- A healthy fishpond with water plants will provide all the food that the fish need.
- Once it is established the pond won't need much maintenance.
- Special consideration must be given in areas where crocodiles may come. Strong fences need to be built around the fishponds to protect the fish (and people) from the crocodiles!

Fish Integration with other systems

There are many other food production systems that fish can be integrated with.

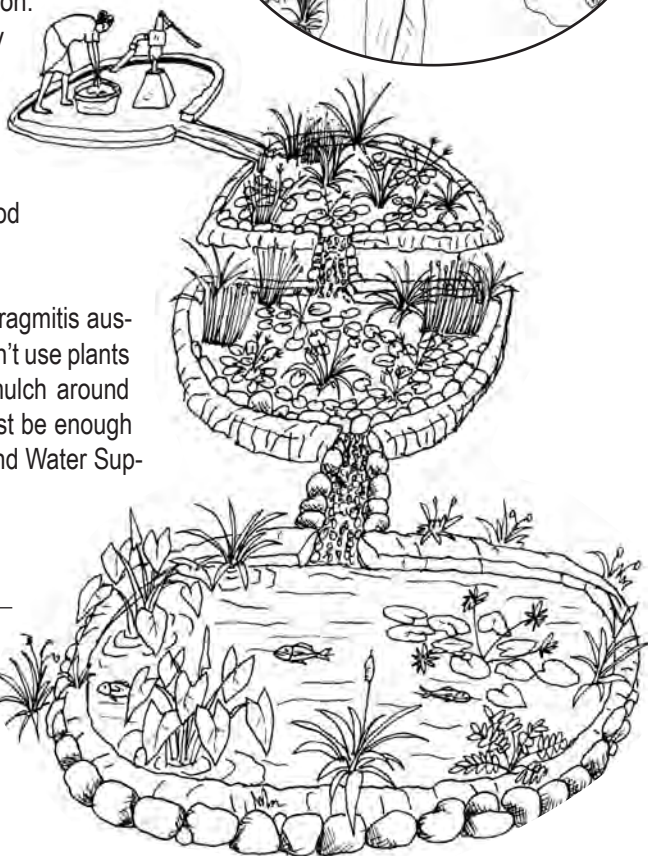
- Pigs, chickens and ducks can be raised together with fish.
- Vegetables, grains, rice, bamboo and fruit trees can also be produced together with fish.



The following examples show some techniques for integration. You can use these techniques or build on the ideas to try your own techniques and ideas.

The water from kitchens and washrooms can be used for aquaculture but it **MUST** be cleaned of the washing powders in separate ponds before it can be used for growing food plants or fish.

Grow water plants in these ponds to clean the water. E.g. *Phragmites australis* (water reed), water hyacinth, bulrushes, water lilies. Don't use plants for eating. These plants can be harvested and used for mulch around fruit trees. Harvest only 25% at one time because there must be enough plants left to keep cleaning the water. Look in the Houses and Water Supply Chapter (CH 13) for more about water cleaning.



Chicken and Fish System

The number of chickens will vary according to the size of the fishpond, the amount of fresh water, and the number of fish:

- 25m² pond (E.g. 5m x 5m) – 5 chickens.
- 100m² pond (E.g. 10m x 10m) – 5 to 10 chickens.
- 1000m² pond (E.g. 20m x 50m) – 30 to 50 chickens.

The chicken house needs to provide protection from rain and strong winds, but still provide good ventilation.



SMART IDEAS:

- Plan where the chicken house will go before building the pond, especially if the pond is cement.
- Make sure that the chicken house is easy to access and strong enough to hold a person for cleaning.
- Make sure that predators cannot enter the chicken house.
- Use metal poles if building in the water. This will prevent rotting.
- For small or narrow ponds, place the supporting poles across the pond rather than in the water.



The chickens can be let out to eat for most of the day and put back in the chicken house at sunset. Keep them in the house until mid morning so that they lay their eggs in the chicken house. Feed the chickens late each afternoon in the chicken house.

Use ground corn, rice and beans and some fresh leaves and weeds. This will bring the chickens back to the house each night and also feed the fish.

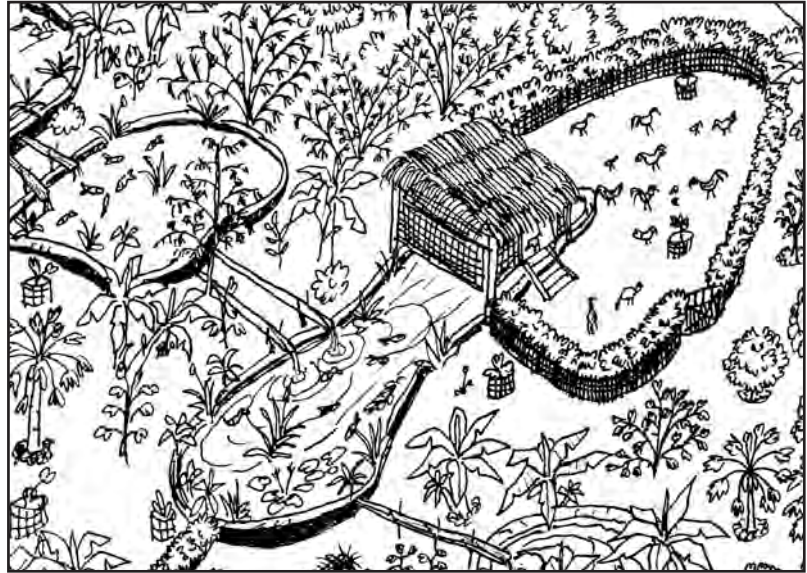
The chicken system is great for raising young chickens. They will be protected from predators and the extra food will improve their growth.

If the chickens stay in the chicken house they must be fed twice a day with ground corn, rice, beans, some fresh leaves and weeds. Some food will drop through and also feed the fish. Drinking water also must be provided.

Because of the extra nutrients from the chicken manure, fresh water must be added once a week so that the water overflows. This will keep the pond water fresh. Use the nutrient rich water as fertilizer. Clean the pond every 1 to 2 years. Watch for signs of too much manure.

Benefits

- The chicken manure and excess feed drops through the floor or can be swept out to provide fish food and plant food.
- The fish and plants will grow faster.
- The chicken house provides some shade for the pond.
- The eggs from the chickens can be easily collected.
- Water plants can be used to provide chicken food.
- Excellent fertilizer is collected every time the pond is cleaned.



Pigs and Fish System

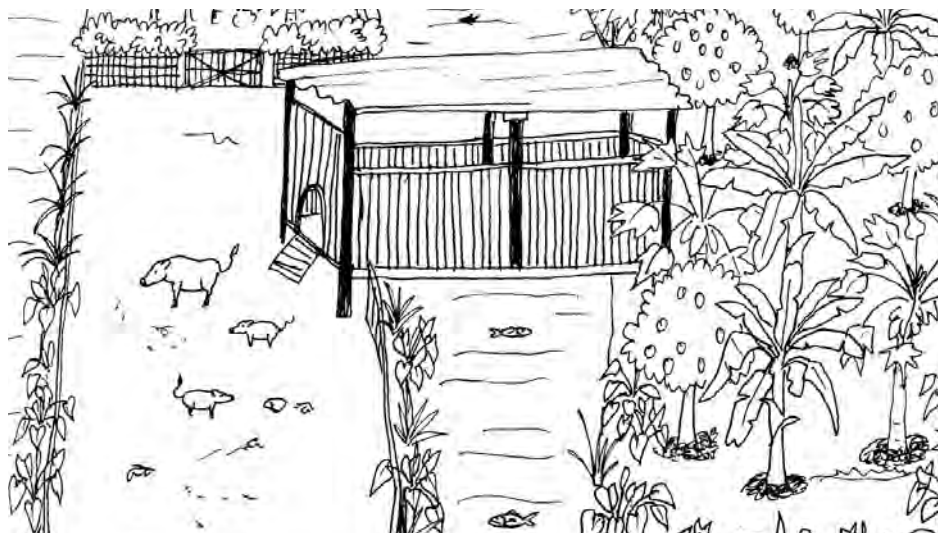
This is similar to the chicken and fish system.

Use 2 or 3 pigs at a time for ponds of 10m x 10m or larger. The house construction will change a little to suit the pigs. Make sure that the pond water overflows regularly, and make good use of the overflow water. The pig house can be used for raising young pigs. They can be raised from 2 months old for 6 months and then changed for new piglets. If the pigs are let out each day a fence is needed to manage them



SMART IDEA:

- Build the pig house over a drain that runs into the fishpond rather than over the fishpond itself. This way the amount of fertilizer and feed that enters the water can be regulated and if there is too much it can be easily diverted away from the pond. Instead it can be diverted to other ponds or used for making composts.
- In China, the pig manure and waste feed is composted and then added to fish ponds.



Rice paddy and Fish Systems

Often some fish will live naturally in rice paddies. E.g. Catfish. Other types of fish, like Tilapia, Ikan gourami and Carp can also be raised in the rice paddies.

The paddies need to be able to hold water for 3 – 4 months, and MUST be free from pesticides.

It is best to use paddies that are close to the house to improve management.

Small fish should be raised in a separate fishpond and added to the rice paddies after the rice is planted and growing. This will greatly improve the survival rate of the small fish and prevents fish from eating the young rice plants.

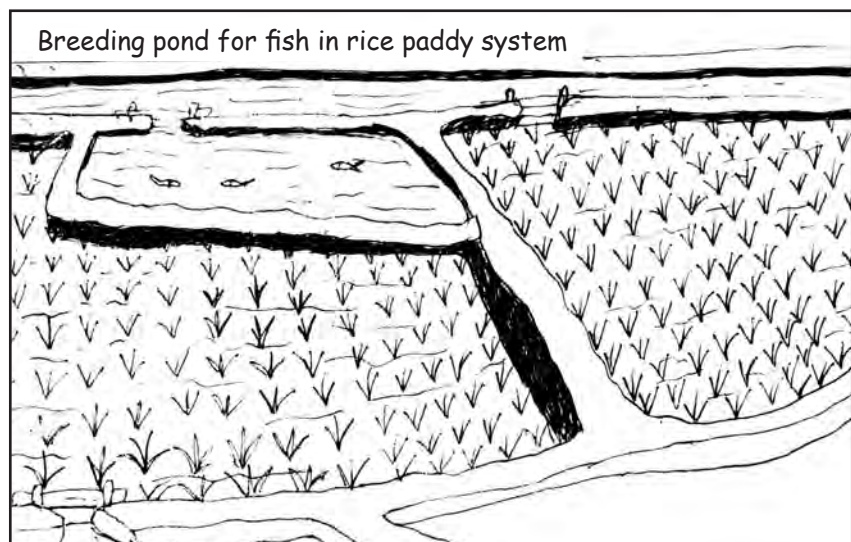
A separate, deeper pond that is connected to the paddies is also very important to have at harvest time. The fish can escape to it when the paddy water gets too hot and when the paddies dry up before harvest. Put it at the low end of the paddies.

This pond must be managed in the same way as a normal fishpond.

Water flow and fish movement between the pond and the paddies can be controlled by using a trench and a removable door.

Benefits

- You will have two different types of production from the rice paddies – rice and fish.
- Some of the fish, e.g. Tilapia and Ikan gourami, will eat the mosquito larvae and reduce mosquito problems.
- The rice plants will benefit from the fish manure.
- The fish may feed on the pest insects that damage the rice.
- The rotten vegetation from the rice plants will create fish food.



SMART IDEA:

Small ponds for young fish can be made next to irrigation trenches that flow into the rice paddies. Irrigation water can then be easily used to supply the ponds.

DANGER

If you use pesticides and herbicides you will kill the fish.

Even some natural pesticides like tuha and tobacco are too strong. (Tuha is commonly used as a fish poison!!) Use IPM techniques to manage the rice crop and be very careful with natural pesticides.



Separate deep pond for mature fish at rice harvest time

Ducks and Fish Systems

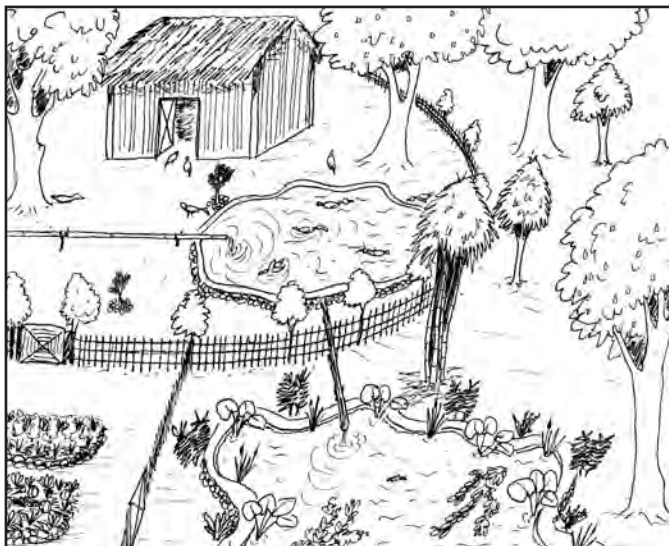
Ducks are a useful and highly productive animal for East Timor. They can be raised together with fish, but this requires large ponds, a lot of infrastructure and careful management. However, there are methods for simple integration that will still provide many benefits.

Make a small separate pond for the ducks that they can swim in, above the fishponds. The water that overflows from the duck pond into the fishponds will contain a lot of duck manure and therefore many nutrients for the fishponds. The ducks must be kept away from the fishponds because they will damage the pond edges and eat some fish and water plants.

This can be achieved by:

- Building a low fence around the duck area and pond.
- Building a low fence around the fishponds.
- For small fishponds you can make a lattice cover out of bamboo. Make sure some light still gets through. This cover will also protect the fish from other birds.

The ducks will need a house and food, the same as chickens. They can be let out during the day and returned to the house at sunset for feeding and sleeping. The ducks need fresh water each night as well.



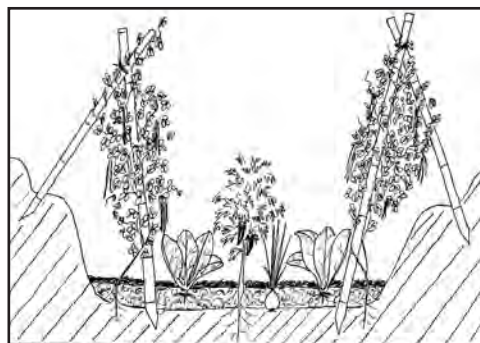
Dry season vegetable growing

Clay fishponds can be used for growing vegetables as well. The soil in the bottom of the fishponds will be very high in nutrients. This is because of the manure and leaves added to the pond during fish production. It builds up to create pond "mud".



SMART IDEAS:

- Don't dig through the clay layer beneath the pond mud.
- Plant vegetables that grow for one season only.
- Grow vegetables that don't need any pesticides. Any pesticide used will damage fish health and the pond ecosystem.



Integration with water catchments

Swales, described in the Reforestation and home garden chapters, catch and store rainfall. With heavy rains water can flow from one swale to another. Swales can also collect the water that runs out from the fishponds. Other types of water catchments like banana pits, boomerang swales and terraces can also be used.

Chinampas – Water Trenches

Chinampa is the name for a system of water trenches from Mexico. They can be used where there is a good source of water and where the soil holds water. Clay soils are best. If there is a continual source of water they can be used all year. They can be used on sloped land or on flat land.

Chinampas can be used to grow fish and water plants. The land around then is highly productive for vegetables, fruit trees, bamboo and more.

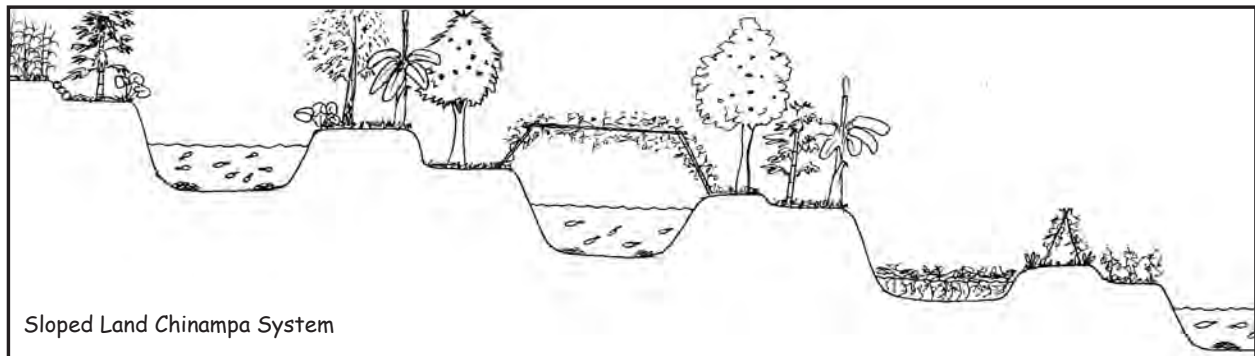
Sloped Land Chinampas

Chinampas can be used to grow fish and water vegetables on land where it is too steep for large fishponds. However, steep slopes are too hard to dig and manage chinampa systems. On sloped land they are similar to swales. The trenches are dug on contour. See the Reafforestation Chapter (CH 7) for how to measure contours and make swales. The trenches for chinampas are wider and deeper than for swales. They should be about 1 - 2metres wide and 1-2m deep in the middle of the trench. The size depends on the slope of the land (smaller chinampas for steeper slopes), the amount of land and what you want to grow – fish need wider and deeper chinampas than water vegetables. Small shelves can be dug for growing plants and vegetables. The trenches are closer together as well, about 3 – 5m between each trench.

Water flows from trench to trench by using:

- Pipes made from bamboo, plastic or metal pipes.
- Overflow trench lined with rocks.

The soil between each trench will stay moist and is ideal for growing vegetables and fruit trees. Structures for trellising can be built over the trenches to provide some shade and give more production area.

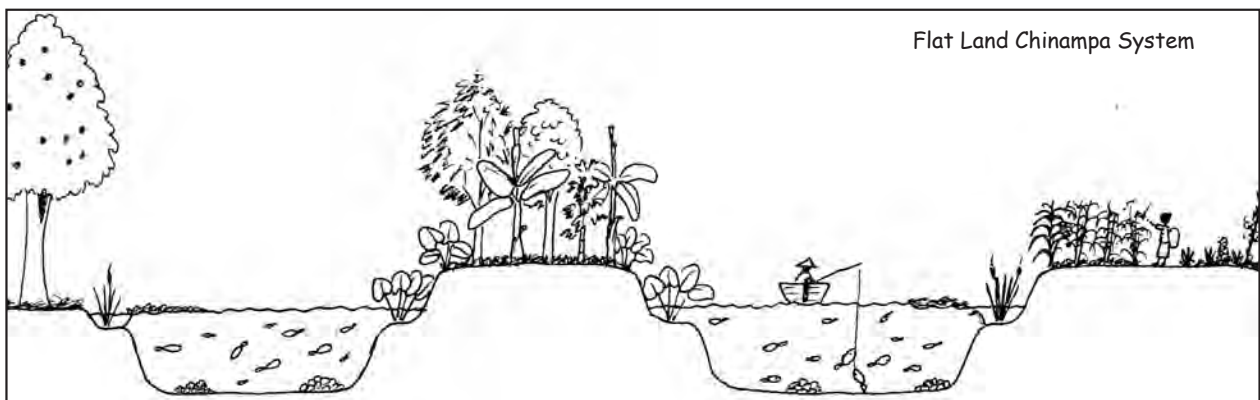


Flat Land Chinampas

Chinampas can also be made on flat land. They can be larger than the chinampas for sloped land, but the size can be whatever is best for your land size and needs. They are especially good for changing flat land that is continually wet, like swamps, into highly productive land. A great example of chinampas is at Ciacoli in Dili. Water runs through a series of trenches where people grow kang kong. Between the water trenches the land is very productive. They don't need to be on contour (there is no contour), and they don't need overflow pipes. They trenches can all be joined up, or an overflow trench can be used.

Benefits:

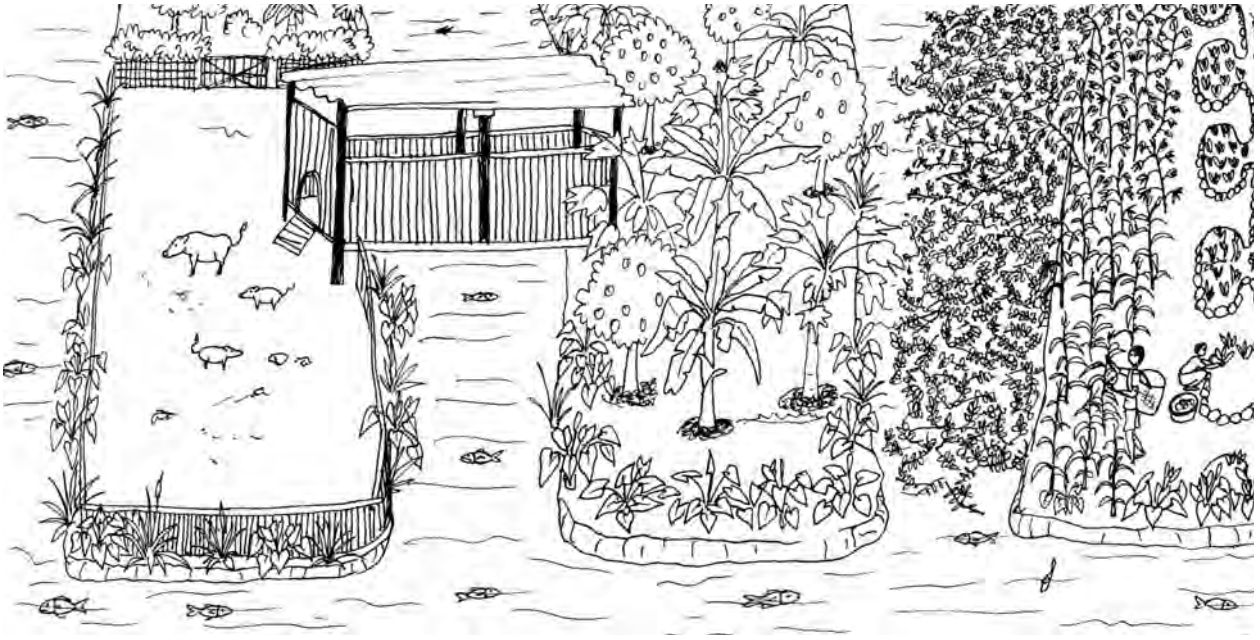
- Chinampas create LOTS of edges, which creates more production.
- Erosion is stopped on sloped land.
- When the chinampas are cleaned the soil, containing a lot of nutrients can be used as fertilizer and to increase the soil between the water trenches.





SMART IDEA:

- Chinampas can be used with chickens, pigs, ducks and rice paddies as well. But be careful to keep the ducks and fish separate.

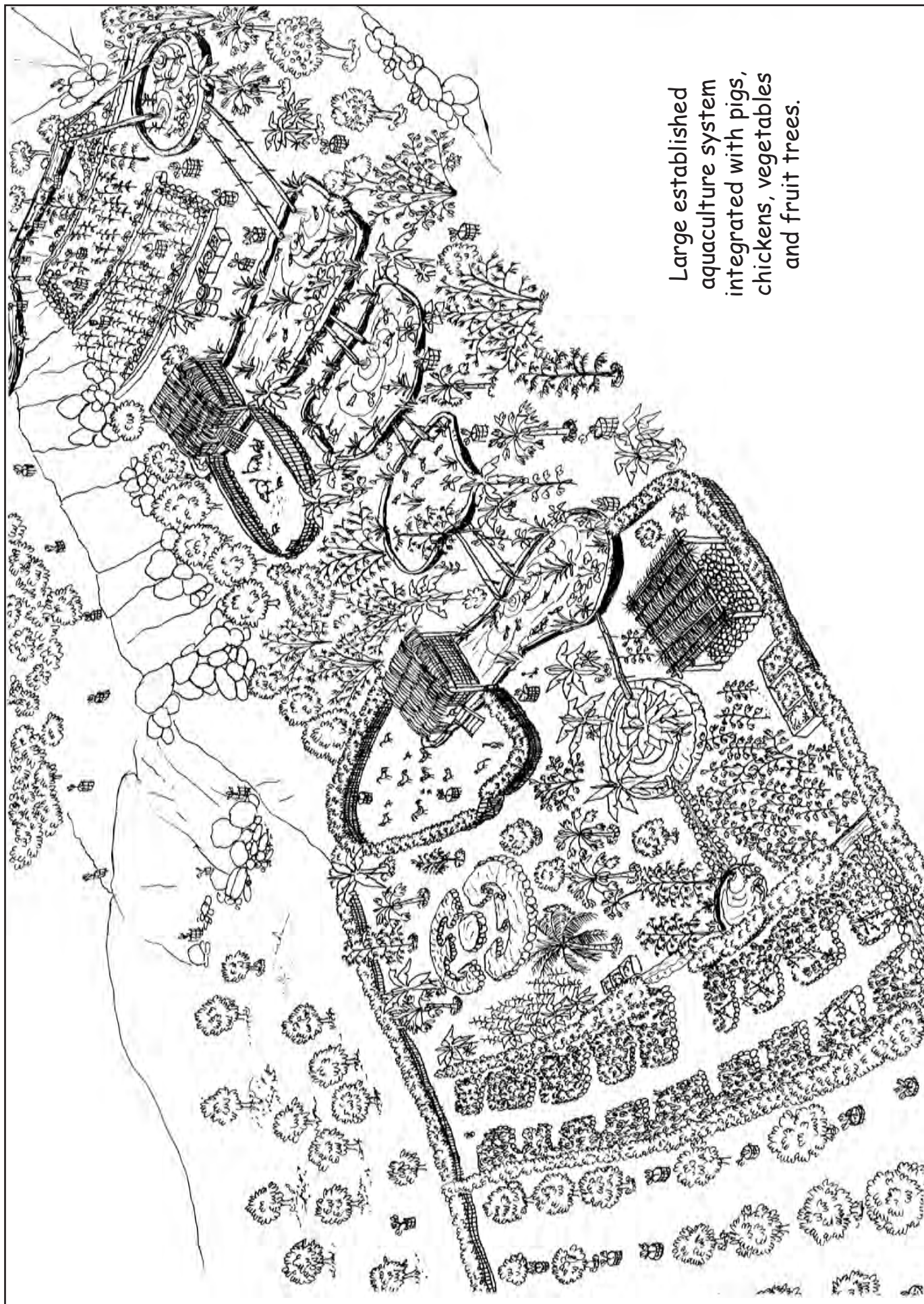


Drying and Storing Fish

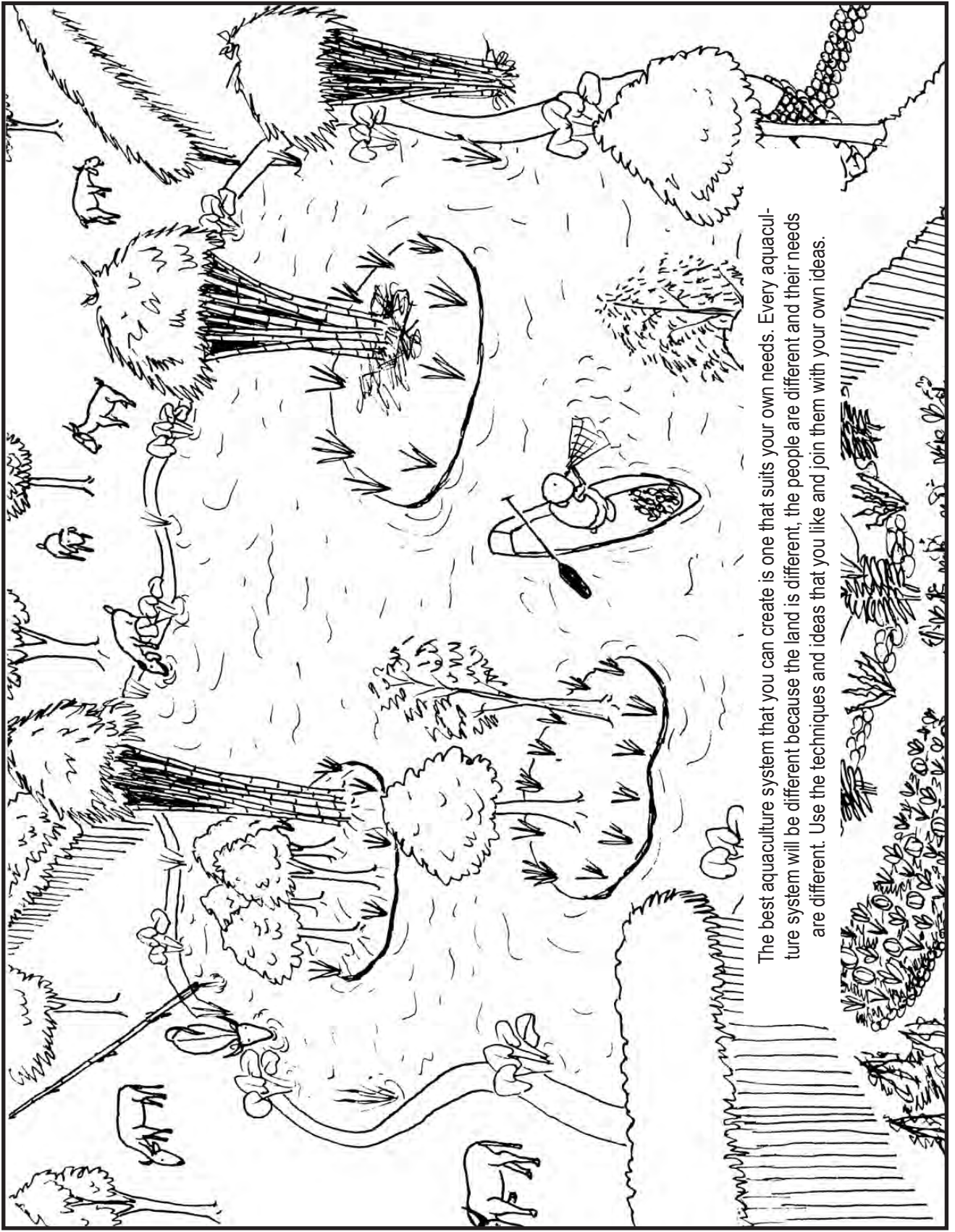
Sometimes there will be too many fish to eat or sell. It is important to dry and store the fish well so that it is not wasted. A Solar Drier is a great way to dry fish because it dries much faster and insects and animals can't touch it. Read in the Alternative Technologies Chapter (CH 14) for making and using solar driers. Dried fish should be stored in a cool, dry place, away from sunlight and protected from insects and animals. A wire box works well. Hanging from a ceiling is also good as long as rats and mice can't reach them.



The Marketing and Selling of fish is important for the sustainability and growth of fish farming, especially selling outside of the community. Read the Community Groups and Cooperatives Chapter (CH 15) for ideas.



Large established aquaculture system integrated with pigs, chickens, vegetables and fruit trees.

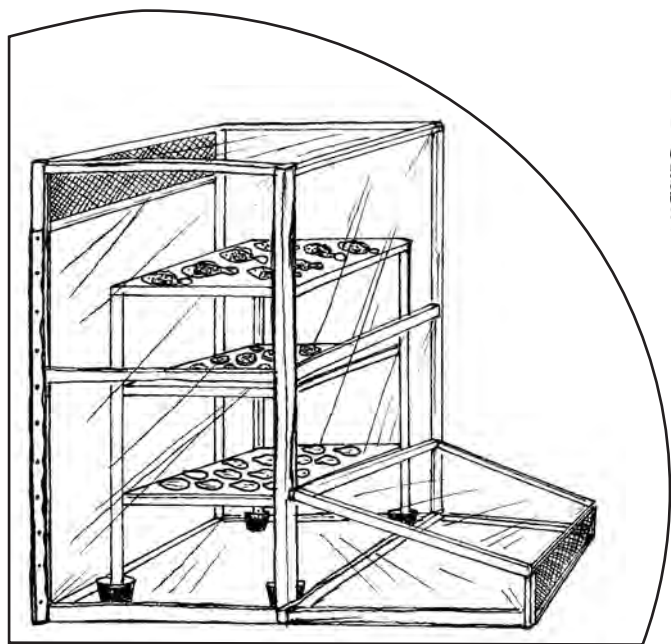


The best aquaculture system that you can create is one that suits your own needs. Every aquaculture system will be different because the land is different, the people are different and their needs are different. Use the techniques and ideas that you like and join them with your own ideas.





Appropriate Technology



CHAPTER

1



Wind and Solar power

New technology is constantly being invented to improve life. Amazing new ideas are continuously helping us to evolve as people and as a society. Sometimes the technology is helping to be more sustainable. However sometimes it has a negative impact for humans and the environment. And often, new technology is difficult and expensive to buy and maintain.

- Cars are necessary for transport but they are using oil and petrol that is taken from the earth and will not last forever and they cause pollution problems all over the world.
- Electricity that comes from generators also uses fuel and creates pollution.
- Tractors can plough fields quickly, but they are very difficult and expensive to use and maintain. And for most of East Timor's sloped land they cannot be used.



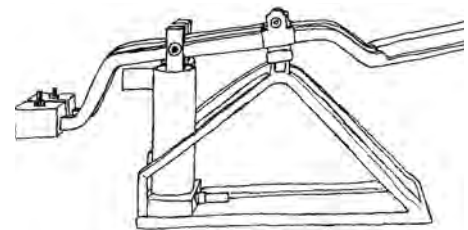
A lot of the technology that has helped make life easier and better are helping to cause a huge problem that the whole world now faces called "Global warming". Too much Carbon Dioxide gas in the atmosphere is interfering with the earth's natural cooling cycle. Ice and snow is slowly melting in some places and the temperatures are slowly rising. This is a situation that will get worse unless changes are made all over the world and better more sustainable technologies are used.

Even East Timor's small population must become sustainable.

A good word for technology that is sustainable and suits the needs of a country is "Appropriate Technology".

Appropriate technology for East Timor is technology that is:

- Able to be understood and maintained by the people using it
- Affordable
- Reducing energy use – electricity, labour, fuel, firewood etc
- Using natural, reusable energy whenever possible



A treadle foot pump for pumping water

Appropriate technology helps to improve life quality while allowing East Timor to protect its land and environment and progress to a sustainable future. It will improve the world's environment as well.

More and more countries in the world are moving to appropriate technology because it is smarter and healthier, and changes must be made as environment problems become worse. Examples of appropriate technology:

- Diesel vehicles and diesel motors can be run using coconut oil!
- Electricity can be created using the sun, wind, water and even manure!
- Buffalos and Bali cows can also plough fields. They are easy to use and are good food too!

This chapter gives examples of technology that can help people from all over East Timor, from Dili to the most remote villages.

Ovens and stoves



Ovens and stoves are maybe the most important simple technology that can easily be made and used in Timor Leste.

- They use a lot less firewood. Therefore you will save a lot of money AND help to protect the environment for the future
- You will save time and effort collecting firewood.
- A lot less smoke is produced, which is very important for improving health
- Some stoves use rice husks, coffee husks, sawdust or charcoal bricks instead of wood.



Clay Stoves

Clay stoves are traditionally used in some districts. They are very simple to cook on.

Make the fire in the bottom of the stove and place the pot on top. The clay directs the heat and flames up to the bottom of the pot. The clay also becomes hot providing more heat for cooking. Only a small amount of wood is needed compared to a normal fire.

Clay stoves are made from clay (75%), dry cow manure (25%) and a small amount of cement, if available. Add some water to make a mix that is moist but not wet. The stove should be about 5cm thick and 40 - 50cm high. Cut 3 sections from the top, 3 cm high and about 10cm long. This is essential for good air flow. If possible the stove should be fired (cooked) in a kiln. This will make the stove last A LOT longer.

Clay Ovens

Clay ovens are even better than clay stoves. They can be made in many different ways. Small simple ovens can be used for cooking inside the oven (bread, cakes etc.) Larger ovens can also be used like a stove to cook food on top of the oven. These ovens can also have a chimney to draw smoke away from people and even out of the kitchen. Clay ovens are also made from clay, dry cow manure and a small amount of cement.

Method 1

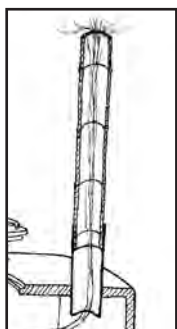
Use clay bricks for bottom and sides. Cover them with a thick render made from clay (75%), cow manure (20%) and cement (5%, if available).

Use wire to shape a frame for the top. Make 2 or 3 holes in the wire, about 10cm wide for cooking pots. The top should be flat so that the cooking pots can sit on it. Make one more hole at the back of the oven for a bamboo chimney to let the smoke out. Cover the wire with the clay mix, 10cm thick so that the wire is in the middle.



Door

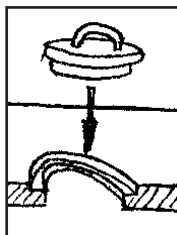
The door at the front has to be large enough to fit the largest cooking trays you want to use. It must be 10cm thick, the same as the oven, and fit very well to stop smoke and heat from escaping.



Chimney

Make a round tin metal sleeve for the bottom of the chimney, about 20cm long and wide enough for the bamboo to fit into the top.

Place the chimney into the prepared hole and use the clay mix to seal the gap and hold the chimney in place. Also use the clay mix to seal any gaps between the metal sleeve and the bamboo.



Lids

Make lids for the cooking pot holes to cover the holes when cooking pots aren't being used. Make a wire frame for the lids and make them about 10cm thick.

Add a wooden or metal handle on top. The lids MUST fit very well into the holes to stop smoke and heat from escaping.

Method 2

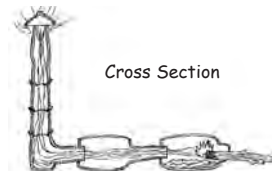
Follow the same steps as method 1 but make a wire frame mold to shape the whole oven. Make sure that all the oven is 10cm thick or more.



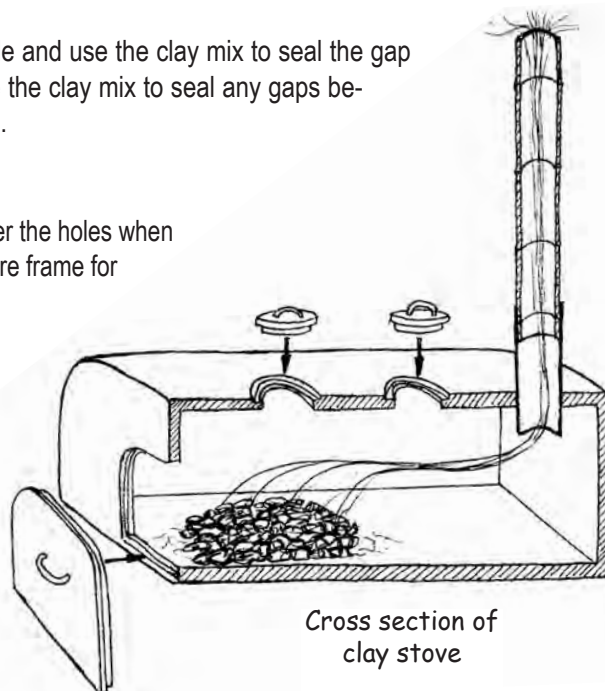
Clay Stove
Cross Section



Clay Stove with 2
burners and chimney



Cross Section



Cross section of
clay stove

Charcoal brick cooking fuel

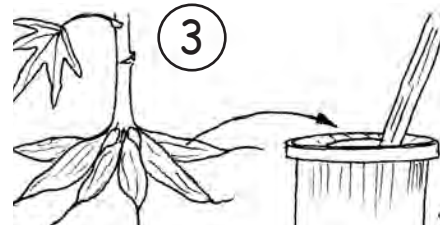
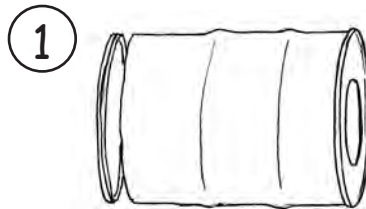
Firewood is expensive and requires VERY hard work to collect it. It also creates a lot of smoke.

Charcoal bricks are a cooking fuel that last a long time and produce very little smoke. Charcoal bricks are easily made using a drum and local materials.

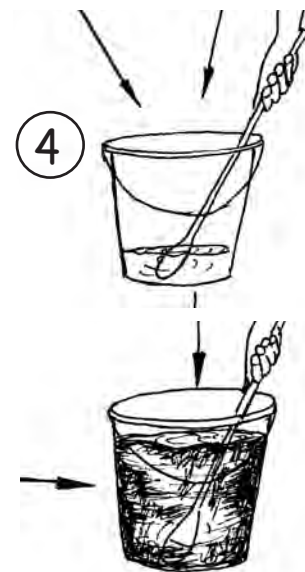
Making Charcoal Bricks

Step 1: Cut the bottom off of a drum. Turn it over and cut a small circle, 20cm wide, in the middle of the other end. Make sure any sharp edges are hit down. This end is the top.

Step 2: Fill the drum with fresh bamboo leaves, thin split bamboo (not dry), coconut shell and husks, coffee husks, rice husks, palm leaves, banana leaves and other leaves. Bamboo is best. Burn the leaves slowly and stir the fire occasionally with a wood pole through the hole in the top. Add splashes of water occasionally to slow the burning process. Add more material as well. When the material has all burnt into black pieces of charcoal, put the fire out with water. The black charcoal will be left at the bottom.

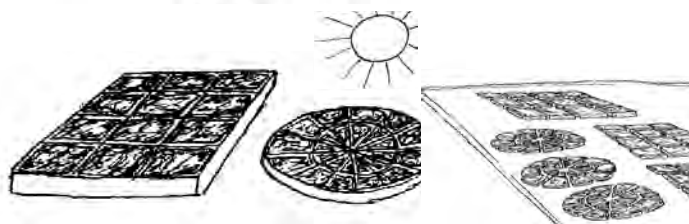
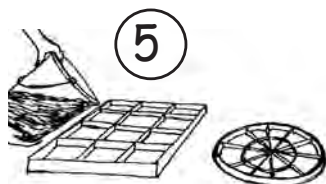


Step 3: Crush some dried cassava root into a powder. Add water to make a thick paste. Or, crush the stems of cassava bushes, put in a bucket (not the skin) and mix with water. Leave the mixture to settle. It will separate into liquid at the top and a thick paste at the bottom. Pour off the liquid so that only the paste is left. Dried and crushed arrow-root root can be used as well.



Step 4: Mix the black charcoal that is left in the bottom of the drum with the cassava paste. (90 to 95% charcoal and 5 to 10% cassava paste.)

Step 5: Put the charcoal brick mixture into a brick "mold" (see pictures), and then put in the sun to dry.



Using Charcoal Bricks

The bricks can be used to cook with on open fires, in cooking stoves and clay ovens. A brick will burn very slowly and will produce a constant heat. Start a small fire with sticks then add the bricks when the fire is alight. The bricks will then burn by themselves. Add more small sticks if you need to increase the heat, and add more brick as necessary.

Bamboo charcoal

Bamboo charcoal bricks can be made in the same way as charcoal bricks.



SMART IDEA:

The thick syrup that comes from the coffee processing may also be able to be used, but hasn't been tried yet. This would turn a waste product into valuable cooking fuel.

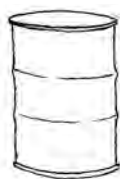
Drum oven

A drum oven is a simple way to cook a lot of food using a drum, sand, rocks and banana leaves. It uses a lot less wood to cook the same amount of food as a cooking fire. It also keeps much more nutrients in the food than boiling or frying.



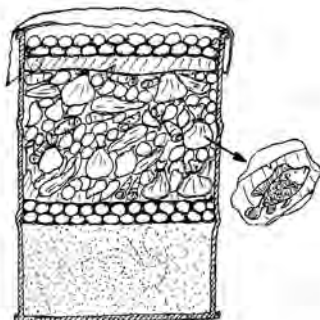
Step 1: Cut the top off of a drum. Clean the inside well with detergent and water. Wash very well with water. Leave in the sun for a few days.

Step 2: Fill to half way with sand.



Step 3: Collect a small pile of hand size rocks. Make a fast fire from palm leaves, bamboo leaves, small sticks etc to heat the rocks. (Don't use rocks from the river as they may explode!)

Step 4: When the rocks are very hot, use a shovel to put 2 layers of rocks on the sand. Then put 2 layers of fresh banana leaves on the rocks. Place the food on the banana leaves. Meat, fish, cassava, sweet potatoes, potatoes, corn, bananas, pumpkins, yams, carrots, and more can be cooked. Then place 2 more layers of banana leaves and 2 more layers of hot rocks. Cover the top with an old cloth and tie it on tightly with twine. Leave for 2 hours.

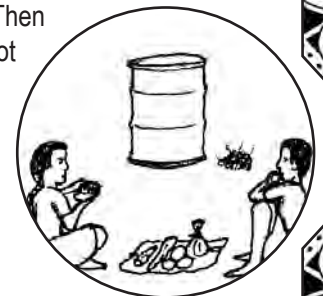


Step 5: Remove the cover, rocks and banana leaves, and then eat the delicious food!



SMART IDEAS:

- Instead of cutting the top off of the drum, cut the drum in half. Then you have 2 ovens, and they are easier to use!



- The same cooking method can be used with a hole in the ground. In areas with sandy soil this is a much simpler method.

Cement / sawdust stoves

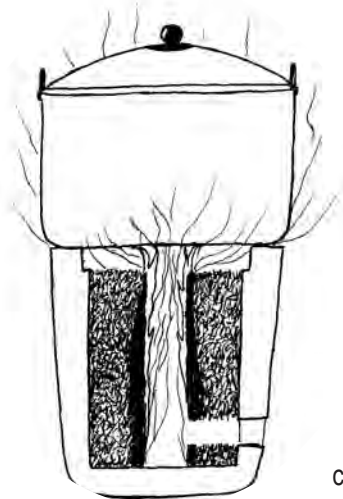
Idea taken from Lik Lik Buk, a guide book from Papua New Guinea.

A cement stove is cheap, long lasting, easily movable and easy to make. It uses sawdust as cooking fuel. It may also work with rice husks and coffee husks, but these fuels haven't yet been tried. Experiment to see what works best. It also burns with little or no smoke.

You will need:

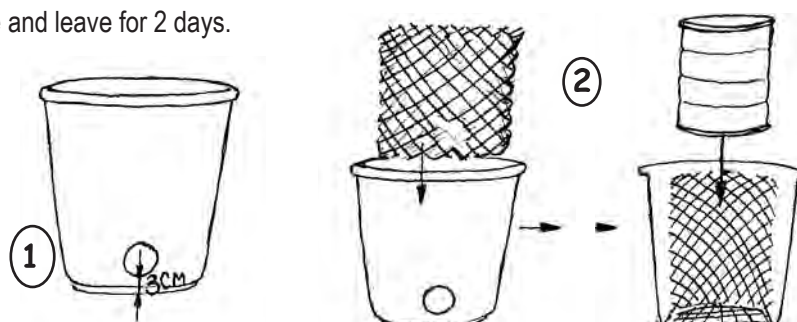
- A 10 litre size bucket
- A sharp knife
- A wire cutter
- A large 2kg size tin (milk tin, or some old tin roof molded to size or even a plastic water/coffee jug)
- 2 pieces of bamboo about 4 –5cm wide (finger length) and 50cm long (make sure that it is taller than the bucket)
- Sand
- Thin wire mesh, about 60cm x 60cm
- Tin snips if you use tin
- Cement (1/4 bag for 1 stove at most)

How to make the Stove

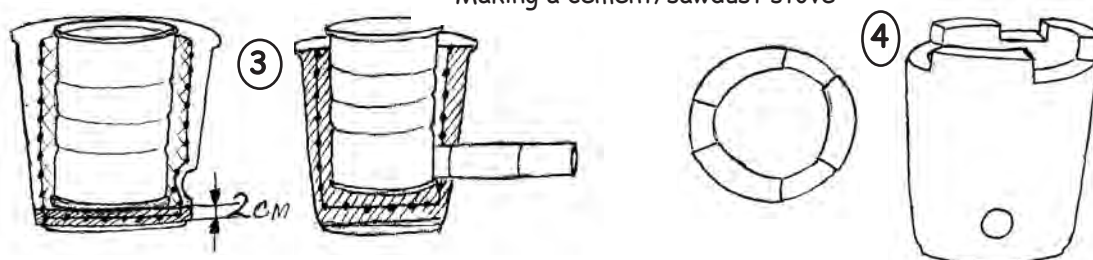


1. Cut a circle in the bucket, 3cm from the bottom and as wide as the bamboo.
2. Mould the wire so that it fits inside the bucket close to the sides and bottom but without touching it. The wire should also be 2cm below the top of the bucket.
3. Mix the cement, about 1 part cement to 3 parts sand. It should be a fairly dry mix. Put about 2cm of cement into the bucket. Place the wire in the bucket so that it sits in the wet cement. Place the tin on the cement, and then make sure the wire doesn't touch the bucket or the tin. Cut a hole in the wire the same size as the hole in the bucket. Put a bamboo piece through the hole until it touches the tin. Put a stone in the tin to stop it from moving. Carefully fill the space between the bucket and the tin with cement. Poke the cement with a thin piece of wire occasionally to remove any air. Fill up to the top of the bucket.
4. When the cement is about 1 hour old carefully make 3 cuts into the top of the cement, spaced evenly, 1cm deep and 2cm wide. These cuts will provide important air flow when cooking and are essential for the stove to work.
5. When the cement is firm carefully remove the tin by slowly twisting and pulling. Remove the bamboo as well.
6. Put the bucket in a dry, dark place and leave for 2 days.

7. To remove the bucket, tap it gently with a stick then turn over and shake until the cement stove slides out. But don't let it fall! Cover with a damp cloth and keep it moist for a week to properly cure the cement.

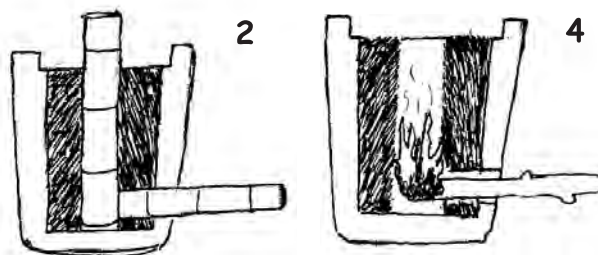


Making a cement/sawdust stove



Using the Cement Stove

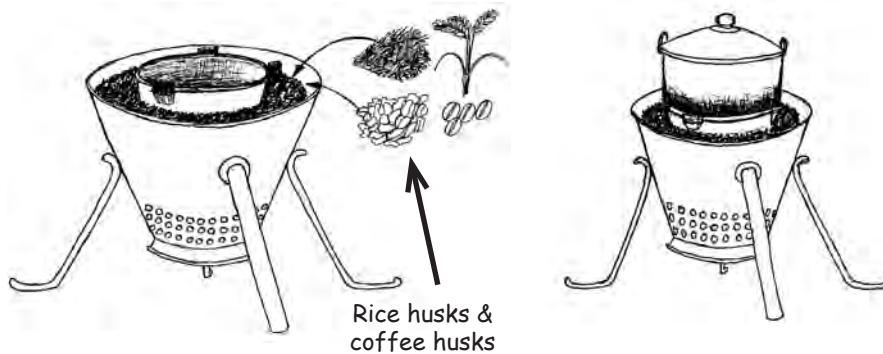
1. Take the pieces of bamboo. Place 1 piece in the center of the stove pointing straight up. Place the other piece through the hole so that it touches the other bamboo piece.
2. Begin to pour sawdust into the stove from the top. Tap it down continuously so that it is very firm. Keep filling the stove until the sawdust reaches the top and then make sure it is very firm.
3. Carefully twist and remove the center piece of bamboo. Then carefully push the bottom piece of bamboo until you can see it through the top hole and then twist and remove it. The sawdust must not move at all. You will then have an "L" shaped tunnel that the fire and air will go through.
4. To light the stove take a finger thick piece of dry wood and dip it in kerosene. Then put it in the bottom hole so that you can see it from the top. Then light a match and drop it down.
5. Soon the sawdust will slowly burn and a good flame will continue as long as the stick is fed into the stove. Once the sawdust in the middle is bright red the stick can be removed. The stove will then provide a constant heat for 2 hours. If more heat is required feed in another stick.



Using a cement/sawdust stove

Tin Metal Stoves

Tin Metal Stoves use rice husks or coffee husks to burn instead of wood. They have been built and tested in East Timor already with good results. They are designed so that air enters through the bottom and keeps the rice or coffee husks burning continuously. Less smoke is produced than a wood fire. Full plans for making and using Tin Metal stoves are available through Hasatil. They are quite cheap and there are blacksmiths in East Timor who could make them.



Gas Stoves

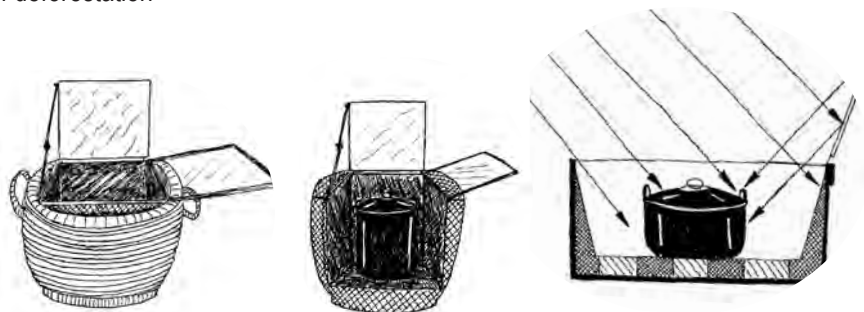
Gas stoves are common in Dili and are also used a little in district towns. They cost around \$80 to buy and then the gas bottles can be exchanged for \$20 when they become empty. This lasts for 1 to 2 months. They cost slightly more than wood, and transportation outside of the large towns is harder but the benefits are more than worth it.

Benefits:

- They are MUCH easier and MUCH cleaner to use than wood fires
- They produce NO smoke
- They reduce the very serious problem of deforestation

Solar cookers

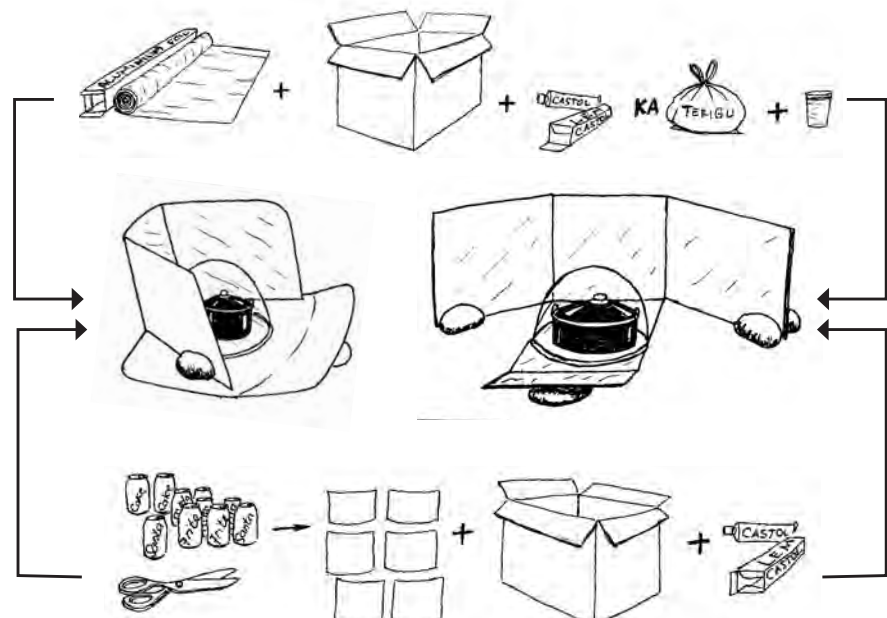
A solar cooker uses the heat from the sun to cook food. Food can be heated on a stove or fire until it is boiling and then put in the solar cooker. The cooker will use the sun to keep the food at the same heat and slowly cook.



How to make a simple solar cooker

Tin foil and glass is used to reflect and catch the sunlight and heat, and insulating material (coconut fibre, kapok etc or wood painted black is used to store the heat.

They are excellent for soups, rice, corn and more. There are many different designs to make solar cookers that use cheap and easy to find materials. They can be a box or closed cooker, or a simple open cooker. Look at the pictures of different designs and look in the reference section for where to find more information.



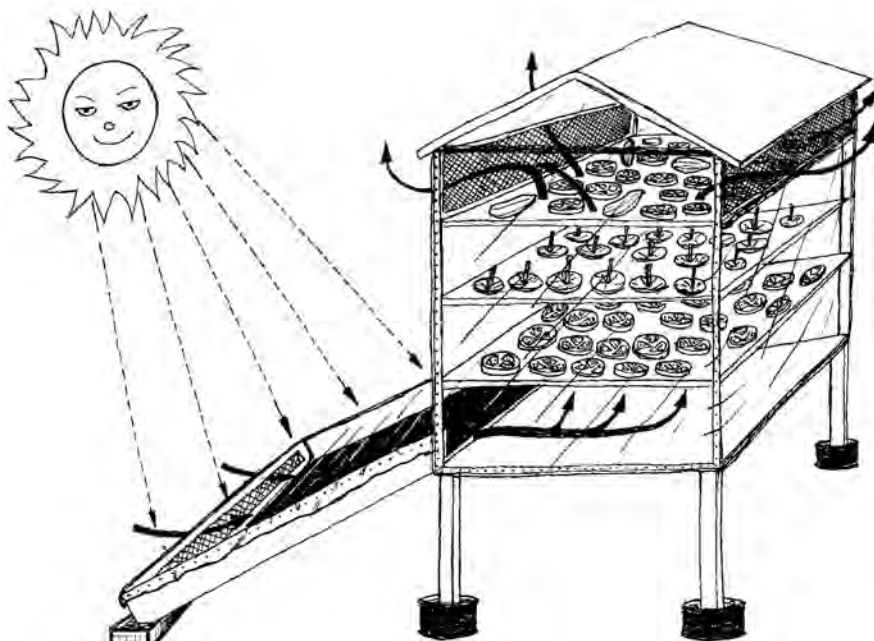
Solar driers

Solar driers are already being made and used in East Timor for drying fish.

They can also be used for drying vegetables, fruit and other meat.

Solar driers are good because:

- They stop insects and animals from eating the food.
- They stop insects and animals from spreading disease to people from touching the food.
- The food dries much faster. Fish that takes 1 week to dry normally takes 2 days in a solar drier. Much more produce can be dried in the same amount of time.
- Less food goes rotten.



Solar driers reduce waste. Any food that can't be sold or eaten can be dried and saved for later use. The nutrients in the food stay in the food. Dried food can also be traded or sold. There are many types of solar driers, big and small but we will explain the 2 types that are being made here.

Plastic Solar Drier

The plastic solar drier is a very simple design.

It has an outer shell, or skin, made of a wooden frame and tightly covered in clear plastic. Inside are shelves made with a wooden frame and insect wire as the base.

The wooden legs of the shelves are put into tins filled with water to prevent ants from damaging the food. The back of the drier can be opened for easy access.

At the bottom on the front side an extra section is added to catch hot air. On this section the top is covered with clear plastic, but the side is covered in insect wire.

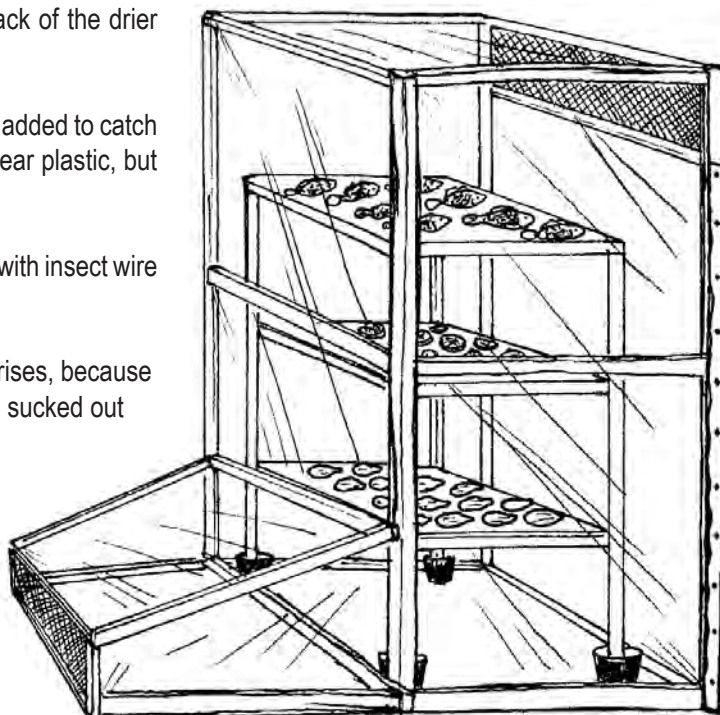
The top section on the other side is also covered with insect wire instead of plastic.

Hot air is collected in the bottom section. It then rises, because hot air always rises, to the top of the drier, and is sucked out through the top insect wire.

More air is then sucked in through the bottom.

This is called ventilation.

It creates airflow inside the solar drier and helps a lot to dry the food faster and stop it from going rotten.



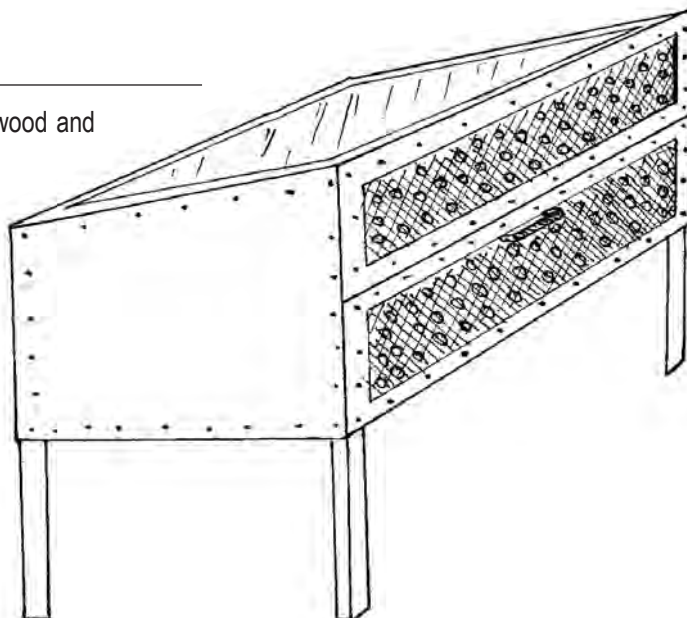
Wood and Glass Solar Drier

The NGO USC East Timor has made and is trialing wood and glass solar driers.

To dry food:

- Big fish – 3 days.
- Small fish – 1 1/2 days.
- Vegetables – 1 day
- Meat - 3 days for meat cut in slices 3cm thick.

This solar drier is more expensive and more difficult to make but it will dry the food faster and, importantly, last many years longer than the plastic solar drier. It costs approximately \$75 for the materials and \$25 for labour for 1 solar drier. It takes approximately 3 days to make. They are being used in Natabora for vegetables and fruit, and in Usu'un for fish and meat. The materials are bought in Dili and they are built in the districts. The driers are easy to clean. If they are kept to instructions, they can last for 5 years, or much longer with some maintenance. Keep away from rain, and keep flat.



They produce more heat than plastic solar driers, and are better for stopping bacteria, moisture, insects and animals. As with plastic solar driers, ventilation is essential.

For more information contact USC East Timor.

COMMUNITY IDEA:

Solar driers could be made for market places to dry produce that is not sold. Food sellers can join together to make and use a drier.

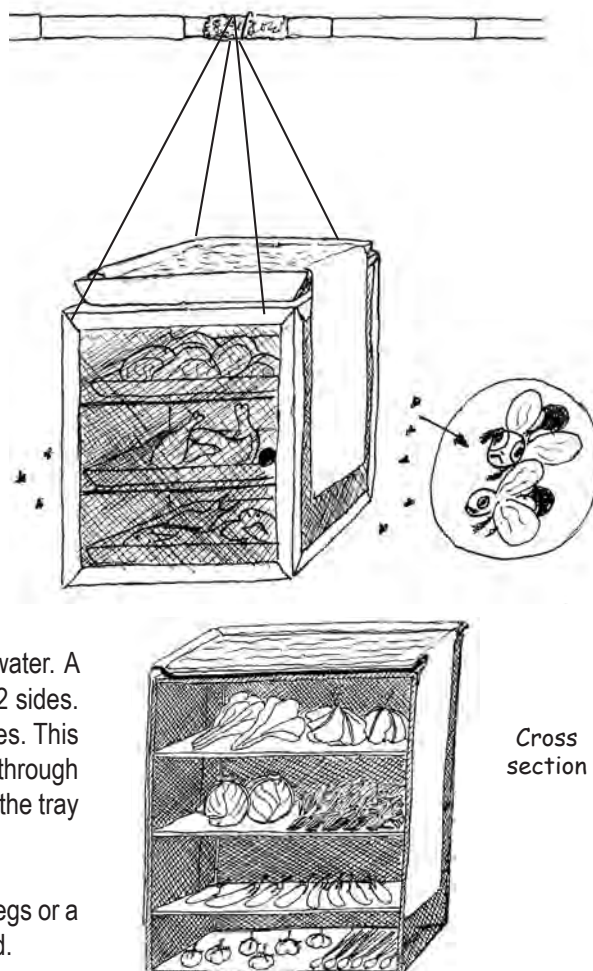
Natural cold food storage

If meat, vegetables and fruit are cold they will last much longer. Refrigerators are too expensive for most East Timorese and rely on electricity to work.

The Coolgardie Safe

The Coolgardie safe, which was invented in Coolgardie, a town in Western Australia, is a simple way to keep food colder as well as stopping animals from eating it and insects from touching it. The safe is a wooden box that has shelves inside for the food to sit on. The box can be as big or small as you need. One side opens as a door. All 4 sides have insect screens with wooden edges. The insect screens allow wind to blow through but stops animals and insects. On top of the box is a tray that is filled with water. A large piece of hessian sits in the tray and hangs down over 2 sides. The hessian draws the water from the tray and down the sides. This works the same as the wick in a kerosene lamp. Wind blows through the wet hessian and keeps the food inside cool. Add water to the tray whenever needed.

The Coolgardie safe can be hung from a roof or placed on a legs or a stand. It is important to put it outside in a place that gets wind.



Clay pots

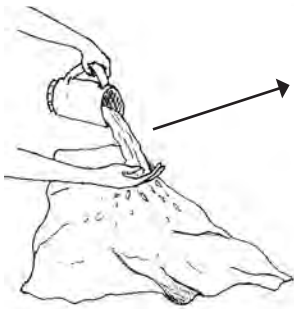


Clay pots are excellent for food storage, especially vegetables and fruit.

They will keep food fresh for many days longer.

Method 1: place food in the pot and cover with a damp cloth. Make sure that the cloth stays wet and keep the clay pot out of the sun.

Method 2: use 2 clay pots, one inside another, with a layer of sand in between. Keep the sand moist and cover with a wet cloth. Keep out of the sun. This method works even better.



Cross section of 2 clay pots

Electricity

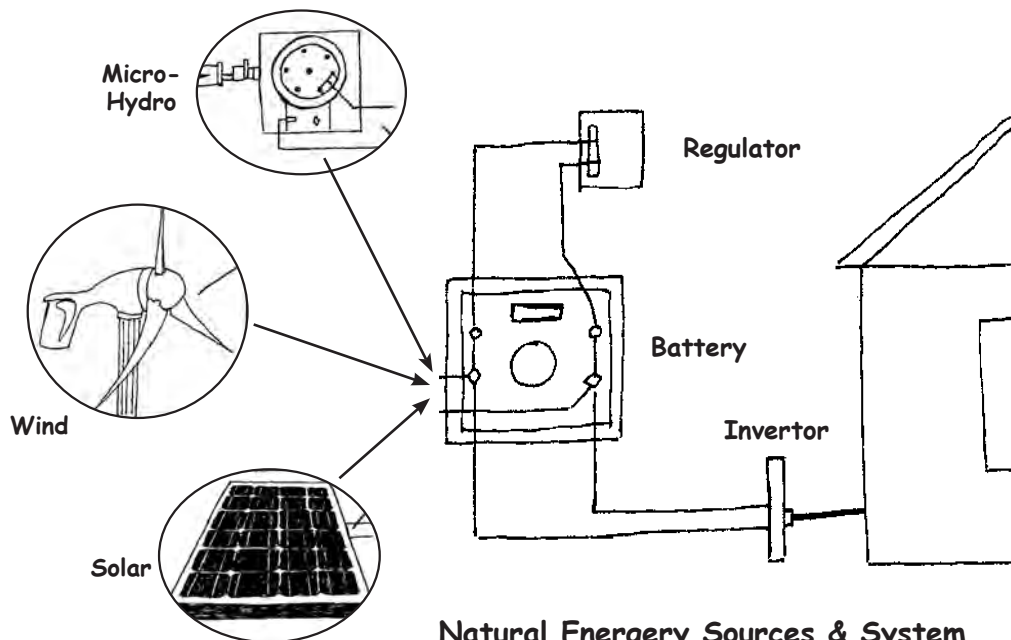
Many areas in East Timor have no electricity at the moment. In some areas this is because there is no infrastructure, some areas because it is too expensive for petrol, and some areas because the generators are broken. And where there is electricity it isn't on all day. The government at the moment is introducing a system where electricity is paid for before it is used. This will make electricity expensive, but is good for using as little as possible. It is also important for people all over the world to use less electricity because of the pollution it causes.

Ways to minimize electricity use:

- * Turn lights, fans, television etc off when not using them.
- * Use low watt bulbs.

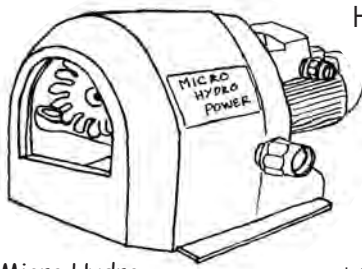
Natural electricity production is much better for the future of East Timor.

It produces very little pollution. It can be used by individual house and buildings, by a group of houses or even a small community.



Natural Energy Sources & System

Hydro-electric systems



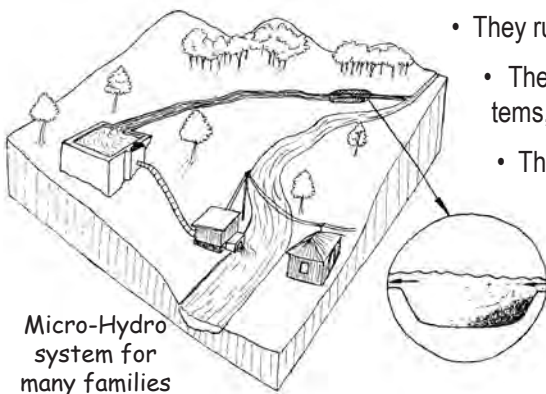
Micro Hydro Turbine

Hydroelectric systems use flowing water to create electricity. The water from a river, dam or lake is run through a pipe that goes downhill. This creates a fast continuous water flow. This water then makes a wheel spin around in the hydro-electric unit, which then turns a turbine which creates electricity. This electricity is then stored in batteries, ready for use.

Hydro-electric systems can be many different sizes:

- * Small micro-hydro systems that provide electricity to a few houses or a village.
- * A larger system that provides electricity to a town or area.
- * Large hydro-electric systems that run from a lake or large dam that can provide electricity for a large area with many towns or cities.

Small micro-hydroelectric systems are excellent for East Timor because:



Micro-Hydro system for many families

- They run a small but continuous supply of electricity.
- They are MUCH better for the environment than bigger hydroelectric systems, both in setting up, and long-term impact.
- They require much less maintenance than bigger hydroelectric systems.
- They need a much smaller amount of storage batteries and require less maintenance than solar systems.

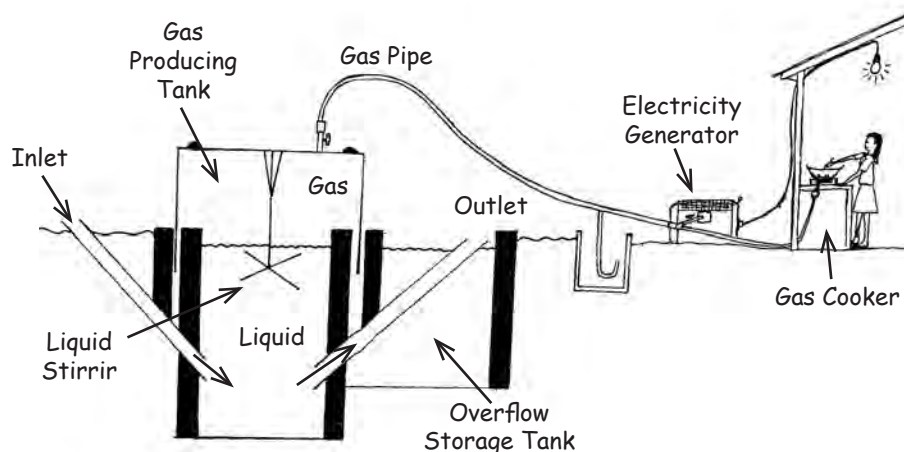
Any project must gain approval of the local people concerning spiritual beliefs and land and water use.

Biogas system

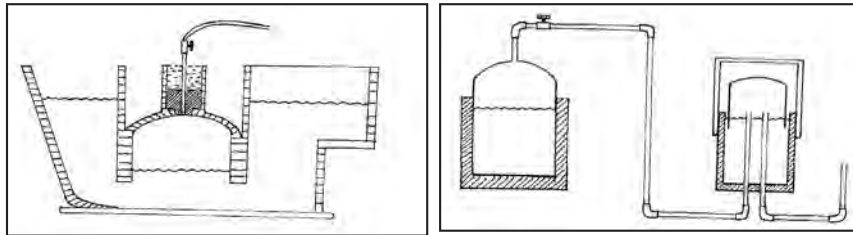
A Biogas system collects methane gas, a flammable gas that can be used to cook with, run gas lights, run internal combustion engines and make electricity. Methane gas is made naturally when animal manure, human manure, rice husks, leaves, water plants and grass decompose. In a biogas system these materials are placed in the biogas tank. The methane gas is then trapped in the tank and collected for use. If new materials are continually added to the tank then gas can be continually collected. Old materials are continually taken out from the tank and used as very high quality fertilizer.

There are many benefits

- Gas, and even electricity is produced from free or cheap resources.
- The gas replaces the need for firewood, and doesn't produce smoke.
- The manure and other materials keep all of their nutrients. In fact, because of the gas producing process the nutrient levels are increased and are more easily used by plants. Once the manure has finished producing methane gas it can be used to make compost, liquid compost or can be used directly as fertilizer – be careful because it is strong.
- Almost all bad bacteria in the manure that can make people sick are killed in the biogas tank.
- Worm diseases for humans and animals are reduced.



Biogas systems can be made for 1 house, or many houses. It is used in many countries and is excellent technology for East Timor. They are especially good for remote areas. There are many, many different designs, depending on the type of manure available, money and building materials available.



2 other Biogas System Designs

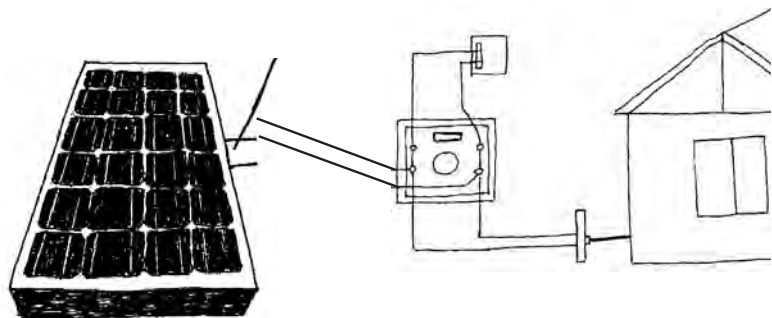
Some basic facts about a biogas system:

1. 1m^3 ($1\text{m} \times 1\text{m} \times 1\text{m}$) of methane gas provides:
 - gas to cook 3 family meals or
 - 700mls of petrol or
 - 1.25kw of electricity
 - 6 hours of light from a light bulb or
 - run a 2horsepower generator for 2 hours or
2. 1.5m^3 of tank size per person will provide enough methane gas. (E.g. 15m^3 for 10 people)
3. A biogas system is anaerobic (no oxygen) and must be made airtight and watertight.
4. Maintenance is important – water levels, PH levels (acidic or alkaline), temperature, material input mixtures, harmful materials and tank stirring all need to be regularly managed.

More information can be collected from Permatil, Hasatil, other NGOs or the internet. Dom Bosco School in Dili are also a good source of information. Creating and maintaining a biogas system needs research and technical knowledge. This can bring better skills and knowledge, as well as the many benefits from the biogas system. It also helps to promote self-reliance.

Solar System

A solar system uses the light from the sun to create electricity. Solar panels create the electricity. A charge controller (regulator) controls the electricity flow. This electricity is then stored in large batteries. The electricity can then be used for lights, radio and other needs. Solar panels must be placed in a very sunny place not shaded by trees, buildings etc.



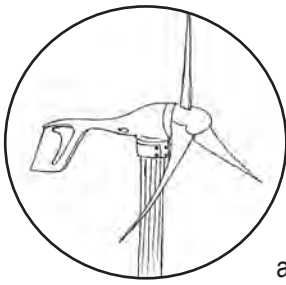
There are solar systems in East Timor already. They can provide electricity anywhere in East Timor and with the correct knowledge, are easy to set up. Once they are set up, knowledge of how to maintain them and use them properly is essential.

**The batteries especially must be looked after well.
If not they can stop working very quickly and become useless.**



SMART IDEAS:

- If the solar panels get too hot they don't work as well. This will happen from touching metal or tin roofs. Keep them away from tin roofs if possible or put lots of insulation (old material, cardboard, bamboo, wood etc) between the roof and the panel.
- An Inverter Machine will regulate the flow of electricity from batteries to the lights, fans, radio, TV etc. They are expensive, but will improve the electricity supply and the life of the electrical equipment. Ground the solar system to reduce problems of supply.



Wind system

Wind can also be used for making electricity. A wind generator uses a propeller that turns when the wind blows. The propeller is like a helicopter but the blades of the propeller turn from wind, not from a motor. The movement of the blades then causes a shaft to turn. A series of gears then turn which transmits power to a water pump or generator. The energy that is created is then stored in large batteries. The batteries are then used to provide electricity.

Wind generators can be small, providing electricity for a house, or very large, creating electricity for many houses.

In Australia and many other countries businesses are putting many large wind generators in areas with strong wind to create a lot of electricity. These are called wind farms! This electricity is part of the electricity system for the cities and towns.

In East Timor, hydro-electric and biogas systems are better for creating electricity, especially for villages because they are cheaper and easier to maintain.

In the future, large wind farms could provide electricity for towns, replacing the diesel generators. This requires the government and businesses to work together. Wind farms cost a lot to build but the money is saved in the future from not having to buy and transport expensive fuel and maintain generators. The wind farms could be part of a national system and can be combined with hydro-electric, solar and other natural electricity sources.

Car fuels

Cars, buses, trucks etc.(vehicles) create a lot of the pollution problems in the world today. This is mostly because of:

- The pollution and environmental damage created from mining, making and transporting the oil and petrol for vehicles.
- The pollution created when the vehicles use the oil and petrol.
- The pollution created from making the vehicles.

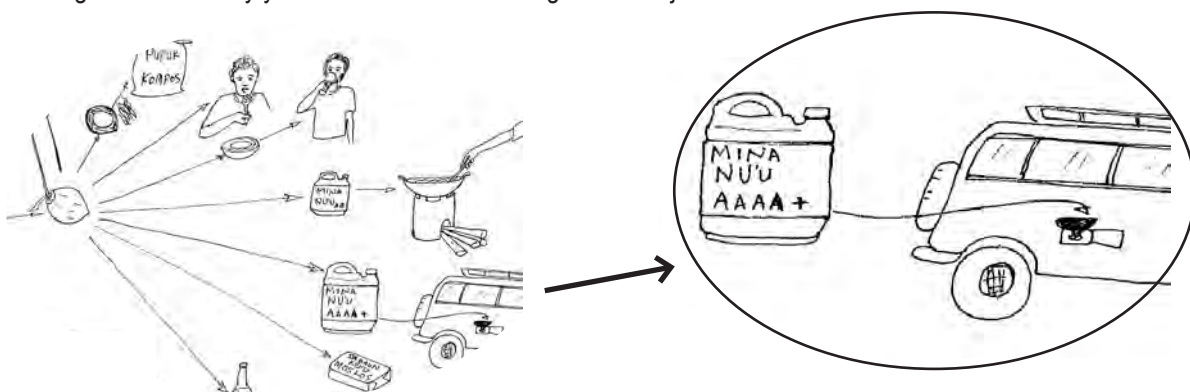


New technologies are being created to reduce these problems.

Cars are being made that can be run on electricity or on hydrogen. However there are also some simple technologies and different fuels that can be used. Diesel cars and engines can be run using good quality coconut oil. With small changes and an oil heater cars can also be run on used cooking oil! This and other technologies can be researched in books and on the internet.

Coconut oil for diesel cars & diesel engines

Coconut oil for diesel engines and cars is the simplest and most appropriate for East Timor, and some research has been undertaken here already. **Coconut oil can be used for all diesel engines, including cars, trucks, hand tractors, rice mills, small generators, pumps etc... It MUST be very high quality coconut oil. If not, it will destroy the engine.** Coconut oil from the markets cannot be used. To use it mix 20 parts coconut oil to 1 part kerosene (5%). This helps to make it thinner. In cold areas, mix 10 parts coconut oil to 1 part kerosene (10%). It has been used successfully in Bouganville for many years and is now also being used in Fiji and Thailand.



Water pumps

Collecting water is very hard work, especially if the water has to be carried up hill. There are ways of pumping water from the ground or uphill from a river.

A motor pump can be used but they are expensive, need petrol to run and need maintenance. There are pumps that don't need petrol and that are much more simple to maintain.

Ram pump

A ram pump uses water pressure created by gravity to move water a long way uphill.

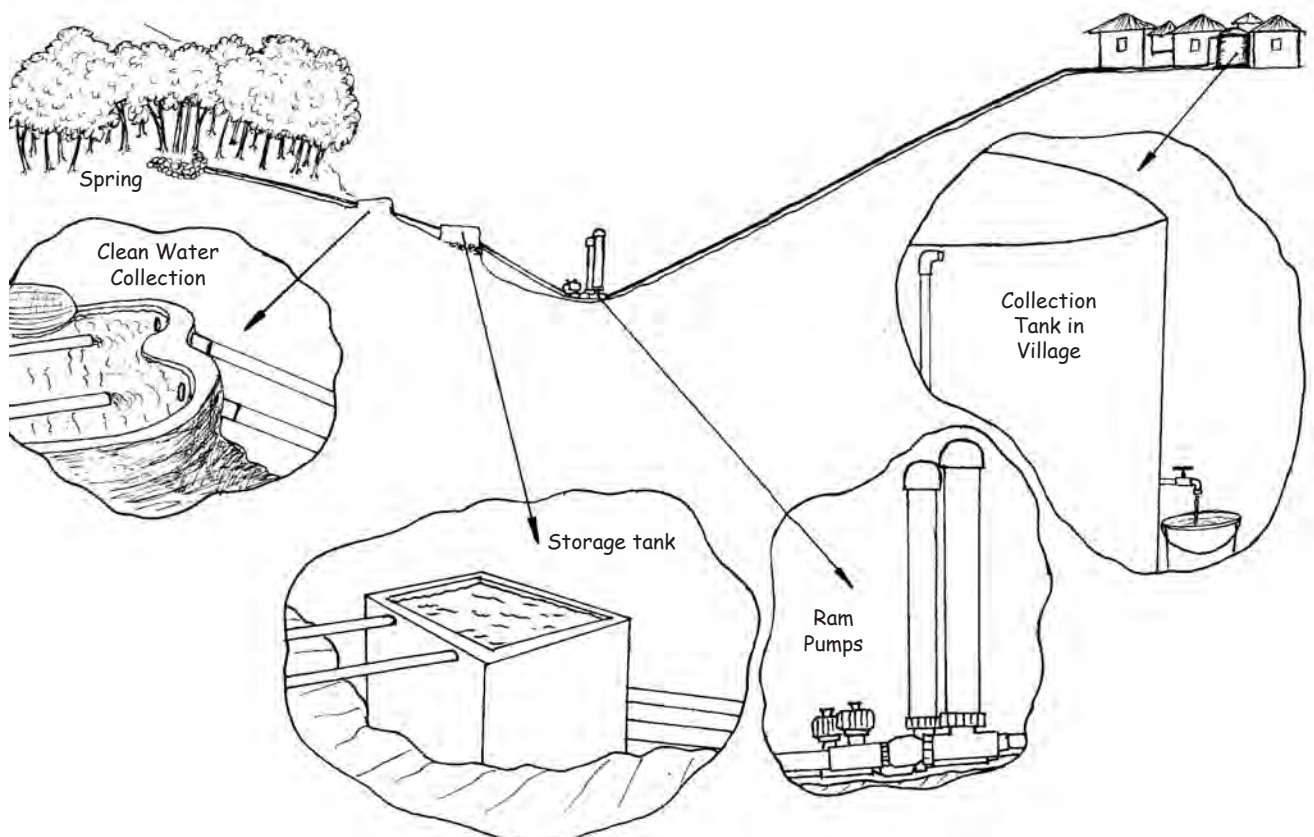
- Water from a spring or other water source is collected in a small tank. It is very important that the water is clean, or dirt will cause problems.
- It then flows downhill through a pipe, usually about 10 - 20 metres long. Pressure is built up as the water runs down hill.
- The water flows into the pump, creating air pressure and pumping the water through smaller pipes back up the hill.
- The water can be pumped up through the smaller pipes for a few hundred metres!
- They can be used for moving water from springs or rivers uphill to village water tanks.

Benefits:

- They are excellent for larger amounts of water and can provide water for many households.
- They are very simple to use and require very little maintenance.
- They require NO petrol and have NO engine.
- If there is a constant water supply they can be used all year.

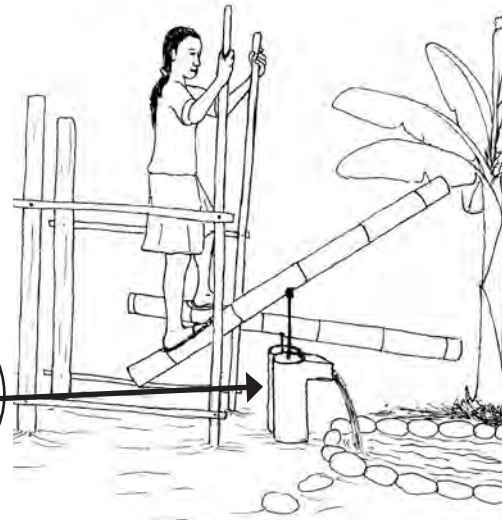
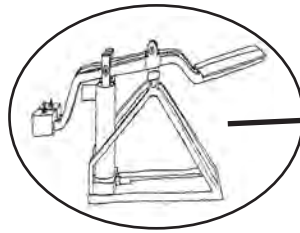
Some ram pumps have already been successfully installed in villages in East Timor.

They are a great long term solution for water supply problems in East Timor.



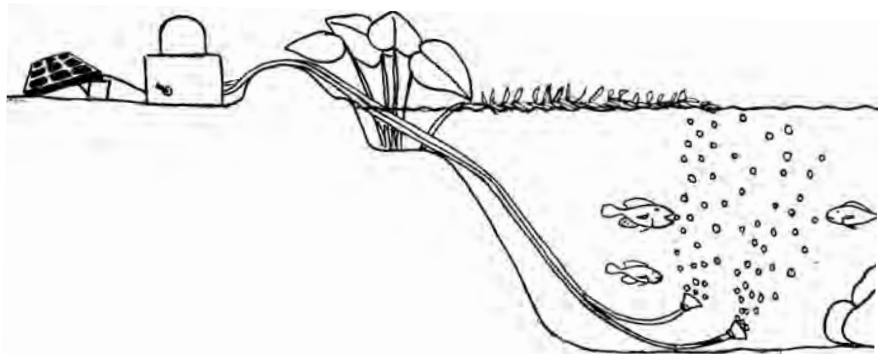
Foot pumps and Treadle Pumps

These pumps can be used to pump water from a bore or well. They can also be used to pump water from a spring or river. 2 boards, connected to 2 cylinders below them, are “walked” on. As the person walks, they move the boards up and down. The boards move pistons inside the cylinders. As the pistons move up and down, air pressure is created and sucks water up through a pipe into the cylinders and out the top. Thus water can be moved up from underground and then run via irrigation pipes or collected for house use. It is very similar to a hand pump, but more water can be moved for less effort.



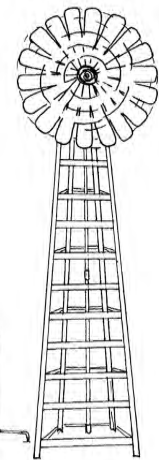
Solar power water pump

Solar powered windmills are used to add oxygen to ponds. The pump is run by a small solar panel that generates the electricity that the pump needs. They are excellent for fish-ponds and can also be used in water cleaning systems.



Windmills

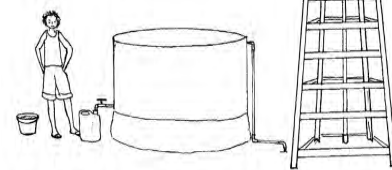
Windmills use the wind to pump water up from underground to use for house water or irrigation. It is like a huge fan. The blades of the windmill turn in the wind. As they turn they force a piston to move up and down, which sucks water up through a pipe from under the ground. The water is then stored in a tank.



Elevated Water Storage

The reason for raising a water tank above the ground is that the water can flow a long way through pipes, bamboo or hoses because of gravity (moving downwards).

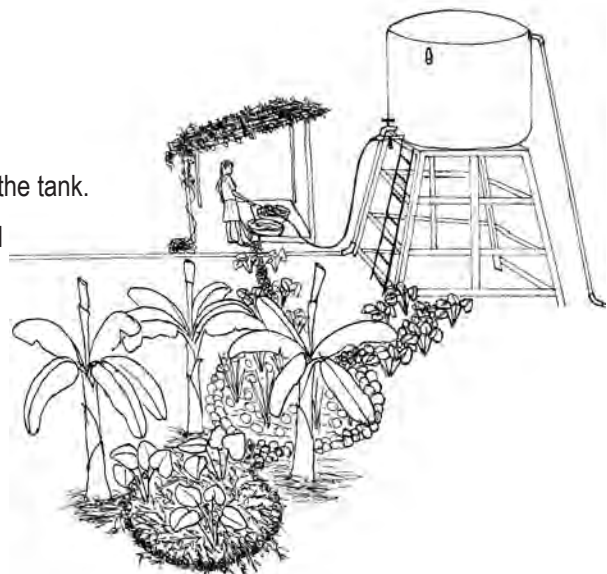
This makes watering much, much easier and you can move water a lot further away from the tank.



There are many ways to get water into an elevated tank:

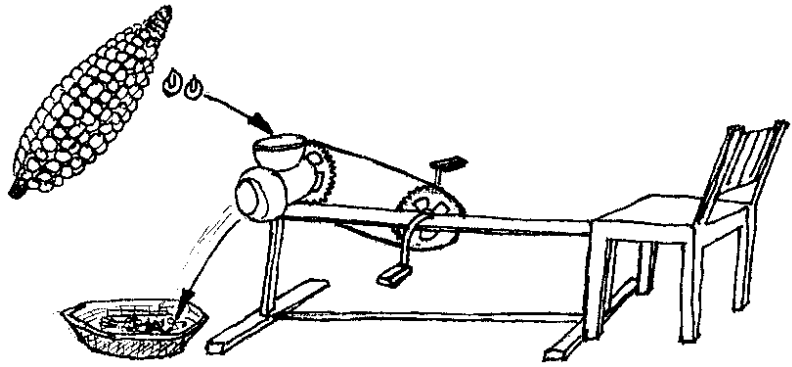
- Straight from a roof using bamboo water collection.
- Use a pedal, treadle or ram pump to pump the water into the tank.
- Using a petrol pump. (other pumps are much cheaper and much more sustainable.)

**Don't forget to
make good use of the
overflow water.**



Pedal – powered grinders

A simple but effective technology. A grinder that can be used to grind corn, rice, nuts and more is connected to a bicycle. Instead of the chain spinning around and turning a wheel, the chain spins a cog, which then spins the grinder. It is much easier than pounding the corn and much cheaper and than using a petrol grinder.



Oil Extraction

Oil can be extracted from a number of fruits, nuts and seeds for use in cooking, added to other foods, soap making, candle making, massage oils, running engines and much more. There are many plants in Timor Leste that provide oil, such as coconuts, candlenuts, ai kia nuts and avocados. The oils will greatly improve nutrition, especially for children, or could be sold or traded. Good quality organic oils are a possible export market in the future.

A simple method for extracting oil that is appropriate for Timor Leste is an oil press. There are many different types and sizes that can be used. Some are already being used here.

The press simply squeezes and crushes the material until the oil is released. The oil then needs to be cleaned to remove any material other than the oil. Good storage of the oil that is produced is essential for the oil to last a long time.

Look in the reference section for more about oil presses and oil production.



Using the Internet

The Internet is one of the most important technologies for the future of East Timor.

- It contains an incredibly large amount of information that is useful to developing a sustainable future.
- It can be used to share technologies and information with partner groups all over the world.
- It can be used to organize trainings with overseas experts and for study tours in other countries.
- And much, much more!

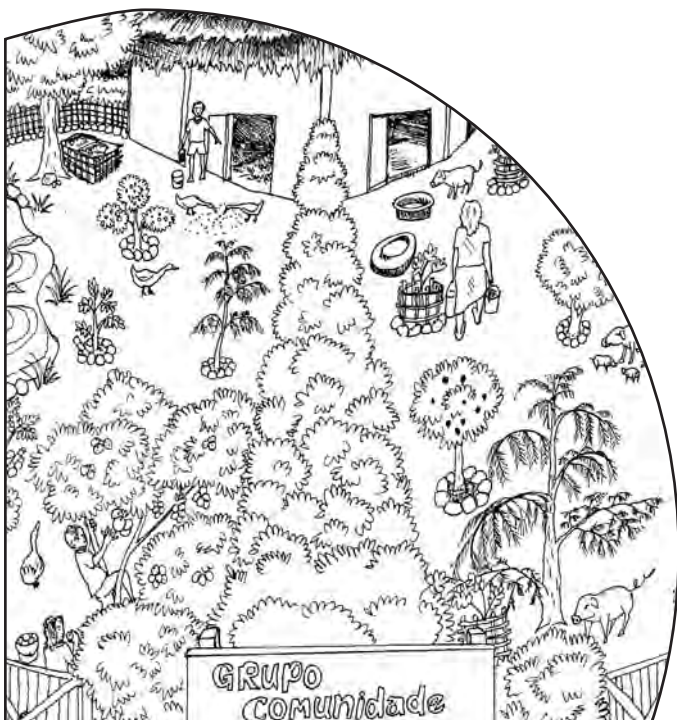
Ideas for easy Internet use

- Use the reference section provided in this book. It provides many excellent sites.
- Use search programs like google to find sites that provide the information you need. Type in many words to find more specific sites.
- **Favourites / bookmark** – once you have found a site that you want to keep using, click on favourites or bookmark, and follow the instructions to save the site on the computer.
- **Searching a site** – whenever a hand appears over words or pictures, you can click on that word or picture for new pages and more information. Most sites have a list of sections explaining what is in the site, which you can click on to access more information.
- **Links** – Most sites have a links section. Click on this word to find many other websites that are related.
- **Downloading** – Many sites provide a section where information is stored as Adobe Acrobat PDF files. These are smaller files that can be easily downloaded and saved on disc, CD or USB drives.





Community Groups & Cooperatives



CHAPTER

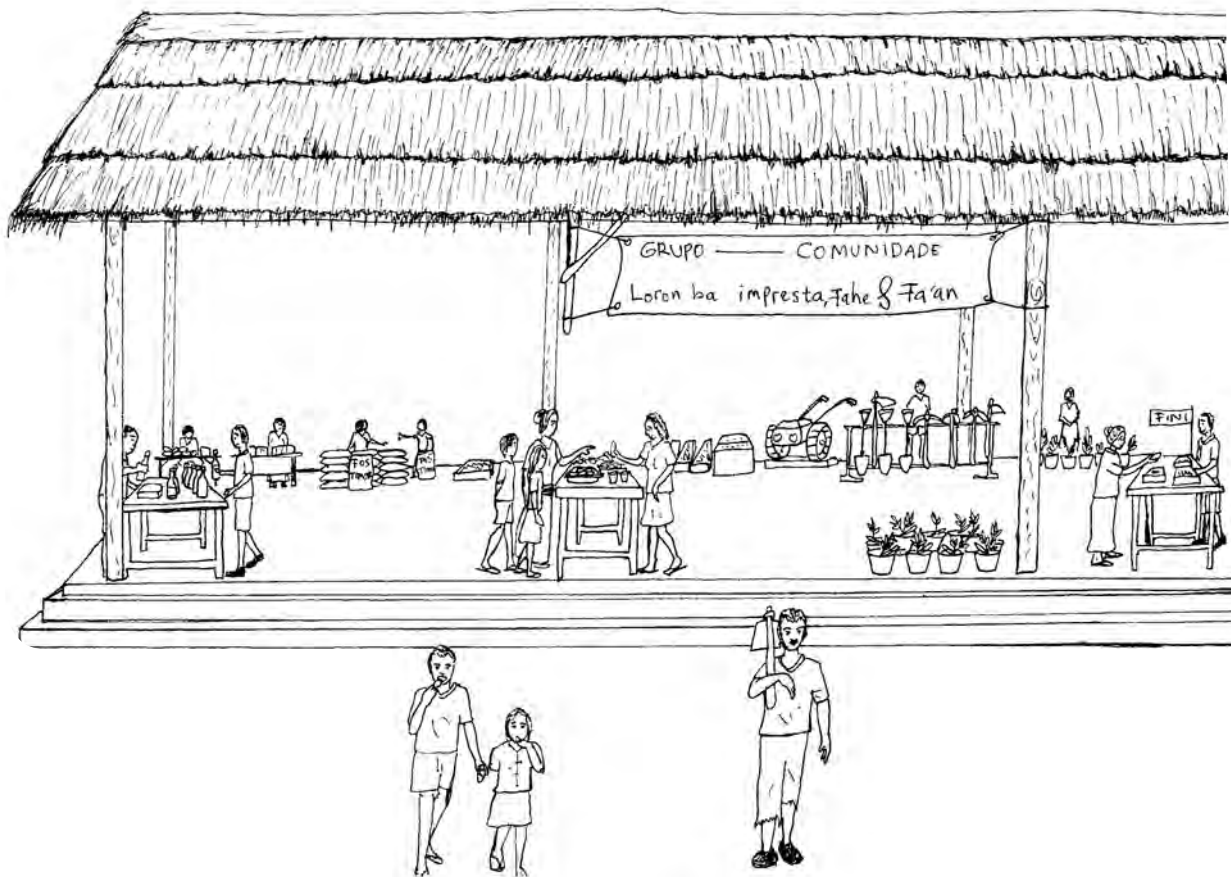
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East Timorese families and communities have a very strong belief and history in working together, in all parts of life. This was especially essential during the Indonesian occupation, for survival and to eventually achieve independence. Community groups and Cooperatives are simply an extension of working together. They can be a small group that helps to share and maximize resources and improve production. Or they can be co-ops or community businesses that produce and sell products. They can also be local NGOs. The cooperatives that were practiced by some Indonesian businessmen, military and government workers during the Indonesian occupation are not actually true cooperatives and have given cooperatives a very bad name in East Timor.

True cooperatives are organized, managed and run by the communities themselves to help the community undertake an activity, which will be of benefit to the community. They are based on the idea of achieving something that cannot be achieved by individuals, by using their collective ability to work for a common goal. This need/goal/objective can be economic, social or a service; the important thing is that the benefit is to the community and also to individuals.

The name or the actual structure of the cooperative or group, which works together to achieve a common goal, is not important. What is important is that the members of the organization use the principles of equality, democracy and working together for a collective benefit.



In this chapter many names are used; cooperative, community group, community business, farmers group. It is up to you to choose which name and which structure is best. The information is useful for all types.

This chapter describes:

- How communities can be strengthened and improved through groups and why they work.
- Different ideas for forming and managing groups.
- Local trading systems
- Micro Finance
- Some examples in East Timor.

Why form a co-op or community group?

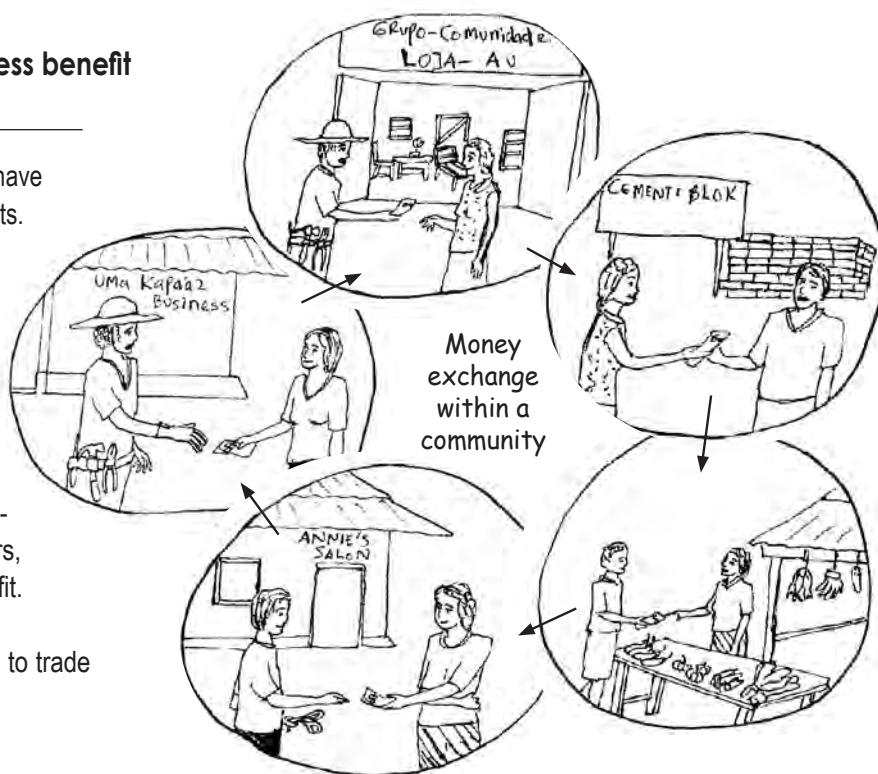
Co-ops and community business benefit to the whole community

Because people make money they have more money to spend on other products.

Even only a small amount of money can make a big difference, especially if it is spent in the community.

Therefore other businesses and people in the community, like farmers, brick makers, builders, carpenters, shops, restaurants, hairdressers, blacksmiths and more will also benefit.

People will also have more products to trade with others in the community.



Easier and cheaper to collect and buy materials

This is true for cooperatives, small businesses and farmers groups and even just a group of families.

Materials bought in large amounts are cheaper than small amounts. Groups can buy tools to share or food in cheaper, larger amounts.

Transport is cheaper as well. Better quality materials can be purchased because more money is available.

Different families will have different resources that they can provide. E.g. bamboo, wood, ponies or truck for transporting materials, labour skills etc

Can make products and amounts of products that can't be made by individuals

One person or one family will not have a lot of time to make large products (E.g. Furniture) or large amounts of a product. (E.g. jam, tools, natural pesticide, soap, etc)

But a group of people or families working together can make much more. This will give the group more products to sell.

It will also mean that the products are cheaper to make. Therefore they can be sold more cheaply and can compete better with products from overseas. This is very important for the future of businesses in East Timor.

Much easier to be listened to or to work with Government, private investors, church and NGOs

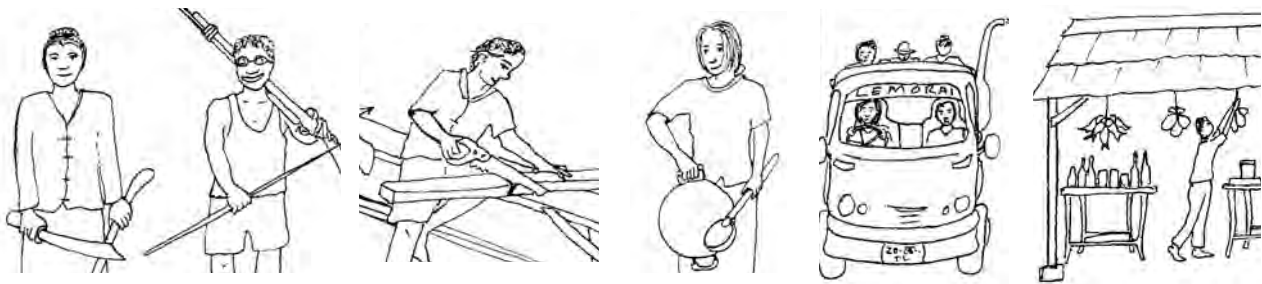
A community group / cooperative / business is much more likely to be able to get training, finance, equipment, partners to start and run an enterprise.

It is also more likely to be able to work with the Government on important issues such as marketing, transport, information sharing, health care or education needs.

Also lobbying as a group instead of as individuals gives individuals within the organization a louder voice.

Different people in the community can contribute depending on their skills

E.g. builders, cooks, book keepers, agriculture skills, etc. Different people in a community will have a wide range of skills. In a co-op these different skills can be used together to make products.



Marketing, transporting and selling goods

Transport can be one of the most expensive parts of selling produce, especially for people in remote villages. Sharing costs and transporting as much as possible each time is important. Timing the production and transporting of products within districts and regions can also help to maximize the use of limited resources. Creating a simple system or schedule within the community using cooperation will help a lot, not just within the cooperative but also between different groups.

Marketing of products can be much easier through a group. Representatives from the group can work to arrange marketing and markets for products. (E.g. markets, restaurants, supermarkets, shops). It is very hard for one person or family to have time to do this important job.

Also, a group or organization will always have more influence than one person and a group infers a higher level of responsibility. Making a product as a group gives a name to the product. E.g. Permatil Seeds. This can help with the marketing of goods where quality, and reliability are important factors affecting the creation of a sustainable market base. Providing a regular supply of products is always one of the most important marketing factors. A group or cooperative will be much more able to achieve a regular supply.



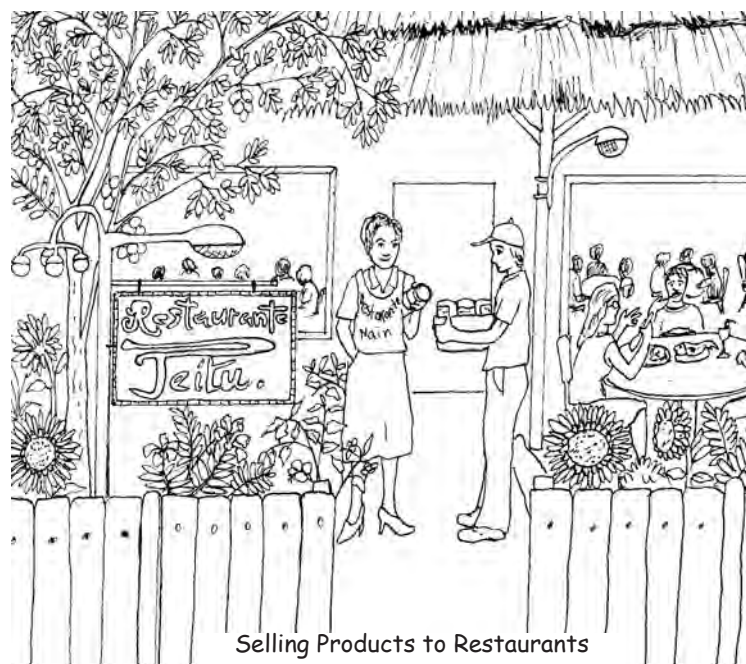
Other benefits

Individuals feel better because:

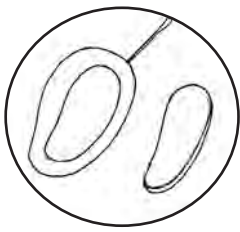
- Have work that they previously could not do alone but can do now as part of a group
- Working together in community and participate in their community
- Can provide more for their family now and also in the future through their continuing collective work within the community
- Are learning new skills and achieving goals that would not be possible to do so as individuals working alone

Community feeling better because:

- More money/goods circulating in village
- More jobs in village
- Can have community name on product – sense of pride

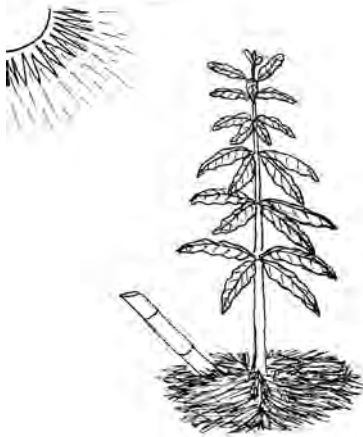


Selling Products to Restaurants



How to set up & manage

A good co-op or community business model is a tree. (E.g. a Mango Tree) First of all you start with a seed. The seed is an idea.

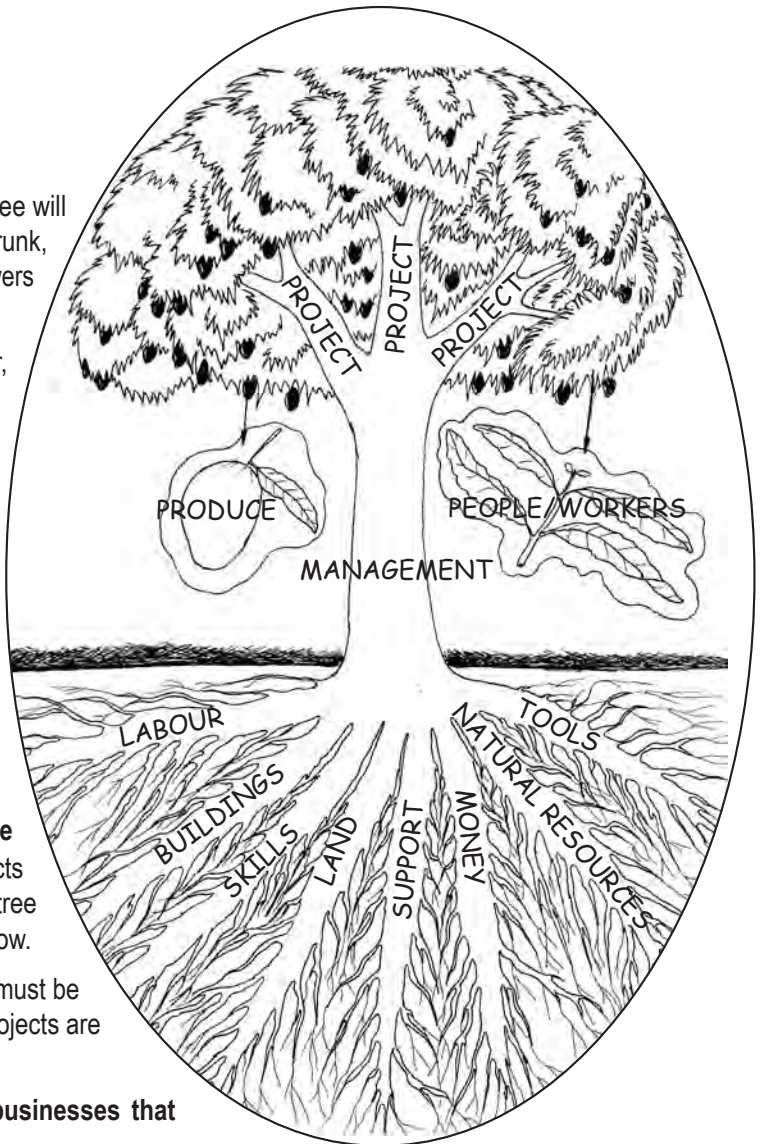


As the seed grows it starts developing roots, a trunk and leaves. It searches for water and nutrients. This represents an analysis of the needs, resources available, products, marketing etc... Developing the idea.

To grow well the seed needs good soil, water and sunlight. It also needs to be in a place where it can grow to its full size. These represent the right place, good planning and structure and a vision for the future. Also providing community support, training, possibly micro finance, transport etc.

When it is growing and then fully grown a healthy tree will have a strong root system, a strong supporting trunk, many branches and leaves. It will produce lots of flowers and fruit and more seeds.

- **The roots are the resource base.** Land, labour, natural resources, skills, equipment, buildings, money, NGO/Government/Community connection and support, etc.
- **The trunk is the management structure.** It enables an efficient flow from the resources to the projects, and must be strong and supporting. Management decides which projects (branches) to support
- **The branches are the different projects.** Many smaller projects are better and more sustainable than one big project. Diversity!
- **The leaves are the people responsible for these projects.** Working together to ensure the projects are successful. Because without people, like a tree without leaves, an organization cannot live or grow.
- **The fruit is the produce from the projects.** It must be picked, stored, marketed and sold so that the projects are sustainable and make money.
- **The seeds are new coops or community businesses that grow up from the first tree.**



Many trees together make a forest.

The trees grow better together than 1 tree growing alone. They support and shelter each other from storms, strong winds and strong sun and provide nutrients (resources) for each other and habitat for animals and birds. It is the same for co-ops and small businesses.

Produce Ideas - The Seed

Some examples of products that could be made and sold by community groups....

Food

- Fresh food
- Preserved food – fruit, vegetables
- Honey, honeycomb
- Dried food – fish, meat, fruit, vegetables
- Sauces, Pickles, jams, oils



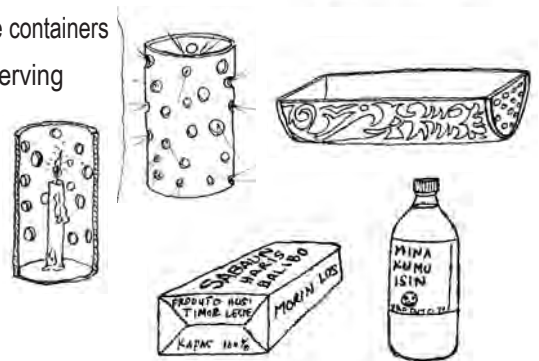
Leather products

- Clothes
- Horse equipment
- Knife and machete holders
- Bags



Bamboo

- Plant containers
- Furniture
- Musical instruments
- Much, much more
- Decorated & carved storage containers
- Food for selling and preserving
- Buckets



Natural health care products

- Soaps
- Traditional Medicines
- Massage oils
- Mosquito repellants

Art

- Sculptures and carvings
- Pictures and paintings

Agriculture products

- Plants
- Fresh and dried flowers
- Manure
- Natural pesticides & herbicides
- Seeds
- Tools
- Compost



Tais

- Blankets
- Wallets
- Clothes
- And more



Woven goods

Bags

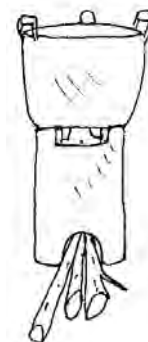
Kapok products

Clay products

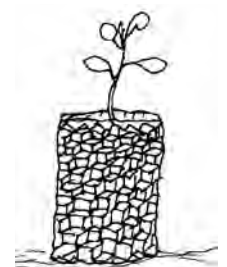
- Stoves, food storage, water filters, bricks

Building materials

- Bricks, wood, treated bamboo, metal work



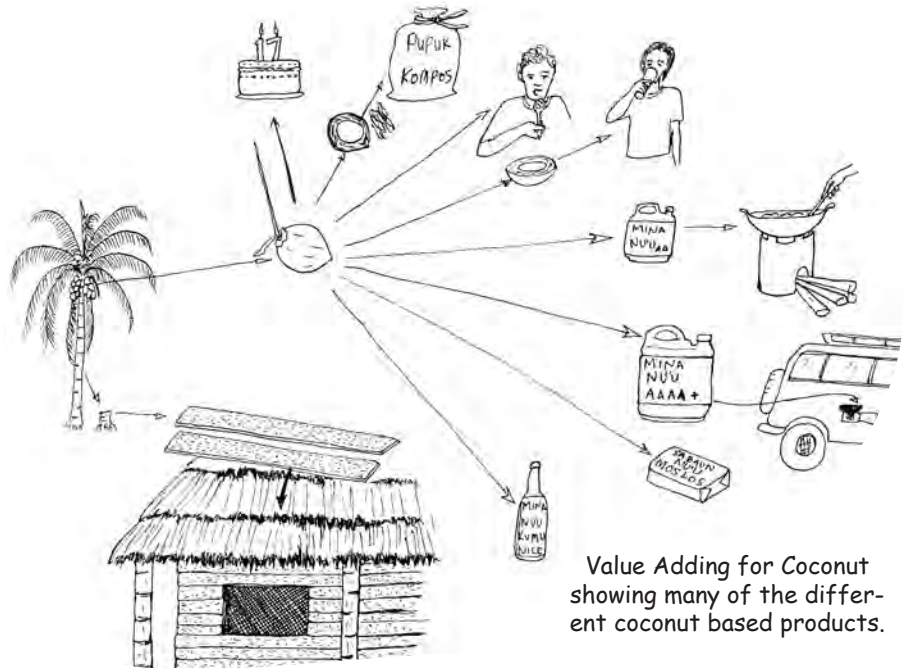
And there are many, many more.



Value adding

Value adding is a term for making a new product to add value to an existing product. For example; making jam from fruit, making tempe from soy beans, making oil from sandalwood, coconut or candlenut, making clothes from tais, and making bamboo furniture from bamboo.

The new product can be sold for more money. It also adds new products – diversity – and new ways of selling the original product. This increase in the cost of the product is because a basic product has been changed and improved using labor and materials. The result is that new jobs for community members can be created using the resources in their community to make new products to sell.



Value Adding for Coconut showing many of the different coconut based products.

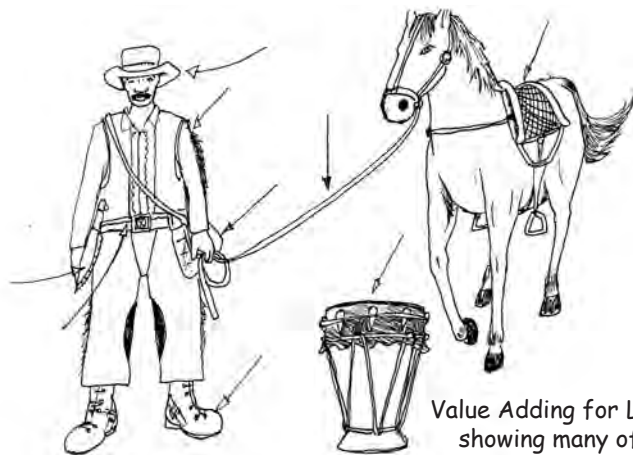
Excess food that would go rotten can be turned into products to be used, traded

or sold. E.g. sauce made from old tomatoes. It is important to make the new products in the village. This adds skills and jobs in the village and keeps the money in the village. E.g. If the bamboo is sold as poles to a business in Indonesia or Australia to make the furniture then that business makes most of the money. The money is lost from the village with no chance of receiving more benefit from using the villages' resources.

Reducing the level of imports from overseas increases the amount of money in the country, provides more employment in East Timor, uses local resources and gives the benefit back to East Timor.

On a community level the benefits from making local products and value adding local resources include:

- The whole value of the product is received by the village, not just a small part.
- Provides employment within the village.
- Increases income levels and also provides money for future potential activities.
- Skills are learned or retained in the community.
- Improves members' sense of worth from their activities.



Value Adding for Leather showing many of the different leather based products.

Providing services

Groups can also provide services as a small business. Some ideas are:

- Providing training E.g. agriculture, computers, buffalo ploughing etc.
- Accommodation, restaurants
- Boat tours, fishing trips, guided walks
- Cultural performances, knowledge and tours



Eco Tourism

East Timor is an amazingly beautiful country with many natural assets that will attract a lot of tourism in years to come. Eco tourism is a business for the future in East Timor. Eco tourism provides for the needs of the tourists and protects the environment and Timorese people at the same time. This includes good waste management, using local workers and food and traditional materials, growing produce and retaining local knowledge of interest to visiting tourists.

Natural resources and knowledge become valuable. For example forests, caves, rivers, mountains, the ocean and sea life, history of the struggle for independence, traditional farming methods and history, traditional stories. Instead of exploiting these resources for short term benefit, looking after these resources has multiple benefits from Eco Tourism in the present and for the future. Natural treasures will remain healthy and future generations will be able to enjoy the benefits from the natural environment.

A good example is the Eco-village resort on Atauro. They have traditional huts and mud brick, solar power, compost showers and toilets and are starting vegetable gardens and planting fruit trees to provide some of their own food. A smaller example is a place in Ossu that has just started.



In both cases money is going to the local communities and jobs are being provided. And in both cases people go there for the beautiful natural environment. Therefore, for the future of eco tourism, the East Timorese environment must be protected by the people who live as part of it. People and the environment together make eco tourism.

Resource & Products analysis - The seed grows

This is an important part of working out what are the best projects and products for a community group or cooperative. When you have a list of ideas you can ask some simple questions to help work out what are the best projects or products for your group.

Product Questions

Is the product you want to make already made locally? If not, good, if yes, is there enough people who want to buy that product that you can also make it. Don't start making something that is already sold a lot or selling your product will be very hard. Unless you have a better product or a different market.

Resource Questions

- What resources are available locally already?
- What resources could be grown, or made locally in the future.
- How much will it cost to buy and transport other resources needed?
- What tools / buildings needed exist already and what don't?
- What technology is required to make the product, e.g. electricity, machinery, basic materials etc.?
- Can these be purchased in country? Does it cost too much? Can this be used without constant maintenance? Is the technology suitable for the community?
- How much money is available and is financing (money loan) a good idea?
- What skills do people in the community have?
- What skills are they interested in learning e.g. Carpentry, food production, making new products from Tais?
- Is there training available for new skills? Can people from Timor provide training, or is there access to skilled people from outside Timor?



Marketing Questions

- What market is there for your products?
- Where will the products be sold?
- What are the transport costs? How – pony, car, truck, cart, bus?
- How many products can be made initially and in the future?
- How much will the product be sold for?

Management Structure - The Tree Trunk

It is very important to set up a good management structure before starting the project. It is also very important that everyone that is in the group helps to make the management structure. It will also be good to include help and advice from other people who have experience and knowledge about co-ops, and the Village Chief, government workers, church leaders etc.

The type of structure will depend on what type of group and projects.

Small cooperatives that provide tool exchanges, food exchange, bulk food purchases and more are different and are explained more later in the chapter but they still need a simple management structure and bookkeeping. Larger cooperatives, groups and Community businesses need a strong structure and transparent management and bookkeeping to work well.

A good management structure needs to include:

1. A Vision Statement

A vision statement is a small document written together by all involved in the group. It states how the group will work together as a group and in the community. It also states the group's goals, now and in the future. It should be short and simple.

2. An Ethical Structure

These are the guidelines and principles for how the group will function. Everyone in the group must be a part of making the guidelines and principles, and everyone must agree to work by them as part of their contract. This helps the organization to work well and effectively. It also helps individuals to have sufficient knowledge of the organization and its policy to make individual decisions based on these principles. It can include:

- Workers rights
- Community involvement
- Environment protection
- Good waste management.
- Sustainable use of resources
- Equality for men and women, especially in meetings

3. A management system

This will depend on how big the group is and what it plans to produce.

Large group example:

- Steering committee
- Finance officer(s)
- Production worker(s)
- Marketing and sellers
- Coordinator(s)
- Secretary
- Transport worker(s)

The steering committee must be separate from the coordinators and might include the Chefe, a government representative, a church representative, and other community representatives. The production, transport and marketing workers must have representatives that are part of the coordinating group. In a cooperative the different producers will be the coordinators, and will be involved in marketing and selling. It is important that all the producers have a part of the decision process. If 1 or 2 people make the decisions for a group then it isn't a cooperative. Decision making must be based on the ethical structure or the principles of the organization, which guide all the members of the organization. It is important that the finance officer(s) and secretary are separate from the coordinators.

Small group example:

In a small group different roles will be covered by the same people. It is still important that all the roles are covered. This is because a group needs to be able to work out how well the business is going, if changes should be made and how time and costs can be improved.

For both big and small groups it is important to share the work and coordinating as much as possible.



4. A set wages, prices and profits structure

This is important, especially for large groups, for transparency and to keep equality for the different workers. The wages and prices can change if needed, but changes should be the decision of the whole group. The decision about the distribution of profits must be made before the cooperative has started. As with all the other activities of the organization the profits must be used to achieve the objectives of the organization. E.g. divide between members, invest in cooperative improvements, social activities or services like road repair, school improvements, etc.

An example – fish production. If a group of fish farmers join together to form a cooperative group they can support each other and make production better and cheaper. It is important as a group that they set prices for the fish types, for transport and to try to keep other costs even as well. Even if they sell the fish separately. Prices may also change depending on where they sell them. Local markets, Dili markets, supermarkets and restaurants all might have a different price. All these prices need to be set by the group.



5. A thorough bookkeeping system

Bookkeeping is part of the financial officers work, which also includes distributing and storing money. This is a part of the cooperative that might not seem important but is very important and must be done. Usually women are better at bookkeeping and handling money than men. Not just in East Timor but all over the world! Bookkeeping involves:

- Recording everything that is bought and sold
- Recording all wages
- Making records for daily, weekly, monthly and yearly costs and incomes
- Recording profits



Careful: This is the one part of a cooperative that has the potential to cause the most problems! Transparency and accountability are very important here. The person or people working in this area should be rotated yearly to help prevent problems.

6. A plan for future changes and development

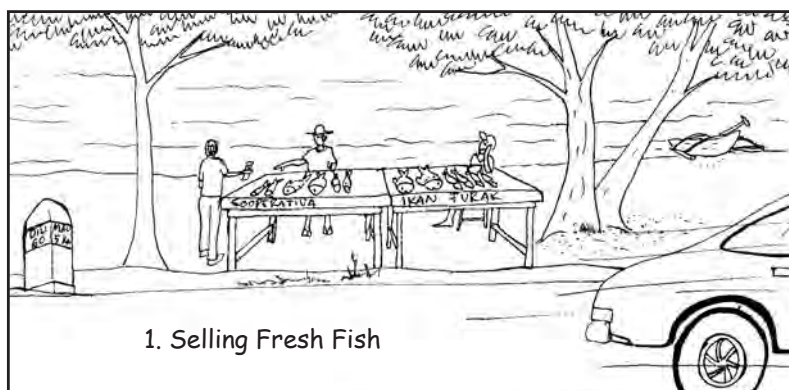
A group needs to be open to changing and growing. This could mean increasing the production, making new products, selling in new market places, making the group larger or smaller, changing production methods, improving infrastructure, etc

The most important thing is that the group is providing the members with an income that is worthy of peoples work, providing support and improving the members livelihoods.

Any changes must be to continue this and to strengthen the community base. All development and changes need to be a decision made as a group. So that everyone understands and is part of the process

Groups usually start with a small number of products. In the future it is good for the number of different products to increase. This allows the organization to diversify and also to respond to the market and remain competitive.

Changes also need to be made to maximize efficiency.



1. Selling Fresh Fish

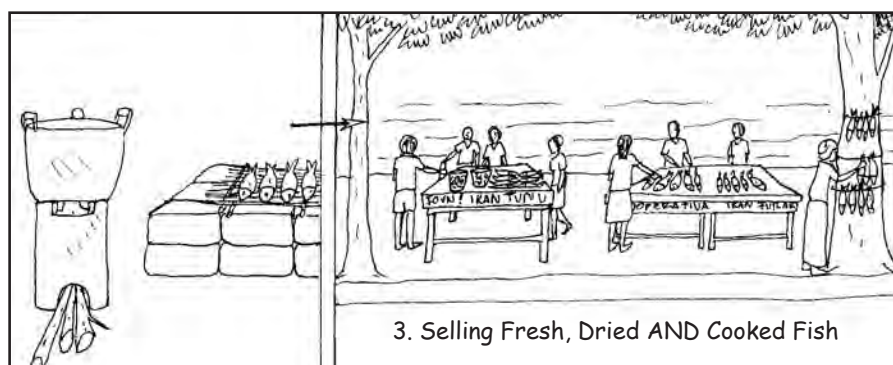


2. Selling Fresh AND Dried Fish

This should be a continuing goal. The more efficient the production, the cheaper the cost. This will improve incomes and will also reduce the price of the products. This is important for competing with overseas products.

Flexibility is very important as well. Being able to change as markets change. Bringing in new technology that can help and diversify production and the cooperative is another part of flexibility.

Markets and the situation can change quickly so it is important that the members can also react quickly and adjust their plans. This relies on the ability to effectively use the management system set at the beginning, to continually change and evolve.



Having the correct ethical structures or principles allows the members to make these decisions quickly and clearly. E.g. a computer for bookkeeping, solar drier for drying produce.

Potential problems

The potential problems are mostly covered by the management ideas. Disagreements over money, use of resources, sharing labour time, lack of decision sharing can all happen. The best time to stop these problems is BEFORE they happen. This can be achieved through:

1. Thorough community consultation.
2. A good plan that provides management structure, short and long term goals and shared power arrangement.
3. Transparency with bookkeeping and all money matters.

If problems do happen then a preplanned course of action should follow as quickly as possible. It is best if this involves traditional community methods of finding solutions.

Women's groups / cooperatives

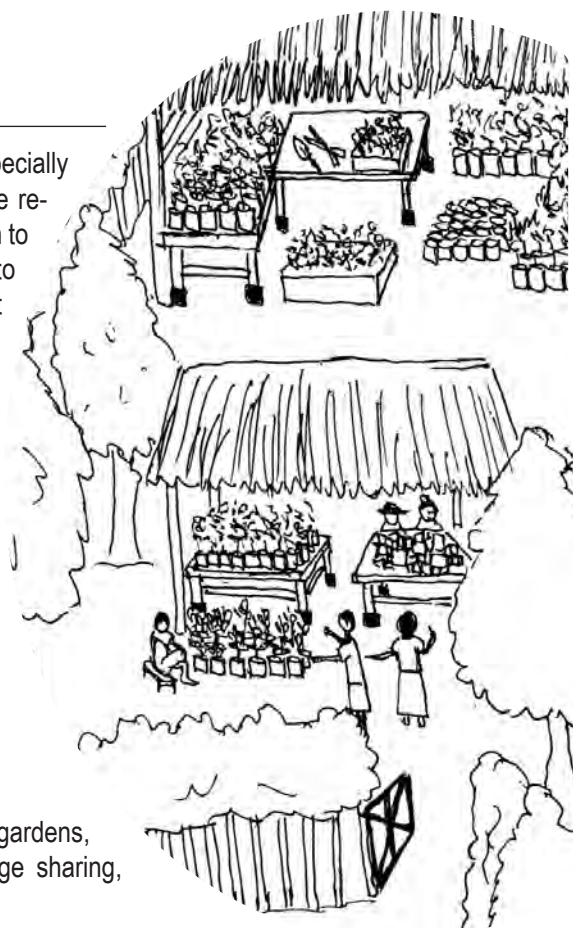
They are a source of support, labour and advice, and are especially helpful for widows that don't have a lot of time and don't have resources to start up their own business. They give representation to women in the community and beyond. And they allow women to have much more control over their lives and the decisions that they make.

Local Needs / Systems

Perhaps the most important function of cooperatives, groups and small businesses in East Timor is to support the community.

The many benefits of a community group include:

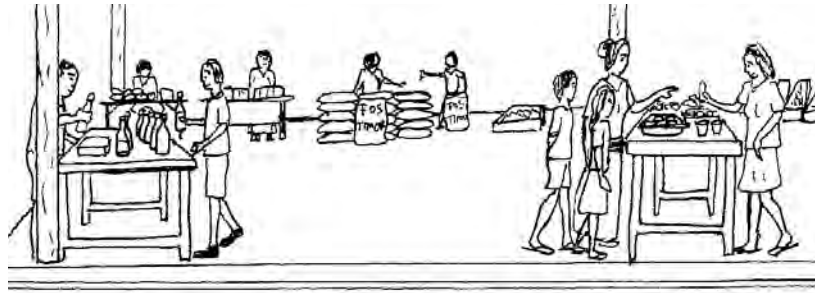
- Encouraging community participation and strength
- Keeping money in a community
- Improving the amount of food in a community
- Improving and supporting production on all levels: home gardens, animals, large-scale agriculture, information and knowledge sharing, resource sharing e.g. seeds, manure, building materials.



Some Examples:

Food co-operative

A group of people form a cooperative to buy food (E.g. rice, noodles, oil, etc). The food can be bought in large amounts at a cheaper price. Transport costs can also be shared. The food is then divided between the members. Everyone will save money.



Tool and resource co-operative

A group of families or farmers join together to share tools and farming resources. There are more tools to use. Local resources can be traded. E.g. manures, seeds, building materials. Other imported resources can be bought in large amounts for the whole group so that they are cheaper. This can also include labour. Sharing labour will save time and effort. It is important that no money or lending costs occur, or maybe only for more expensive tools or a hand tractor. Also, that a system is in place to deal with broken tools.



Food drying and storage cooperative

A cooperative or community group for drying and processing produce will help to make the work and the costs manageable.

Buying clay pots or other food storage containers is much easier. This type of group is excellent for supporting market sellers.

Even small cooperatives need a simple management structure including bookkeeping.

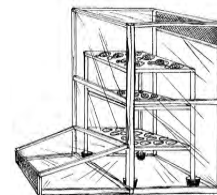
This helps to keep track of money, goods and work, and be transparent. Cooperatives and community groups and small businesses will work better and help the community even more if they are combined with local trading systems and even a local currency.



Clay pot



Cross section of
2 clay pots



Solar drier

Local currency, local goods and local trading systems

Throughout this manual using local resources is encouraged. This is because East Timor has many natural resources and can provide many of its needs with these resources. Also, importantly, whenever local resources are bought or traded the money and wealth STAYS in the community.

Using local labour, local building materials, local food, local rice, etc, is the best way to build East Timor's wealth and economy in the districts.

Which imports into a community can be locally made or are already being made? E.g. rice and bamboo. A lot of the rice eaten in east Timor is imported. This is especially true in Dili. And most bamboo products sold in East Timor are imported, when very high quality bamboo grows in East Timor and some furniture is being made.

Which exports can also be locally sold or traded? E.g. fruit and vegetables.

Direct and non-direct trading

An excellent way to strengthen a community and its economy is to start a trading group. A lot of trading already happens in East Timor. A trading group is a way to encourage more trading and to make it an official part of the community economy.

A system that is used in many countries is called the **Local Enterprise Trading System (L.E.T.S.)**.



Martina

Anyone in a community can become a member. A book is made containing all the members names, their skills and their resources.

For example:

1. Martina Soares

Skills – cook, making clothes and tais, growing vegetables and trees, curing leather, weaving baskets, producing fish. **Resources** – Land, fish ponds and fish, tais, seeds, compost, leather goods, vegetables, fruit trees, weaving grasses.

2. Adorito da Costa

Skills – Buffalo ploughing, building, making natural pesticide and medicines, growing vegetables, raising animals. **Resources** – Land, animals, trained buffalo, building tools, natural pesticide plants, natural pesticides, medicines, bamboo.

3. Esperanca Ximenes

Skills – Bookkeeping, computer skills, cook, making clothes, hairdresser, growing vegetables. **Resources** – clothes, vegetables, computer training, hairdressing.

And many more.



Adorito

How does L.E.T.S. work?



Esperanca

- A member can ask another member for a product. A money value is agreed for the trade. But no money changes hands!

- The trade is written down in the trade book. The person giving the product gets a credit, the person receiving the product gets a debit.

- A record is kept of every trade that takes place.

- Only members can trade and be a part of the system. The idea is that each member over time will have, more or less, an equal amount of credit and debit.

- It is not essential that every member stays at equal amounts and usually it will balance by itself. The credits and debits can be added up at the end of 3 or 6 months so that a record of what people have traded is known.



- This system is based on individual honesty to try to keep an even number of credits and debits. But because each trade is recorded it is clear to all members if someone is taking much more than they are giving.

- A system for paying back excess debits could be arranged to deal with any large debit problems.

For example (for villages in districts) :

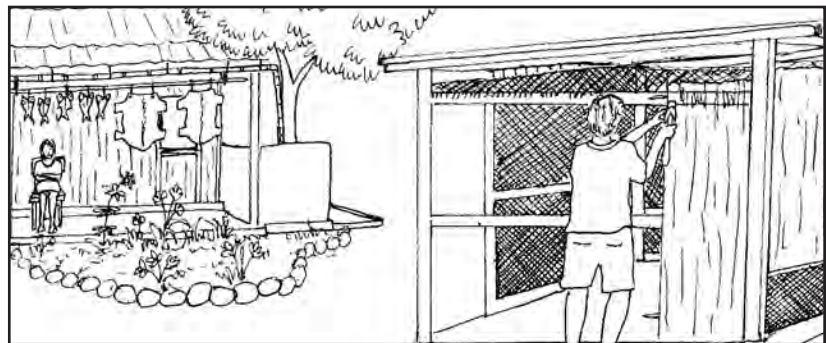
a. Esperanca wants to grow some vegetables but doesn't have land available. She asks Martina, who has land, to rent her some. They work out a price and then the trade is recorded in the book.



b. Adorito needs some new clothes and a haircut because he has fallen in love. He asks Esperanca to trade him some clothes and a haircut. They agree on a price and the trade is recorded.



c. Martina is producing a lot of leather and seeds, and has started drying fish, but she needs somewhere to store it. She asks Adorito to build her a small storage house to protect her produce. They work out a price and the trade is recorded.



Person	Trade	Credit	Debit
Esperanca	Land for vegetables		\$10/month
Martina	Land for vegetables	\$10/month	
Adorito	Haircut and clothes		\$6
Esperanca	Haircut and clothes	\$6	
Martina	Storage house		\$20
Adorito	Storage house	\$20	

Direct Trade

Direct trading can also be a part of this system. For example: Martina wants to learn computers skills from Esperanca. And Esperanca wants to buy some leather to make some wallets. The prices for each product are agreed to. If the price is the same then a simple exchange can take place but if not then both exchanges can be written down in the LETS book.



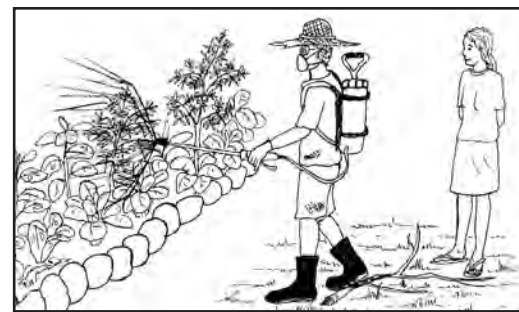
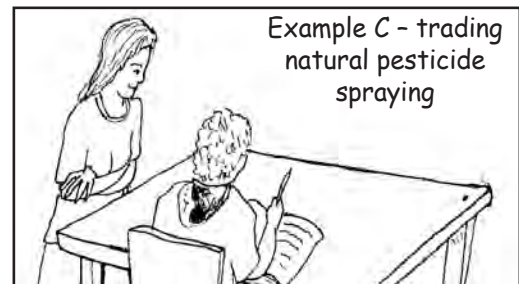
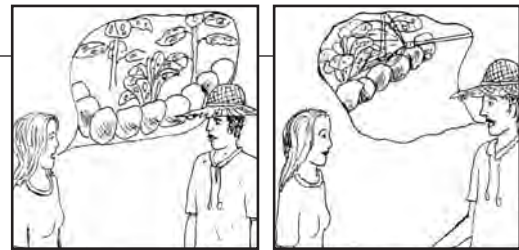
Part money – part trade

A trading system can be combined with money. Members can use part trade when buying goods to make them cheaper and help support local goods. The amount that is money or trade is up to each member to decide and can change with each trade if needed. Each trade is still recorded in the trading book.

For example:

- Adorito wants to buy fish from Martina for a party but cannot afford a lot so they agree that he pays 50% money and 50% is traded.
- Martina has an area of land she wants ploughed for vegetables to save her time and labour but doesn't have the money to plough the whole field. She asks Adorito to use his Buffalo plough. They agree on a price and that Martina pays 30% money and 70% trade.
- Esperanca needs some natural pesticides to stop insects destroying her vegetables and doesn't have time to spray them. She asks Adorito and they agree to 75% money and 25% trade for him to come and spray her crops.

Shops, restaurants and other small businesses can also be members. They can sell their goods for part money and part trade, but only to other members. Usually this would be about 80% money, 20% trade.



Local currency

Introducing a local currency (type of money) is another way to strengthen local communities by keeping money in the communities. The local currency is used to buy locally made products and food. They promote buying local products and help to develop village economies. Local currencies have been successful in many communities in countries all over the world. They can be used with trading systems and the national currency. Look in the reference section for where to find out more about local currencies.

Micro-finance

Micro-finance is a way for poor Timorese to improve their incomes and living situation. There are some micro finance groups operating in East Timor already. E.g. Moris Rasik, Tuba Rai Metin, Opportunity International.

Micro Finance can be very effective at helping to improve community living standards and injecting money into communities that don't have much. Improving the economy doesn't have to replace trading with money, they can function together. However, if not implemented carefully and correctly they can cause problems and have little or no positive effects.

The aim is to help people to be able to look after themselves and to take responsibility for improving their situation. It is not a system of dependence or free money.

The basic system is:

- People in need are identified by the micro finance groups.
- Those people in a community form a group and provide a plan for a small business.
- Once the plan is approved a loan amount is determined and provided to the group.
- A system of repayment is set and an amount is then paid back each week or month until the money is paid back.

An example of a Micro Finance group is Moris Rasik. They started in 1999 in the Bobonaro district with a small budget and staff. They now operate in 5 Districts – Bobonaro, Covalima, Manufahi, Ainaro and Aileu. They now have 80 staff (only 2 foreigners), 5300 members and have distributed more than \$1.3 million.

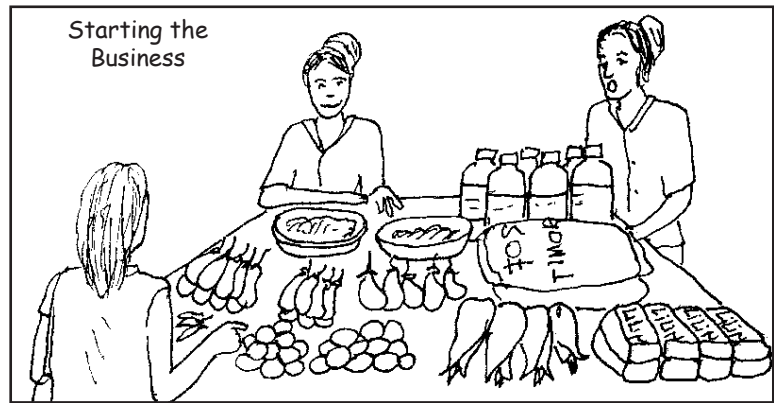
Their goals are to:

- Improve the incomes and livelihoods for poor women in East Timor.
- Build a sustainable institution that can continue to provide micro finance in the future.

The staff of Moris Rasik identify, look at a sub district and then work to identify poor women in the villages of the sub district. If possible, every village in the sub-district is covered. Anyone identified can qualify for a loan. These women can then form a community group and make a plan for a small business. Once the plan is approved, Moris Rasik decides the size of the loan. A community meeting is held once a week, where the women's groups discuss their business and make their weekly repayments. It is important that the meetings are public. The group is the guarantee for the loan. If one person cannot pay back for a week then the others in the group must cover it. The usual loan cycle is 6 months.



Some villages are cut off for periods in the wet season. This makes it impossible to run the loans for 6 months. Often, the villages that get cut off are very poor. Moris Rasik is going to try two 4-month loan cycles each year and a rest period during the wettest months to try to overcome this problem.

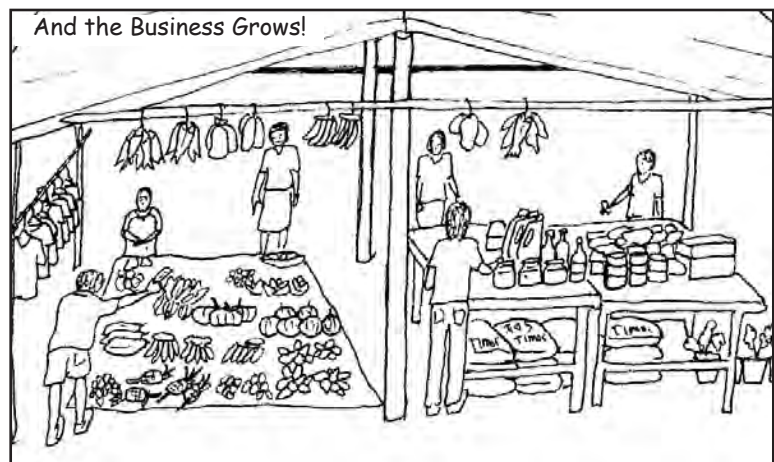


So far, the rate of loan repayments has been very high, which means that it is helping the women to find income. Helen, who started and manages the organization says that often the success is hard to see for the first few years, but that at first, the most important goals are that the families have enough food to eat all year, and they have enough money to send their children to school.



SMART IDEA:

- Micro Finance will be much more effective if the groups providing it work together with groups like NGOs, farmers groups and government workers who can provide training and skills in areas such as permaculture, sustainable agriculture, craft making, tool making, food preservation, animal production and marketing.
- And groups providing these skills and who have projects to improve community wealth and livelihoods can work with micro finance groups to help facilitate better long term self reliance.



Case studies

Name of Group: Veru Pupuk

- **Area where the cooperative/group is located:** Home and Los Palos, Lautem District
- **When Started?** 2000
- **Structure of the group** – cooperative/farmers group/community business/etc...: Collective structure, no director but coordinator, every member has voice in meetings and same rights in group. Large community farm is divided into areas for many different families and groups to produce food.
- **What the group produces:** organic agriculture and permaculture, art, sport, information and education on advocacy, environment and human rights.
- **Where the product is sold:** agriculture produce sold at Los Palos markets, art sold in Veru Pupuk office, Los Palos, in future in Los Palos and Dili. The education and information is for members and the Lautem District community
- **Problems encountered and how they were overcome:** Members have commitment but are volunteers so problems, with money and food. Members also must look for work, often in Dili.
- **Benefits for members and communities involved:** people are more creative, learning more skills, producing food and starting to create incomes.
- **Future plans:** To better enable people to be self reliant, to learn and to have an income.



Name of Group: Hanau (Beloi Community Permaculture Group)

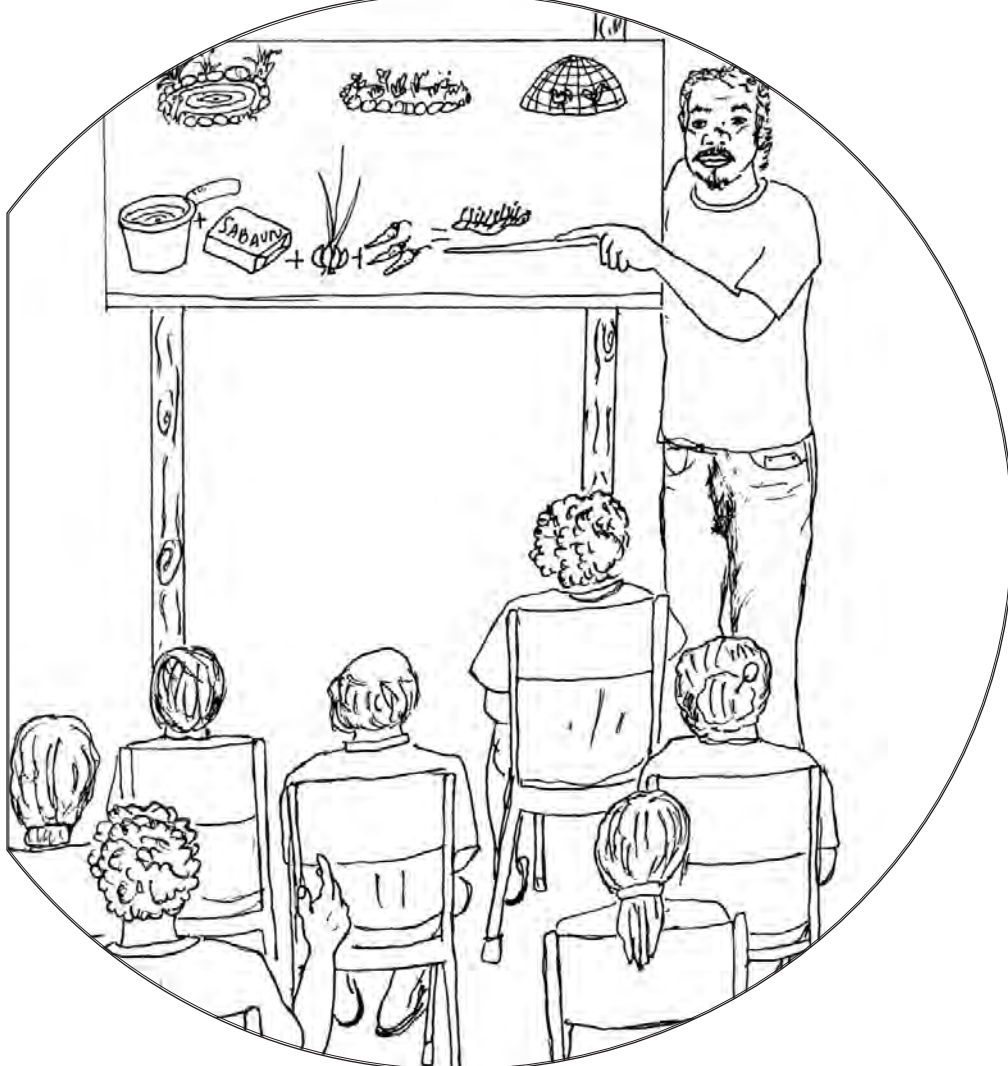
- **Area where the cooperative/group is located:** based in Beloi suku, includes all the villages in the suku.
- **When Started?** 22nd May 2004, but working informally since March 2004
- **Structure of the group** – cooperative / farmers group / community business / etc...: chefe aldeas chose 30 people to attend permaculture course. Those people form the basis of the group. E.g. Beloi aldeia group has structure of coordinator, secretary, and administration which revolves every 6 months. Everyone is involved in the planning and decision making, and always sit in a circle.
- **What the group produces:** community garden seed bank and individual house gardens that produce food for eating, trading and eventually selling. Tool bank trading system.
- **Where the product is sold:** not yet sold, some trading happening.
- **Problems encountered and how they were overcome:** introduction of money into project can cause problems; trading works better and set definite guidelines first to prevent inconsistencies.
- **Benefits for members and communities involved:** work in dry season, improving nutrition and food security, small cash injection into economy, labour trading
- **Future plans:** nursery including trade medicine plants, bamboo workshop, long-term cash crop E.g. sandalwood, adding to tool bank trading system.



For Trainers

a Trainers

Guide



There are several things to think about when teaching a Permaculture course.

Permaculture students are mainly rural men and women who make a living from farming small plots of land. On average in Timor Leste, rural people spend 3.1 years at school. Only 37.2% of men and women in rural areas can read or write and women are less likely to be literate or have the same years of schooling as men. This means that most Permaculture students, especially women, will have difficulty reading and writing and lack confidence in a traditional classroom.

Before teaching a course, you should consider these kinds of barriers to learning and develop teaching methods that help all your students to benefit from Permaculture training.

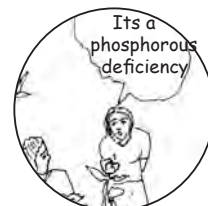
This section will give you ideas about planning a course, classroom activities and how to provide ongoing support so that students will receive the greatest benefit from the training.

Women & Permaculture Training

One of Permaculture's priorities is to create long-term solutions that improve the day-to-day lives of ordinary people. These solutions work best when all members of a system or community work together equally, in balance with each other.

Permaculture tries to consider the equal happiness and wellbeing of all individuals. This means that men and women must have the same opportunities to learn and receive training.

Currently, in Timor Leste opportunities for men and women are not equal. For a number of reasons, women are much less likely to receive training than men. Permaculture trainers must give time and energy to considering women's needs and to ensuring that permaculture techniques reach women.



Barriers to Learning

The following, is a list of problems facing women who attending training. These issues applies to all kinds of training, not just Permaculture.

- 1. Age and status:** Young women with young children and little female support in the household are less likely to attend a training or meeting than older women or women from noble families. These women require extra support to participate in Permaculture courses.
- 2. Childcare:** Childcare responsibilities either prevent women's attendance or hinder their participation in training. Women with old enough children can benefit from childcare arrangements. However, women with very young babies are unlikely to attend any kind of training.
- 3. Education:** Women have fewer years of schooling and lower levels of literacy than men. Because they have less education experience, women have difficulty with analysis and lack confidence in a formal classroom.
- 4. Language:** Women are more likely to speak local languages than the official languages (Tetum Praca, Portuguese, Indonesian).
- 5. Mobility:** Because of the essential role of women in organising and running the household women are unlikely to be able to travel to a training outside their local area.
- 6. Free Time:** Women have less free time than men because of their dual roles in the home and working in the fields. Cooking is a major commitment that women recognise as their sole responsibility. At previous courses, women have sometimes excused themselves from class in order to cook the midday meal.
- 7. Inequality in mixed groups:** Women participate less in group discussions when men are present. This is either because men may prevent women from speaking or disrespect women's opinions when they do speak, or because the women themselves feel shy and not confident.
- 8. Lack of women decision-makers:** There are few women in the position of community decision-makers. Men generally represent villages in Timor Leste. For Permaculture trainers it can be difficult to identify women's needs. Approaching women's groups and cooperatives can solve this problem.



9. Women’s attitudes to training: Many rural women believe that technical information is too complicated for them to understand and that new information is difficult to learn. Women also assume that Permaculture and agricultural techniques mean heavy labour. Because of their dual roles in the home and in the fields, women do not wish to add to their workload. They also assume that agricultural work and training will be uninteresting compared with other women’s activities e.g. tais weaving, basket making and cooking, which are creative, relatively light tasks.

10. Community attitudes to training: Probably the biggest barrier to women’s participation in training is a general resistance to women’s formal education. Although useful to a certain point, women’s education is perceived as disruptive to the family unit and village way of life because it presents women with opportunities and livelihood choices outside their domestic and reproductive duties. In this light, a training of any kind could be perceived to be in direct conflict with the interests of social stability and the maintenance of culture and community in the village.

Problems and Solutions

Some barriers to learning affect both men and women e.g. low levels of education, age and status and language abilities.

Use this table to help you start thinking about your students and the barriers they may have to attending and learning in a Permaculture course.

Men and Women

Problems	Solutions
Age and status	<ul style="list-style-type: none"> • Practical support for household and other daily duties • On-going support from trainer
Childcare	<ul style="list-style-type: none"> • Organize childcare within the family for training hours • In small villages children can also be looked after by neighbours
Education	<ul style="list-style-type: none"> • Illustrated training resources • Short films and videos of dramas and demonstrations • Group involvement activities: role-play, discussions, group mapping • Practical demonstrations and activities • Positive encouragement from trainer
Language	<ul style="list-style-type: none"> • Simultaneous translation into a local language • Pre-training preparation for translator

Women

Problems	Solutions
Mobility	<ul style="list-style-type: none"> • in-village training
Free Time	<ul style="list-style-type: none"> • Organize family childcare • Organize home-cooking arrangements in women’s families so they do not have to cook during course hours • Get support of local leaders to ensure that students are formally supported • Employ cooks for the students
Inequality in mixed groups	<ul style="list-style-type: none"> • Gender aware trainer • Use topics about which women have knowledge • Women-only training • Neutral or woman translator • Use resources specifically designed for women
Lack of female decision-makers	<ul style="list-style-type: none"> • Pre-training preparation with community leaders • Work with local women’s groups • Include high-status women in pre-training preparation
Women’s attitudes to training	<ul style="list-style-type: none"> • Present the benefits of Permaculture and the positive outcomes for women • Present the training as specifically women’s information • Build confidence of women as experts on their work and their land • Emphasize beauty and function • Emphasize labour saving techniques • Use classroom techniques that don’t rely on literacy • Encourage adaptation of techniques
Community attitudes to training	<ul style="list-style-type: none"> • Educate the leaders first • Present benefits of Permaculture as a way of supporting and improving the traditional way of life and values • Inform the community of the course and what it is for



Permaculture systems work best with the equal participation of all community members. Although women experience more barriers to learning than men, these are concerns for the whole community. If women are unable to attend training, their families and the wider community are less likely to benefit from Permaculture techniques in areas where women work e.g. health, nutrition, economic activities.

Permaculture Course Plan

The aim of a Permaculture course is to give students new ideas and practical techniques that will improve their every day lives. This section tells you how to plan and execute a Permaculture course in a village. It includes ideas on how to give your students an equal chance to participate in the course and the best opportunity to succeed after the course is finished. Use these steps to start you thinking about the best ways to implement training in your own students' village.

There are three main phases of any permaculture course:

1. Pre-training preparation
2. Training
3. Post-training follow-up

Pre-training Preparation

All trainers planning a Permaculture course will need to make preparations. Ideally, a trainer should be backed by administrative support for the preparation stage, especially for organising meetings and resources.

1. Choose the Community

The process of choosing who your students are and which area they come from may already be decided for you depending on your organization and its projects. If you are not from the village/hamlet you plan to teach in, you will need a contact person who can help set up meetings and liaise between you and the community. This person or group of people will be very important to the planning stages.

2. Meet the Community Leaders

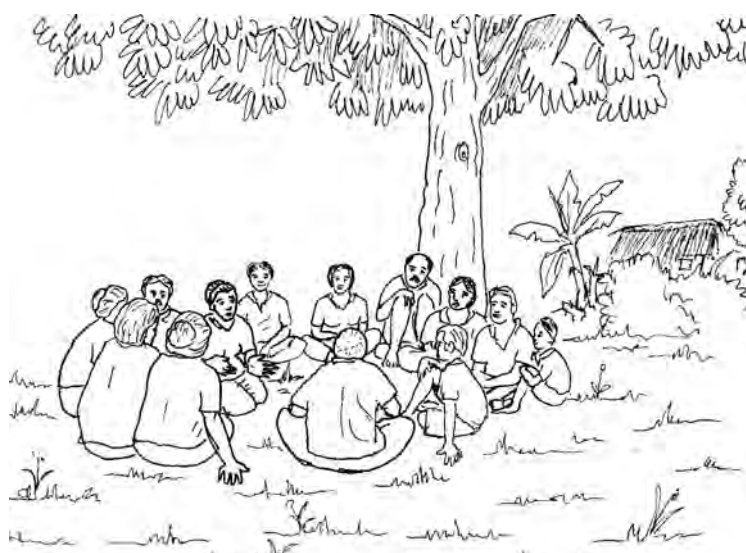
Spend a day or 1/2 day introducing the concept of Permaculture training. The starting point of any training in a village is to meet and speak with the leaders of the community e.g. the village head, the head of the hamlet, the men and women of the local noble families. Encourage the attendance of as many high-status women as possible at this meeting. The support of these leaders gives your training a much better chance of success. Because of the general resistance to women's education, you need to show village leaders the positive aspects of educating women in Permaculture techniques.

- Augmenting women's knowledge about soil, planting, harvesting and nutrition means better food for the family. Better food means stronger husbands and wives, smarter children and healthier old people
- Teaching women about waste water and waste re-usage preserves resources and saves labour

The specific benefits will differ according to each course and the type of training you plan to give. Take the time to show village leaders that Permaculture's communal and family aspects will actually support the family unit and the village way of life not undermine it.

This includes:

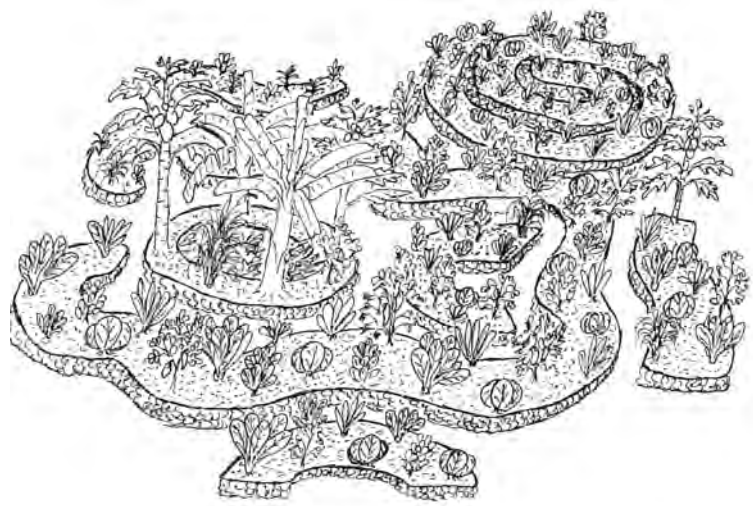
- Long-term sustainability
- Farming methods to improve yields
- Improved family health
- Cooperative and work group solutions
- Designs for better housing



If village leaders are going to give practical and moral support so that men and women have an equal opportunity to attend training, then they also need to see that permaculture techniques work better than methods already in use. If possible, take community representatives to see a demonstration garden. This is a list of successful Permaculture gardens.

- Permatil Gardens, Farol, Dili
- Hasatil Gardens, Farol, Dili
- Grupu Hadomi Demonstation site, Turiscaí
- Bocoli Community, Baucau, Baucau
- Yayasan Rai Maran Foundation, Maubara Lisa, Liquica (Maubara has many demonstration sites including gardens and forest)
- Community group gardens, Luro, Lospalos
- ETADEP, Dare and Natabora (gardens and forest)
- Beloi Community, Atauro Island
- Arte Moris Art School, Dili

You can contact or organise visits with these gardens directly or through Hasatil in Dili. Bring “before and after” photos of a demonstration garden to show the leaders. Talk about the successes of Permaculture techniques in Timor Leste.



Hasatil Gardens, Dili



Pond at Arte Moris Garden

3. Follow up Meeting with Community Leaders

If the leaders accept the training, hold a second meeting to begin the organization. The second meeting should cover all the organizational points for which you will need the leaders help or approval:

- **When?** Set a date considering women’s seasonal calendars
- **Where?** Choose an appropriate site in the village for demonstration activities and decide where classroom activities will take place.
- **Who?** Make a list of possible participants
- **How?** Discuss the support to be given by community e.g. childcare, cooking, translator. Discuss support to be provided by trainer e.g. food, trainer, follow-up.



4. Survey Specific Needs

Conduct small focus groups. Discussions in separate men's and women's groups are a valuable opportunity for the students to voice their concerns and needs prior to training. **It is very important for students to understand that Permaculture is about helping to create solutions rather than giving out tools or money.**

Identify the division of labour between men and women and their main concerns with their every day work. Conduct a day-mapping exercise to ascertain the amount of time spent working, on which tasks every day. In this meeting you can also talk about attendance at class. Ask the students to share their commitments and the problems they may have attending. Ask community leaders what their main agricultural and livelihood concerns are. As a trainer you should use your own observations of the land and the community to augment this information.

You may not have to conduct as much research if the course has been requested by the community for a specific purpose e.g. the members of a local women's group want a Permaculture training on home and market gardens.

5. Design

Design a Permaculture course which suits the lives and needs of your students. Use the information from the questionnaires, the discussion groups and your own observations to plan the course. Consider as many aspects as you can to make your training more interesting and more practical for your students. Making a practical course often means limiting what you would like to teach to only the information you think your students can use. The next step is to involve the students in the planning process.

On the first day of the course you could organise transport to show them another working garden and then let them choose specific techniques from those they have seen. This way you ensure that the course will be interesting to the students and at the same time address their needs.

6. Prepare the Site

Prepare the demonstrations site and check the facilities of the training room. Depending on the facilities available you may need to make mulch-pit toilets and an open-air shelter. Prepare your example demonstrations e.g. liquid or dry compost, mulched and un-mulched garden beds, 3-D model.

7. Prepare the People

Arrange practical support for students and locate a translator. Make sure that childcare is arranged with the families of students who need it. Arrange meals for the students for the days of the training. Make sure the women will not be called home to cook for their families. If the translator is from the village and unfamiliar with Permaculture then spend time explaining basic concepts and working on translation of technical vocabulary. If possible the translator should have the chance to visit a demonstration garden.

8. Prepare the Community

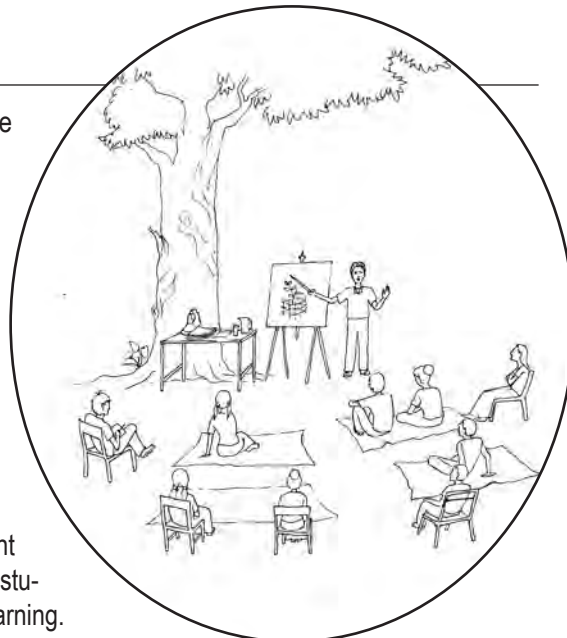
Hold a public meeting to inform the community. Community leaders should announce, attend and run this meeting. Introduce Permaculture and the objectives of training and explain the kinds of activities the students will take part in.



Training

A Permaculture trainer is usually someone with practical experience of Permaculture techniques and specially training to teach others how to work with Permaculture designs. However, Permaculture is relatively new to Timor and the writers imagine that agricultural workers in the government and local NGO's and university teachers may also teach the material in this manual. Whatever your background, the most important aspect of being a Permaculture trainer is practical work and demonstration.

Remember to teach what you know and contact Permatil or Hasatil for information if you think you need to teach other techniques in this book. This section is a guide to help you run your Permaculture course in a way that encourages equal participation, class enjoyment and long-term effectiveness of the teaching material. You want your students to remember what they have learnt and enjoy the process of learning.



Timing

Schedule the course with the students' daily responsibilities in mind. Even with support for cooking and childcare, most people (especially women) can not devote two or three whole weeks to a Permaculture course.

A course that occurs two days a week but runs for five weeks may work better. A longer time period gives students a chance to see techniques in action as the course progresses and the demonstration garden develops.

Consider how the timing of the course impacts on the seasonal calendar for the village. For example, harvest and festivals are obvious times when students will not attend class. You should also consider dry and wet season considerations as they relate to planting and the availability of water.

Women Only Trainings

Women-only training builds women's confidence to participate in group discussions and class activities with other students who respect their opinion and who they can interact with as equals.

Depending on the resources available to your organization you can run simultaneous men's and women's training. These groups could come together for certain activities but cover different topics in class, according to the students' needs. They would also be run by separate male and female trainers.

The benefit of having two trainers working in the same place is support for the trainers. It also provides a working example of equality and cooperation between men and women.

Translation

Women are less likely to speak Tetum Praça, Indonesian or Portuguese than men. It is therefore very important that if possible, you find a translator for the local language. Without simultaneous translation only a select number of women will be able to participate in your course.

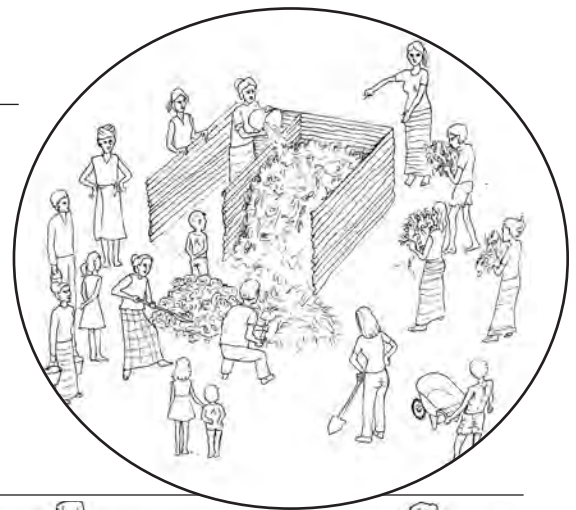
The trainer should prepare the translator by explaining complicated techniques and vocabulary in advance. Part of this preparation could be to attend the organizational meeting with the community leaders. The translator must also see a demonstration garden in order to better communicate the course methods.

The translator must also understand that his or her role is to translate without intervening or contributing to the class discussion. In Timor Leste translators will sometimes join in or influence discussion. This is especially the case if a man translates for a group of women.

If possible, locate a female translator for women-only courses.

Classroom Techniques

At least 50% of Permaculture training is spent outside the classroom. Good Permaculture trainers work along side their students to produce practical results in the garden and the field. However, when it is time to teach inside there are several techniques you can use to help your students concentrate and learn better. Because the literacy levels of men and women in rural Timor Leste is low you need to think of ways to communicate ideas that do not rely on written words. Here are some techniques to start you thinking.



Diagrams

All Permaculture trainers use diagrams as the best way to explain designs, maps and systems. Draw them in class or prepare them in advance. Good diagrams are simple to look at and to understand. You don't need to be an artist to draw them. Practice drawing the diagrams you will need before you begin the course. A teacher drawing in class is interesting for students to watch.

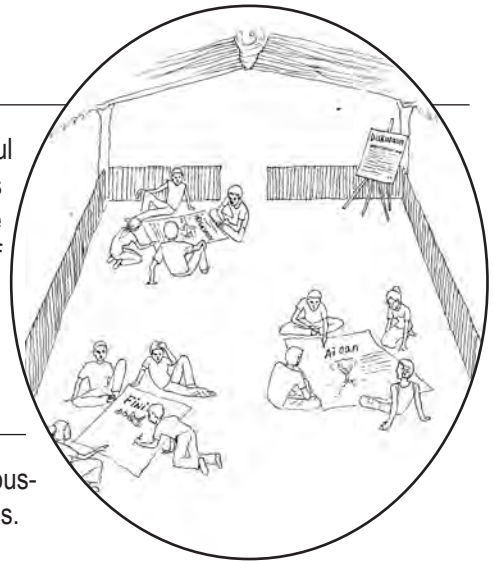


Role-play

Put students into groups and give them a situation that they have to perform to the class e.g. a non-sustainable land practice, forming a seed saving group, balancing food groups for the evening meal. Role-play has been highly successful in Permaculture courses. Students enjoy watching and participating.

Focus groups

Divide the class into groups to work on small projects e.g. a list of useful trees in Timor Leste, create a land design for the village. Focus groups help to concentrate thought and produce better results with several people working together. Students often find it easier to speak in a small group of peers rather than as individuals in front of a class.



Mapping exercises

Use coloured markers and large paper to create maps of home gardens, houses and the local area as well as designs for the future layout of these areas.

Mapping exercises can be done in focus groups or with the whole class. Students are often more confident drawing than writing.

A living map - 3D Model of terracing and swales

Discussion

Ask your class questions. Invite them to share their knowledge and encourage the class to discuss course topics between themselves.



Asking students' opinions and valuing their knowledge is a good way to build their confidence and increase their participation in the course.

The more students feel involved in discussion, the more interested they will be in the course and the more likely they will be to remember what you teach them.

Celebration

The Final Night Party is a Permaculture course tradition. Plan a party for the end of the course so the students can celebrate their achievements. There are lots of ways to make this interesting:

- Play games eg a Permaculture quiz with the class in two teams
- Play music
- Have the class members present items for a small concert
- Give funny prizes to students who did silly things during the course

The final night is the chance to have fun when the formal learning is over.



Creativity

Permaculture encourages creativity in every aspect of practice.

A design for the house, the garden or the field can be beautiful and functional at the same time. A lot of women's livelihood activities reflect creativity e.g. basket making, tais weaving.

Women can draw on their knowledge of design to create patterns for garden designs.

Encourage both women and men to make designs which look good and work well. A beautiful house and garden is nicer to live and work in.

This is also a way that all family members, including children, can contribute to the home and garden.

You - the Trainer

Culture

As a Permaculture trainer, your job is much more than just communicating a set of practices and techniques. You are responsible for the learning environment or the 'culture' of your class. All students should feel that they can voice their opinions, and be heard and respected by others. For women this is especially important. The best way to create this kind of 'culture' is to practice it yourself. Listen to students' opinions and try to give everyone time to speak. Encourage those who are shy. The atmosphere of the class is vital to the learning process of its students.

Creativity

Permaculture is about making the best use of the resources available. Use all your talents to make the course more interesting.

- Use songs and rhymes as a learning tool or as a break in class time
- Use art to help explain concepts or to make your designs more beautiful
- Tell stories, or use poetry to make a point
- Play games to help students remember facts

Students learn better in a fun and creative class. The more effort you put into teaching creatively the more your students will participate and use their own talents. A class like this is also more fun to teach.

Women trainers

If you are a woman trainer you can play an important role in the teaching of Permaculture techniques in Timor Leste. Permaculture is an opportunity to educate other women about practices that will make their lives and the lives of their families better. You will also inspire and build confidence in women to think practically and creatively about designs which affect their everyday lives.

Post-Training Follow Up

Why?

The Permaculture Course is only the first part of your work with the students. When the course is finished you should visit the village at least twice a month. Because Permaculture relies on sustainable solutions, your job as a trainer is not complete until students use the practices and techniques as part of their every day lives. Follow-up is the key to a successful course.

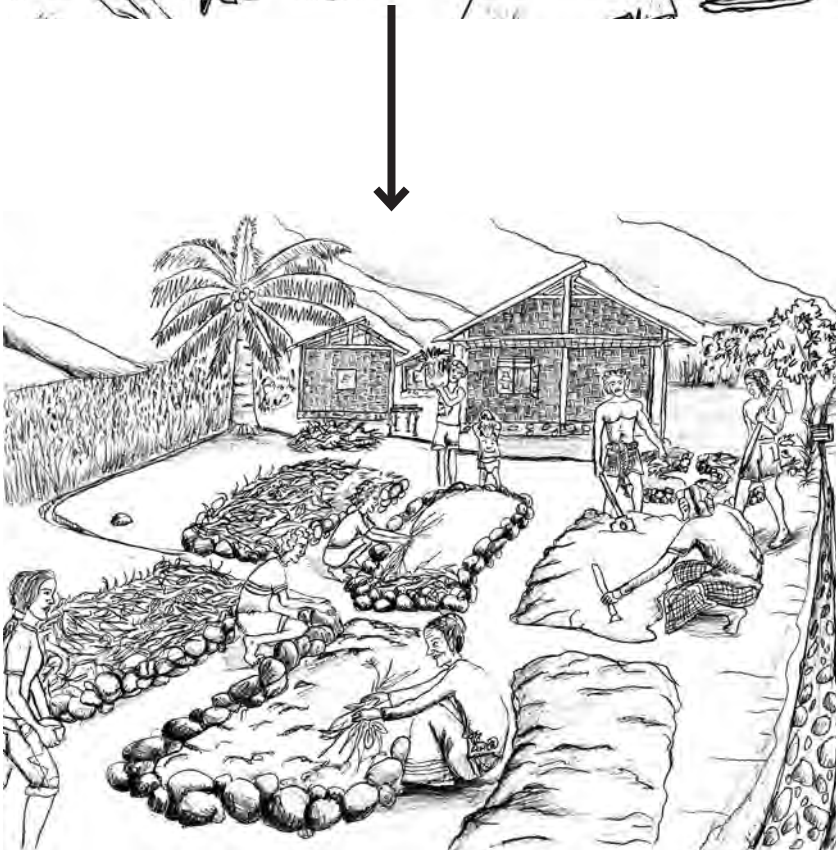
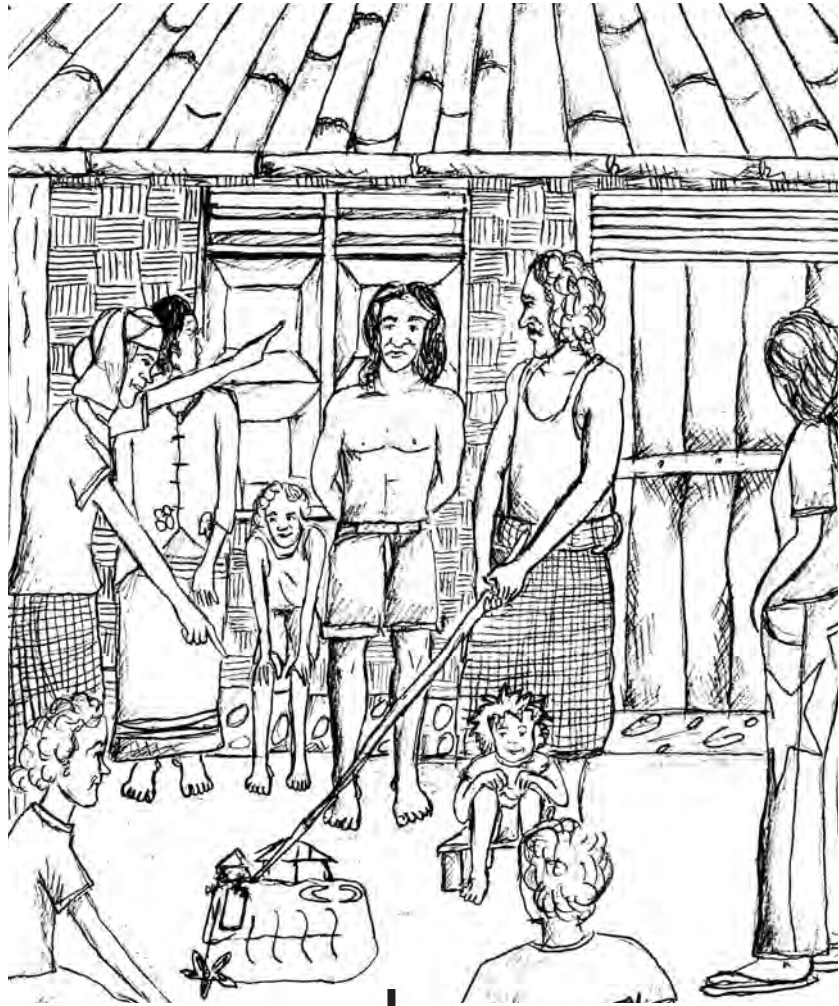
How?

Set students a long-term project that they will continue to work on after the course finishes. It can be designed around the home, the garden or the field, or may be some aspect of community-based work eg. a cooperative. Work with each student to decide on which project is the most appropriate for them and which is most likely to succeed.

On each visit you will monitor progress and offer technical advice and encouragement. You will also facilitate their problem solving process. Be careful not to offer solutions. Help students to think through problems themselves.

For all students, but especially for women, your ongoing encouragement will help them to see the results of their own continued work. It will also give them the confidence to try new techniques in the future. Encourage the students to form their own Permaculture group so they can advise each other and give practical help.

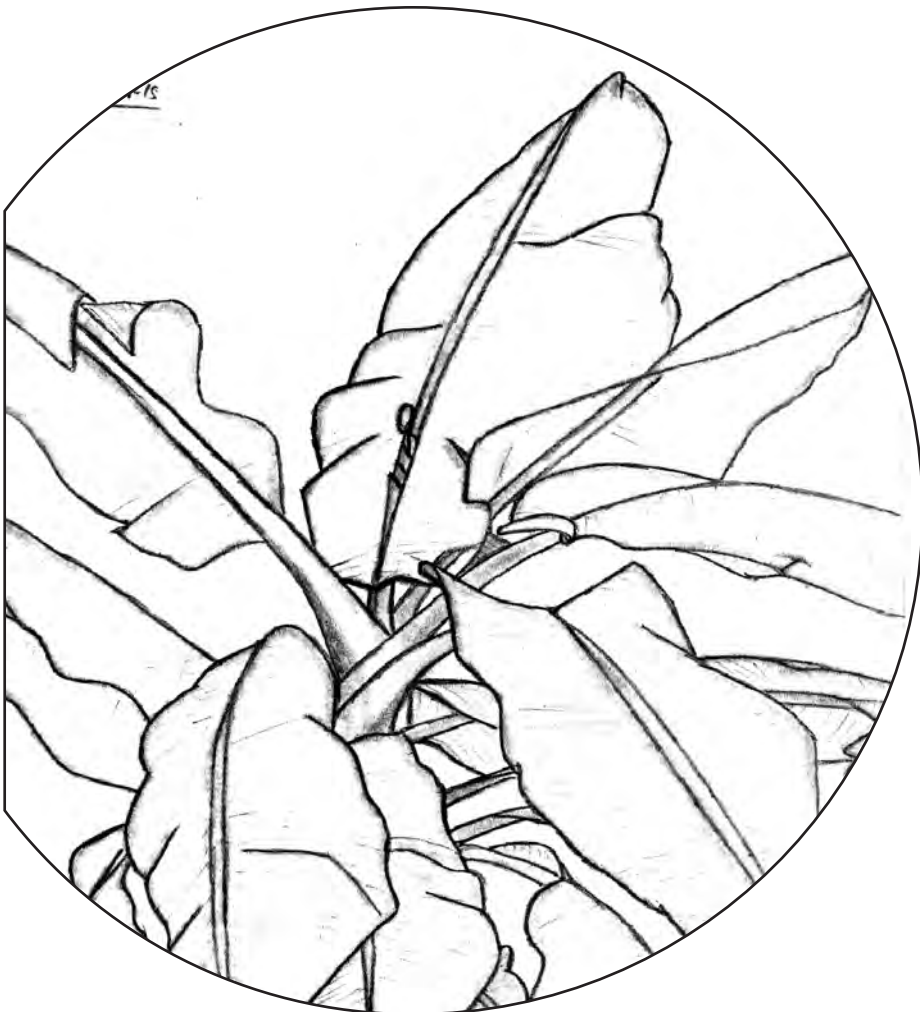
Use your visits to the community to assess your own teaching methods and to decide which techniques are most useful and successful. Follow-up is a valuable learning opportunity for both the trainer and the students.







Glossary of Terms



A

- Aeration :** To put air (with oxygen) into the ground or into a liquid.
- Alignment :** To place an element so that it is in agreement with another, or in relation with another.
- Analysis :** To study something in detail in order to discover its meaning or essential features.
- Annual :** A plant that completes its life cycle in one year.

C

- Canopy :** The covering or top layer of a forest or of plants and trees provided by the tallest trees. Like a roof of a house.
- Charcoal :** A black substance obtained by burning wood without much air. It can be burned as a fuel.
- Citrus :** A general name for the group of trees of the same family that produce sharp tasting, often large fruit. Examples: Orange, lemon, lime, mandarin, grapefruit, pomelo.
- Compost :** Natural fertilizer and soil improver that is made from decomposing manures, plant materials and other natural ingredients. "To compost" is to turn plant materials, manure and other natural ingredients into fertilizer.
- Contour line :** A line connecting points of equal height.
- Cross Pollination:** The transfer of pollen from the male part of the flower of one plant to the female part of the flower of another plant.
- Cutting :** A piece of a branch from a plant or tree that when planted will grow into a new plant or tree.

D

- Decompose :** To rot.
- Deficient :** Not enough. Of a quantity not able to fulfill a need or requirement. E.g. nutrient deficient soil means that the soil does not have enough nutrients or not all the nutrients that are needed.
- Design :** To work out the structure or shape of something by making drawings and plans.
- Diversity :** Many different and mixed varieties in one area. E.g. a natural forest has a diversity of plants, animals and birds.

E

- Efficient :** Working or producing well without wasting labour, energy or money.
- Element :** One of the fundamental components making up the whole. The different elements of something are the different parts it contains.
- Energy :** The capacity of a physical system to do work. Physical systems can be people, animals, machines etc. Energy can be created and it can be used.
- Evaporation :** To change from liquid or solid shape into a vapour or gas. E.g. water when it boils, or water when it dries on the road after rain.
- Evolution :** The slow but continuing change in the characteristics of a forest, humans, animals, plants or system over many generations.

F

- Feature (on map) :** An important or unique part of the land that is mapped. E.g. house, river, fence.

Fingerling :	A young fish usually under 1 year old, about the size of a finger.
Fry :	Young, baby fish.
Function :	The intended use or purpose of a person or thing. E.g. some functions of bamboo are to stop erosion, make a living fence, reduce wind, provide poles, provide food etc.

G

Germination :	The process of a seed coming to life and growing.
Gravity :	The force which attracts objects towards one another, especially the force that makes things fall to the ground.

H

Harmony :	A state of peaceful agreement and cooperation.
Hedge :	A thick row of bushes or small trees.
Holistic :	Looking at the whole of something or someone and not just a part.

I

Integrate :	If you integrate one thing with another, or one thing integrates with another, the two things become closely connected or become part of one whole system.
Insulation :	A thick layer of a substance which moderates temperature, keeping the temperature cooler in hot periods and warmer in cold periods. Usually used for buildings. Insulation substance examples: Rock, clay, dry grass, kapok fibre, render.

L

Larva :	An insect at the stage of its life after it has developed from an egg and before it changes into its adult form. More than one larva – larvae.
Leach :	To remove or be removed from a substance by a liquid passing through it.

M

Microclimate :	The summation of environmental conditions at a particular site as affected by local factors rather than regional ones.
Micro-nutrient :	A mineral nutrient element required in very small amounts by plants.
Mineral :	A naturally occurring solid inorganic substance with a characteristic chemical composition and structure.

N

Nematode :	The general name for a class of very small worms which live in the soil. Some types of nematodes cause damage to plant roots because they feed from them.
Nutrient :	A substance that provides the food necessary for life and growth.
Nutrition :	The process of providing the foods necessary for healthy life and growth.

O

Organic Matter (O.M.) :	Material in or on top of the soil which comes from plant or animal origin.
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P

- Perennial :** A plant that continues its growth for three years or more.
- Pest Predator :** A bird, animal, insect or spider that eats the pests that eat crops.
- Photosynthesis :** The process by which a plant uses sunlight to build up sugars for plant food.
- Pioneer :** To open up an area or prepare a way. To take the lead or initiative in or to participate in the development of something or somewhere new.
- Plankton :** The mass of very small plant and animal organisms that live in great numbers in fresh water or sea water.
- Pollination :** A powder produced by the male part of a flower, which is carried by insects or the wind and causes the female part of the same type of flower to produce seeds.
- Prevailing wind :** The most usual direction that the wind comes from. Propagation: To take a piece from an original plant to grow more plants.
- Prune :** To cut off some branches from a tree or bush so that it grows better the next year.

R

- Render :** To cover a wall with a layer, usually made from clay or cement, to protect and strengthen it.
- Resilient :** Capable of recovering easily and quickly from misfortune or illness.

S

- Scale (on map) :** The ratio between the size of something real and that of a representation of it.
- Soil Biota :** All of the plant and animal life in the soil. Usually they are very small.
- Strategy :** A general plan or set of plans intended to achieve something, especially over a long period.
- Succession :** A following of one thing after another in time. The gradual and orderly process of change in an ecosystem brought about by the progressive replacement of one community by another until a stable climax is established.
- Swale :** A mound of soil, rocks or other materials made in a line along the contour of a piece of land. It is built to collect and store water, soil and organic matter. It usually has a trench dug directly above it to provide the soil for the swale and improve its effectiveness.
- System :** The manner in which parts of something fit or function together. A network. A set of methods for doing something.

T

- Technique :** A way of doing something or skill used for a particular task.

V

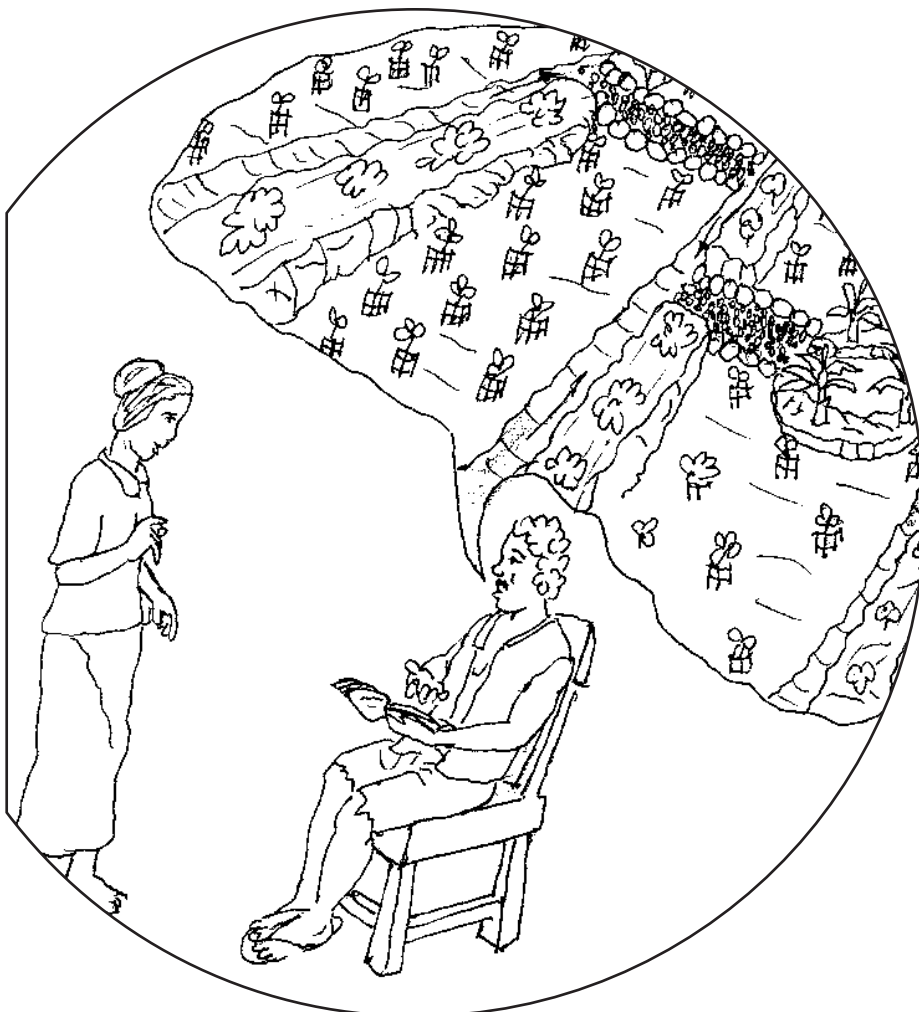
- Vehicle :** A Vehicle is a machine with an engine, for example a car, bus or truck that carries people or things from place to place.
- Ventilation :** When fresh air is allowed to enter an enclosed space.

Y

- Yield :** To produce or bear.

References

Related internet sites
&
Referenced books



Internet Sites



Many, many internet sites have been searched whilst researching this guidebook, too many to list here. Some key sites are listed here.

To the site authors and information providers, thank you. If you have internet access, visit websites to see what people are doing to create practical solutions and improve their methods of design and practice.

Use a search website to help you find websites in the right language for you.

General websites

www.gov.east-timor.org/MAFF/index.htm

An important website for referencing because it has a large amount of information on many different topics and all the information is specific to East Timor. It is especially good to use for specific plants, animals, soil types and agriculture conditions in East Timor. Can use in Tetum, English or Portuguese.

www.permacultureinternational.org

A great website for linking with the worldwide permaculture community. Follow the links section and global directory sections. Also contains a lot of excellent news and information.

www.idepfoundation.org

Excellent general permaculture site, in English and Bahasa Indonesian, with information, illustrations and photos on home gardens, nutrition, environmental issues, seed saving, waste management, grey water systems and more.

www.journeytoforever.org

An NGO site that covers a huge range of information with detailed technical information. Topics include community development, organic gardening, alternative technology, seed saving, reforestation and much more. Extensive links to other sites and a great schools project section as well.

b.webring.com/webring?home;ring=sustainability

A link page to a huge range of websites on all issues of sustainability. A great starting point to finding the sites and information that you need.

www.leisa.info

The Low External Input Sustainable Agriculture (LEISA) website has a wealth of information on soil, animals, agriculture, agroforestry, water management, trade and marketing and a whole lot more. The easiest way to find what you want is through the topics section.

www.proseanet.org

PROSEA – Plant Resources of South East Asia website contains great information about all plants, cultivated and natural. Use the E-PROSEA section to find the information you need. Good knowledge of English is needed.

www.viacampesina.org

Worldwide farmers' group network supporting organic agriculture, local seeds, farmers' rights, environmental protection and much more. East Timor is a member. Portuguese language is available.

Bahasa Indonesian websites

These websites are in Bahasa Indonesian. Some other websites in this reference section have Bahasa Indonesian options as well.

<http://beritabumi.or.id>

This website contains many articles on organic farming and environmental issues. It also has a kids section and a forum for discussing issues about organic farming and the environment.

www.elsppat.or.id

This is the website for the Institute for Sustainable Agriculture & Rural Livelihoods. It contains a lot of good articles, information, groups and links.

A search of “**pertanian berkelanjutan**” using www.google.com offers a range of sites as well.

Seed Saving And Nurseries

www.seedsavers.net

The Seed Savers Network are based in Australia and have provided workshops and helped start many seed saving groups in Australia and many other countries including East Timor. Their site provides a lot of information, photos and reports from all over the world.

Grafting

www.extension.umn.edu/distribution/horticulture/DG0532.html

A good website that explains all the basic aspects of grafting in words and pictures. Easy to find what you want.

Trees and Reforestation

www.winrock.org

A general website for sustainable forestry information with an emphasis on projects in developing countries and using forestry and forest preservation to help fight climate change. Also contains a lot of agriculture and alternative technology information

Moringa – Marungi

www.treesforlife.org/project/moringa/default.en.asp

An excellent website explaining all about Moringa’s many uses and benefits. The site has a lot of other useful information too.

www.moringanews.org

A good general site on moringa information. Excellent for networking and for the links provided to other sites.

Bamboo

www.inbar.int

The International Network for Bamboo and Rattan (INBAR) website offers a wide range of information about growing, harvesting and using bamboo as well as many links and contacts and information about their activities.

www.bamboonetwork.org

The bamboo network website involves exchanging data and research materials and identifying knowledge gaps and future research needs. It provides access to a lot of information trading and partner possibilities for future bamboo development in East Timor.

Large Scale Agriculture

[System of Rice Intensification \(S.R.I.\)](#)

ciifad.cornell.edu/sri

An extensive website about S.R.I. which gives detailed explanations about the techniques involved, and many examples of research and results from different countries and different conditions.

www.earthinstitute.columbia.edu/cgsd/documents/uphoff.pdf

Another very good website (PDF file) which explains all about S.R.I. techniques and gives examples of trials and results from many different countries.

Intergrated Pest Management

www.communityipm.org

Excellent website with well researched and tested information on community I.P.M., as well as organic agriculture and other techniques. Use the documents and concepts sections for lots of practical information and training guides and there is a great links section that leads to other websites like www.farmingsolutions.org, www.ifoam.org and www.foodfirst.org

www.neemfoundation.org

Excellent site for detailed information about neem trees, neem products and how neem works.

Animals

[Goat Milking](#)

www.fiascofarm.com

This site contains a lot of information about goat farming, milking goats and making products from goat milk. The methods described are all natural and mostly simple. Some products described are not available here, but it still provides many useful techniques and ideas and a lot of good information.

Aquaculture

www.enaca.org

Network of Aquaculture Centers in Asia-Pacific website. More for larger scale fish ponds and some information is based on high-external inputs but also has a lot of information that is relevant to East Timor.

Houses and Water Supply

www.networkearth.org

Use the “Art of Natural Building” section in this website to find a lot of information about natural building with explanations of how to use different building materials. Great information, but unfortunately not many pictures. Has information on other topics as well.

www.oasisdesign.net

Has lots of good information about all aspects of house design and construction, compost toilets, grey water systems etc. Use the links button to loads of other great sites including www.oikos.com and www.users.bigpond.com/brookman

Compost Toilets and waste water systems

oikos.com/library/compostingtoilet/composting.html

This is a lengthy excerpt from The Composting Toilet System Book and contains a lot of excellent information.

www.riles.org/

This is the website for ReSource – Institute for low entropy systems. They work with communities on ecological sanitation issues emphasizing composting toilets. The library section has good information and it has lots of photos too.

Clay Water Filter

info.anu.edu.au/mac/Media/Media_Releases/_2005/_January/_190105filters.asp

This site has a fantastic new method for making simple, cheap but very effective clay water filters. The process for inventing this method was started from work in Manatuto! Click on the step-by-step guide at the bottom of the article for the instructions.

Appropriate Technology

www.ata.org.au

The Alternative Technology Association website offers a vast range of information on all aspects of alternative technology, through the technology basics and Renew magazine sections, as well as the latest inventions and a fantastic links page to other technology, permaculture and sustainability sites.

www.solarcookers.org

An excellent site for all about making and using solar cookers of many varieties, as well as other food technology. Click on solar cooking archive to get to www.solarcooking.org This has a lot of practical information and pictures The Plans section is especially useful and shows how to make many different cookers. The site is also available in Portuguese.

www.arecop.org

The Asia Regional Cookstove Program website offers a lot of information about programs and ideas about cookstoves in Asia. It also contains many good links.

www.itdg.org

The Intermediate Technology Development Group (ITDG) website offers a huge amount of excellent practical information for technology that can be used in Timor Leste. Click on one of the sections on the left side of the page then choose the section you want to read. The "practical answers" section contains a lot of useful information. These files can be downloaded and saved very easily. It also contains many links to other web sites.

<http://www.villageearth.org>

This is a huge alternative technology site. Most of the information is for sale rather than free, but this could still be very useful for NGOs, government, etc. The site contains reviews of all materials on offer, a lot of other useful sections and many links to other sites.

Oil press site

www.itdg.org/docs/technical_information_service/oil_extraction.pdf

This site is from the www.itdg.org website and contains a lot of information and pictures about oil extraction, oil processing and oil storage.

Cooperatives and community groups

www.coop.org

The International Cooperative Alliance website is an extensive and detailed website. It is very useful and based on cooperative ideals, but most of the information is based around larger organizations and developed countries, not small community cooperatives.

www.appropriate-economics.org

Connected to the Complementary Currency website America but with a lot of separate articles specifically about Asia, Africa and Latin projects and research.

www.appropriate-economics.org/asia/asia.html#indo

A direct link to Complementary Currency Resources in Bahasa Indonesia

www.complementarycurrency.org

Complementary Currency Resource Center- Use links section for an excellent range of links, the help desk for starting new systems, the library section for access to detailed information on many different topics and the database section (Also in Portuguese) for projects, contacts and websites worldwide.



Books

Permatil and Hasatil have a collection of reference books and materials, in Bahasa Indonesian, English and Tetum. These books and materials cover a range of topics including, soils, gardens, seed saving, tree crops and management, houses, alternative technology and more.

Hasatil also produce a small magazine, which contains a lot of excellent information and ideas.

Books referenced for this guidebook

I am deeply thankful for all the information I have referenced and learned during the researching for this guidebook. Thank you, the writers and illustrators, for all your efforts in providing these books and reference materials. ***You have all contributed greatly to expanding the knowledge and resource base in East Timor.***

Earth User's Guide to Permaculture

Rosemary Morrow
Kangaroo Press, 1993

Earth User's Guide to Permaculture – Teachers Notes

Rosemary Morrow
Kangaroo Press, 1997

Bamboo Rediscovered

Victor Cusack
Earth Garden Books, 1997

The Seed Savers Handbook

Michel and Jude Fanton
The Seed Saver's Network, 1993

Permaculture, A Designers Manual

Bill Mollison
Tagari Publications, 1988

Introduction to Permaculture

Bill Mollison
Tagari Publications, 1991

Liklik Buk

Edited by Amanda Twohig
Published by Liklik Buk Information Centre,
Lae, Papua New Guinea, 1986

Sapa, The natural way of growing food in the Solomon Islands

Joini Tutua with Toni Jansen
APACE, 1994



Community Seed Saving – A South Pacific Trainers Manual

Emma Stone

Kastom Gaden Association, 2002

Energy From Nature, 11th Edition

Compiled by Peter Pedals

Rainbow Power Company, 2001

Mud Brick Techniques

Ron Edwards

The Ram Skull Press, 1990

Farming in Ponds and Dams

Nick Romanowski

Lothian, 1994

Fish for Farm Dams

Malcolm R McKinnon

Queensland Department of Primary Industries, 1989

Natural Pest and Disease Control

Henry Elwell and Anita Maas

The Natural Farming Network, Harare Zimbabwe, 1995

Minanao Baptist Rural Life Centre Series (SALT)

Minanao, Phillipines

Notes from Permaculture Design Course and Permaculture for Third World and Indigenous Peoples Course

Robyn Francis

Djanbung Gardens Permaculture Education Centre

Manual for the promotion of Family-Scale Aquaculture in the Northwest Provinces of Cambodia

Prepared by Wayne Gum for UNOPS/CARERE

Organic Gardening

Peter Bennett

Child & Associates Publishing Pty Ltd, 1979

Companion Gardening in Australia

Judith Collins

Lothian

to finish...

Remember that this is only a guide. The most important part of permaculture is to use your imagination and adapt to the situation. Don't be afraid to experiment and make mistakes. It is best way to learn. But try small experiments first and learn from them. Learn what works and what doesn't, then improve and try more.

Step by step is the key

And remember, conditions will always change. Continual observation and adjustment is essential for dealing with different situations and problems that will happen.

Look towards the future. Many of the important solutions for East Timor will take time to get good results – E.g. improving soils, improving health and nutrition, building village economies, building infrastructure, stopping erosion, improving fruit trees production, Sandlewood, teak and mahogany plantations, etc. These are the most important steps because these are the base for good health, good production and more secure incomes.

Many important environmental solutions will not give a lot of direct financial benefits now. E.g. Protecting forests and rivers, stopping erosion, reducing burning, protecting the ocean. But the future benefits, including financial benefits, are enormous, and the work is necessary to protect East Timor's wealth and environment for future generations.

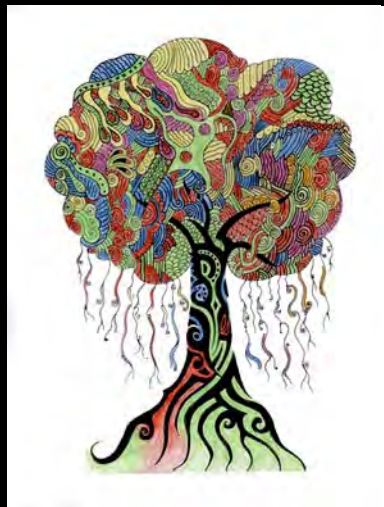
Use the reference section. There are so many more good ideas and techniques being practiced all over the world that can be adapted and used in East Timor. And more and more are being invented and tried all the time.

this book is just the beginning...



Hadomi Ba Rai,
Hadomi Ba Ema,
Ho Futuru
Timor Leste Nian

A Permaculture Guidebook from East Timor



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