The Fields

The Farmers' Handbook

This Volume's Authors : Chris Evans, Laxman Rana, Bhuvan Khadka, Ms Hommaya Gurung, Mrs Deumaya Rana
Edited, Designed & Produced by: Chris Evans & Jakob Jespersen
Translated from Nepali by Chris Evans
Proof reading: thanks to Mike Feingold, Margaret Evans, Ted Albins, Rupert Greville, Andy Langford, Looby Macnamara
Photos: Jakob Jespersen, Chris Evans
Addional photo credits are given in Volume Five
Cover illustration: Mr Motilal Phauja
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The Farmers' Handbook is about techniques for sustainable farming and this is the fourth of 5 volumes. There are 9 techniques presented here. In five volumes there are 40 techniques and approaches in total.

CONTENTS

Subject ▽ **Chapter No:** ▽

Chapters are separated by a yellow page

The Farmers' Handbook - this Volume's Introduction

This is the fourth volume of a five volume production of the Farmers' Handbook. In all there are forty techniques & approaches shown, of which nine are in this fourth volume. In this volume we introduce you to some of the methods used in the fields. The titles of these are given on the previous contents page.

This Farmers' Handbook has been prepared to provide information about sustainable farming techniques as well as being a resource to run literacy programmes. Information about such programmes and how the Handbook can be used is provided in the fifth volume. As well as technical information, a glossary of new and difficult words is also provided in the fifth volume.

Aims

The main aim of this handbook is to help farmers make their own farms more successful. This is done by providing information about using simple methods which strengthen, rather than damage the environment, and help to create sustainable livelihoods for future generations.

Background

The techniques described in the handbook are the results of research made by the farmers of Surkhet and Jajarkot districts of Mid-Western Nepal. We believe these methods will also work well for farmers of other countries. However, around the world there are diverse climates and soils, and so we expect that small changes will need to be made in the techniques according to this diversity. Similarly, it may be necessary to change plant species according to climatic region, but their function will remain the same. For example, the chapter on the **Living Fence** describes the use of thorny plants as a barrier. In the low altitude, hot Tarai of southern Nepal, "Babool" (*Acacia nilotica)* is suitable for this. But this does not grow in the higher elevations. Here, species such as wild pear, wild blackberry and Sea Buckthorn make a good living fence.

Evaluation & Feedback

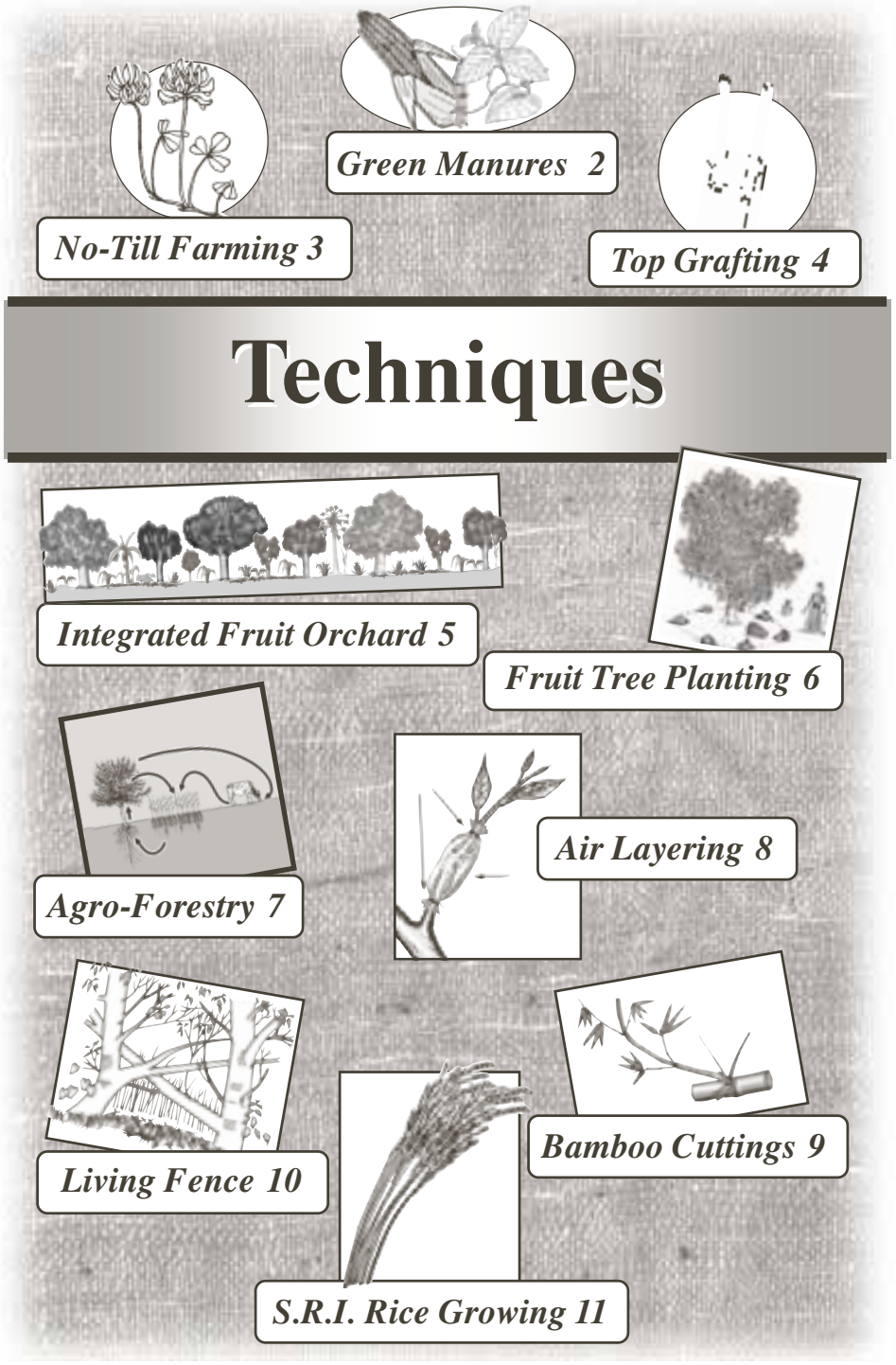
Comments and questions about the techniques and approaches described in this handbook will be most welcome. Suggestions for improvement will be used for future editions of this handbook and other similar publications.

Structure of the Handbook

Inside the handbook each method is descibed in a separate chapter, or chapter. All methods are descibed in the same way:-

- "What is?" - the method is defined and described.
- "Why?" - the benefits of using this method are then described.
- The main part is then "How to?" make or do the method;
- In the "How To" section the centre pages show colour pictures about the method.
- After describing how to create the method, how to maintain, care for, manage and/or operate it is described.
- After this, there is an interview with an experienced farmer who has built and used the method.
- Finally, information is given about other chapters in the Handbook which are directly connected to this method.

There are minor changes to this structure as appropriate.



Appropriate Technology Asia
P.O. Box 8975 EPC 849
Kathmandu, Nepal
tel: +977 1 5549774
nepal@arasia.org.uk
www.atasia.org.uk

Distributor and main contact addresses

Permanent Publications
The Sustainability Centre
East MeonHampshire GU32 1HR
tel: +44 1730 823311
info@permaculture.co.uk
www.permaculture.co.uk

Permaculture Association UK
BCM Permaculture Association
London WC1N 3XX
Tel: +44 845 4581805
office@permacuture.org.uk
www.permaculture.org.uk

Himalayan Permaculture Group, P.O. Box 19121, Kathmandu, Nepal
lxdfn lb3f{o' ;d"x, n]v°;f{ — @, k'/fgf] ufp“, ;'v]{t

Nepal Permaculture Group
P.O.Box 8132, Kathmandu, Nepal
Tel: +977-1- 252597

email:- npg@earthcare.wlink.com.np

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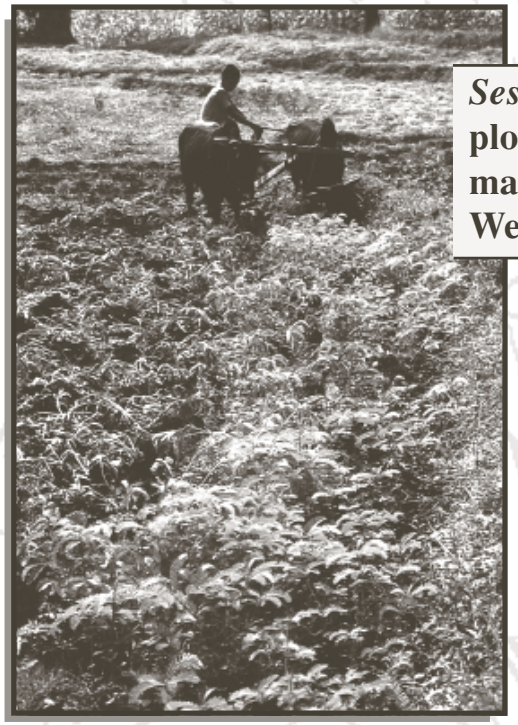
What are Green Manures ?



***Sesbania* being ploughed in as a green manure , Surkhet, Western Nepal**

Every farmer knows how much work goes into the production of a basket of compost and carrying it to the fields. But it never seems that the farm production gives an equal return for the hard work that goes into making and carrying the compost. **Green manures** are a method of replacing that basket of compost with a handful of seed. In this method, the plants that grow from the handful of seed are ploughed back into the soil. After a while in the soil, the plants rot down to become compost. Plants used in this way are called **Green Manures**. It's a very good way of increasing the fertility of the soil, and can give huge benefits for farmers. So let's read about it here.

Why grow Green Manures ?

Benefits of Green Manures

- **Reduce the need for artificial fertilizers** - by using green manures the need to bring in fertilizers is reduced. By not using fertilizers, costs are saved and the soil is not damaged. Also, production can be increased to feed the family for longer, or excess produce can be sold.

- **Increase biomass production in the fields** - in an example from Brazil in South America, where 40,000 farmers have converted to using green manures, they have calculated that using velvet bean as a green manure has produced **50 to 140 tons per hectare** of extra biomass. This is the equivalent of carrying up to 3000 loads of leaf litter! But the green manure biomass doesn't need to be carried from anywhere. Wherever the fields are, that's where the biomass is produced and, that's where it rots to form compost.

- **Increase in micro-organisms and their activity in the soil** - Beneficial micro-organisms live and work around the roots of green manure plants in the soil. They help the plants to catch and create nutrients in the soil. The fertility isn't just for the plants, it helps to make the soil rich. The microorganisms help the plants and the soil, and in return the green manures help to protect the microorganisms from being damaged by the sun, wind, rain, leaching, etc.

- **Increase Farm production** - using green manures can increase the production of grains, pulses, vegetables, fodder, fuel, etc. grown on the farm.

- **Decrease work and expense** - less compost needs to be carried. By using green manures, the soil becomes loose and easier to plough or dig.

- **Reducing weeds -** green manures cover the ground and so reduce the work and cost of weeding.

- **Protect the soil** - by covering the soil, green manures protect it from the damaging effects of hot sun, wind and hard rain.

- **Improve the soil** - where green manures have been regularly used the soil is softer, lighter and easier to work. As a result, the soil has a greater capacity to absorb and store water and nutrients.

- **Improve the quality of crops** - crops grown with green manures are more tasty and nutritious than those grown with chemical fertilizers.

Mr Thek B. Gurung of Gumi VDC - 4, Surkhet, likes using *Sesbania* green manure on his fields

How to grow Green Manures ?

There are 2 ways of using green manures :-
1. When land is unused, or fallow between crops;
2. While crops are still growing in the fields.

1. Using green manures as fallow

When crop land is empty after crops have been harvested, green manure seeds can be sown as thickly as sowing wheat. When the green manure plants are about to flower they can be cut and left, or ploughed into the soil.

2. Using green manures mixed with crops

This method is used mostly with maize growing. An easy method is to sow a green manure at the same time as maize, and then dig it in when it is time to weed the maize (after 3-4 weeks). At this time green manure seeds can also be sown, and the green manure is cut and mulched or ploughed in after the maize is harvested to provide even more fertility.

Green manures are easy to use, but it's important to note certain things, such as :-
- green manures can be used in all seasons;
- which-ever type of green manure is being used, they will give most benefit to the soil if cut and/or ploughed in at flowering time, before seed is set;
- climbing types of green manures can smother the crops they are growing with. If so, the climbing stems need pulling down from the crops.

Selecting which green manures to use.

There are many plants which can be used as green manures. In particular, the type of green manure should be selected according to the type of crop it is growing with or in between. For a large plant like maize, a large green manure like velvet bean or *Sesbania* should be used. For a short crop like many vegetables, smaller green manures such as mustard or buckwheat can be used.

Criteria for selection of green manures include :-

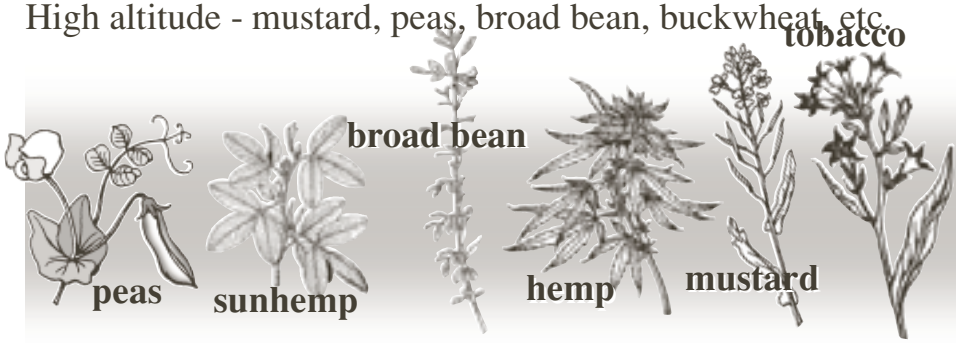
- plants are fleshy and soft
- fast growing;
- fast to decompose;
- leguminous;
- don't attract pests and diseases;
- don't compete with crops;
- provide nutrients needed in the soil (more information about this is given on p.21)

Examples of winter-grown green manures

Low altitude - mustard, peas, broad (fava) bean, fenugreek, tobacco, buckwheat, etc.

Mid altitude - mustard, peas, broad bean, fenugreek, buckwheat, etc.

High altitude - mustard, peas, broad bean, buckwheat, etc.

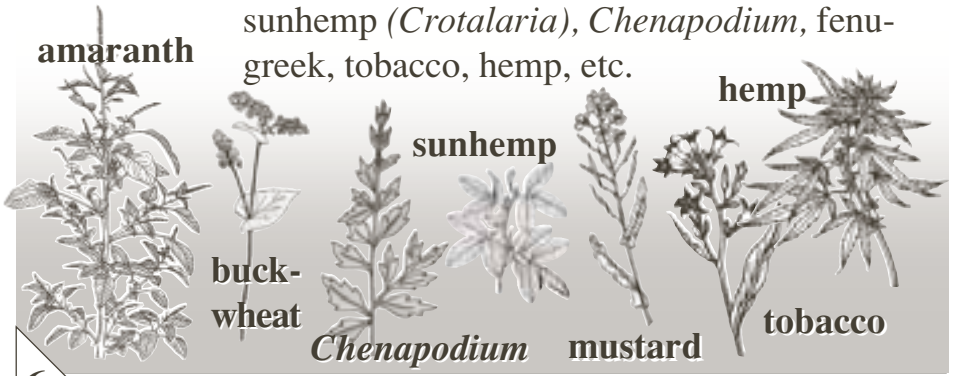


Examples of summer-grown green manures

Low altitude - mustard, buckwheat, amaranth, sunhemp *(Crotalaria), Sesbania, Chenapodium,* fenugreek, lab lab, velvet bean, jack bean, tobacco, etc.

Mid altitude - mustard, buckwheat, amaranth, sunhemp *(Crotalaria), Sesbania, Chenapodium,* fenugreek, lab lab, velvet bean, jack bean, tobacco, hemp, etc.

High altitude - mustard, mustard, buckwheat, amaranth, sunhemp *(Crotalaria), Chenapodium,* fenugreek, tobacco, hemp, etc.



Examples of using green manures

Now we'll see some specific examples of green manures. On this page *Sesbania* is used with rice. On page 17 *Sesbania* is used with maize, then on page 18 velvet bean is used with maize, and on page 20 mustard is used with wheat.

Sesbania and Rice

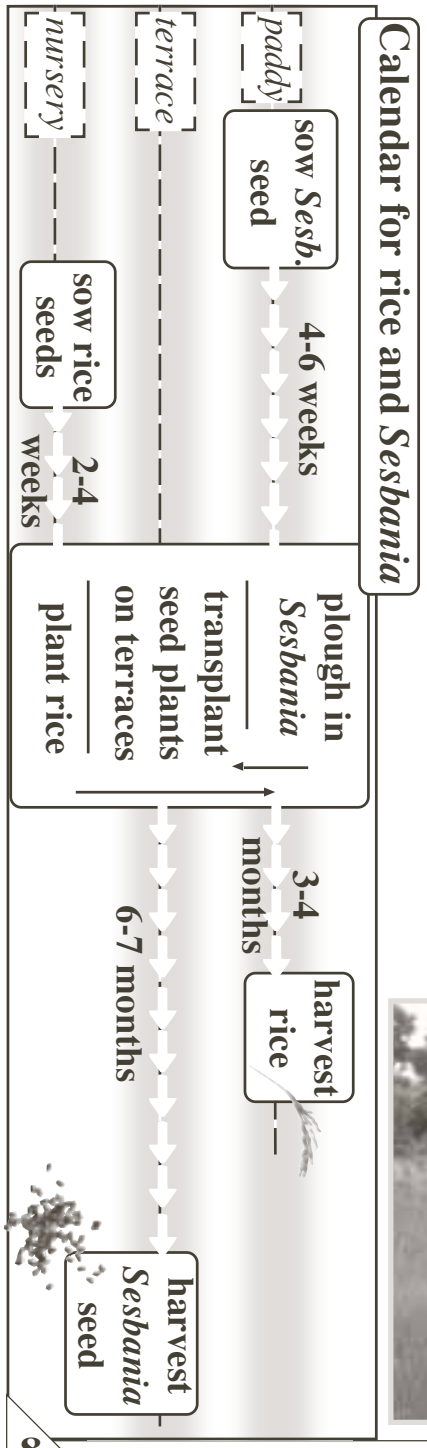
In this method, *Sesbania* is sown before rice is planted. As rice is sown into nurseries, all other paddy areas are fallow, which is when *Sesbania* can be grown.

How to sow	Sow the *Sesbania* as densely as wheat or mustard seed. Then lightly till to cover the seed with soil.
Timing	Sow after winter crop is harvested, or in the Spring. *Sesbania* will grow faster if the soil is kept moist, so irrigate if possible. After 4-6 weeks, the *Sesbania* will be 18-36 inches tall. Cut at ground level and plough in as the paddy are prepared for planting rice.

Seed production of *Sesbania*

When *Sesbania* is being ploughed in during paddy preparation, transplant a few of the largest, thickest, healthiest plants onto the edges of the paddy - space at 2 metre intervals along the terrace edges. These will grow on to produce seed for green manure use next year. The seed will be ready after 6 to 7 months

Calendar for rice and *Sesbania*



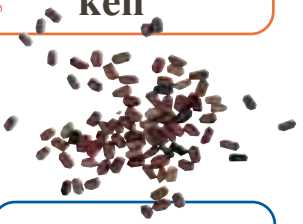
Seed plants will grow at 2 metre intervals on the terrace edges. When between 1-1.5m tall, pinch out the tops. This helps to thicken the stem and prevents the plant growing too tall, when the wind can blow them over. Pinching also produces more branches, and so more seed. There's a picture of this on p.11.

After the *Sesbania* has been cut and ploughed in, the paddies are flooded, and rice is planted. The fertility from the rotting green manure is a good food for the rice.

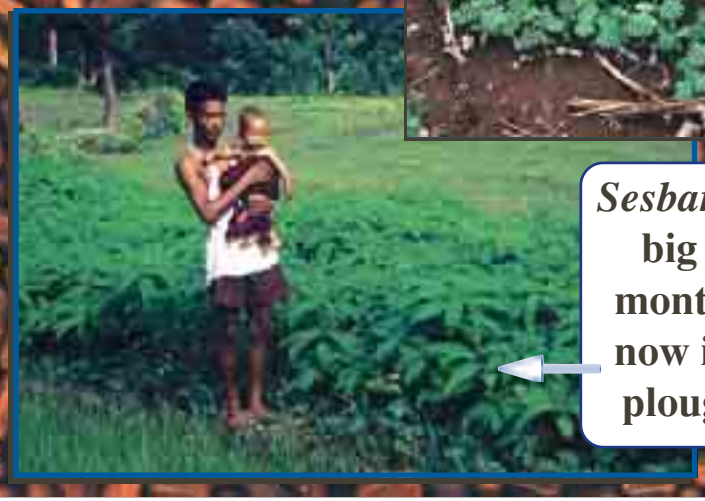
***Sesbania* seed plants growing on the terraces**

Let's See how to grow Green Manures

***Sesbania* is sown as the fallow is broken**



***Sesbania* germinates in 6-10 days**



***Sesbania* is this big after a month. From now it can be ploughed in.**

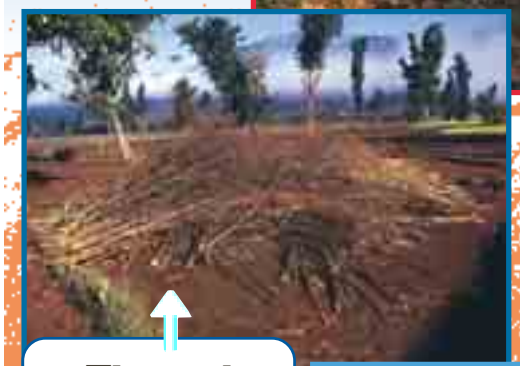
The *Sesbania* is cut at its base before ploughing in.

This makes ploughing easier

Land ready for planting after *Sesbania* has been ploughed in

The tips of the *Sesbania* seed plants are pinched out. This makes more branches, and the plant has a stronger stem.

After the rice is harvested the *Sesbania* seed is ripening



The seed plants also provide a fire-wood yield.

Seed is cleaned and stored for next season

Sesbania or velvet bean is sown as the maize is weeded for the first time

If maize is also weeded by hand this is still the time to sow green manure

Sesbania grows amongst the maize

The *Sesbania* is ready to plough in after the maize is harvested

Velvet bean growing as a green manure

A Guatemalan farmer inspecting the velvet bean after the maize has been harvested

The velvet bean is cut at the roots when it starts to flower

Velvet bean after it has been cut

Velvet bean flowers and seed pods

This wild "weed" is also a good green manure plant

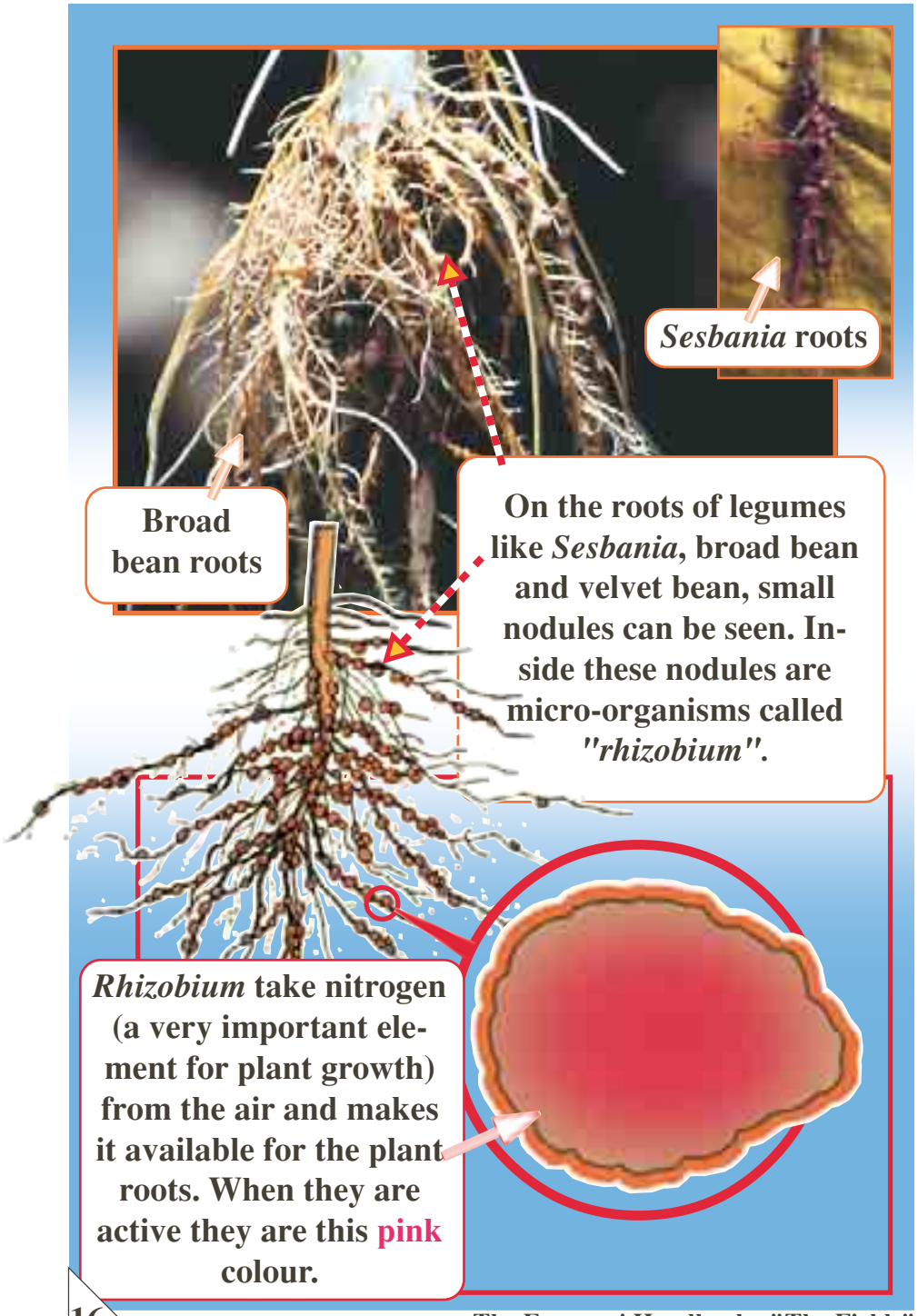
Sunhemp used as a green manure with millet

White clover is sown as a green manure in a fruit tree nursery. This keeps weeds down, conserves water, and adds nitrogen to the soil.

Perennial white clover

Agroforestry on the terrace edges and velvet bean green manure in the maize

2 years before, the soil on this Guatemalan farmer's fields was too poor for farming. After using velvet bean as a green manure, look how black the soil has become and how big the corn is (also see p.22)



Sesbania and Maize

In this method *Sesbania* is sown with maize. There are 2 methods of sowing the *Sesbania* as a green manure with maize .

Method 1 :- Sowing *Sesbania* at the same time as maize.

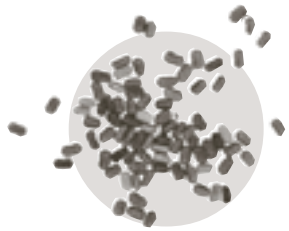
- The maize and *Sesbania* germinate together. The *Sesbania* is dug or ploughed in when the maize is weeded after 3-4 weeks, and the fertility from the *Sesbania* helps the maize crop.
- Instead of *Sesbania*, many other types of green manure can be used to provide nutrients for the maize.

Method 2 :- Sowing *Sesbania* when maize is being weeded

- As maize is being weeded for the first time, 3-4 weeks after sowing, sow *Sesbania* as thickly as you would sow wheat. While weeding, the *Sesbania* seed will be covered.
- After the maize has been harvested, the *Sesbania* is cut and ploughed in as the land is being prepared for the next crop.
- The fertility from the *Sesbania* will benefit the next winter crop.

Sesbania seed production

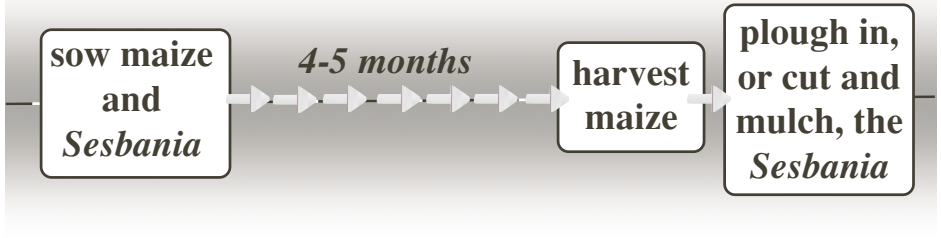
Sow seeds on the terrace edges. Select as many of the best plants as are needed for growing on to produce seed.



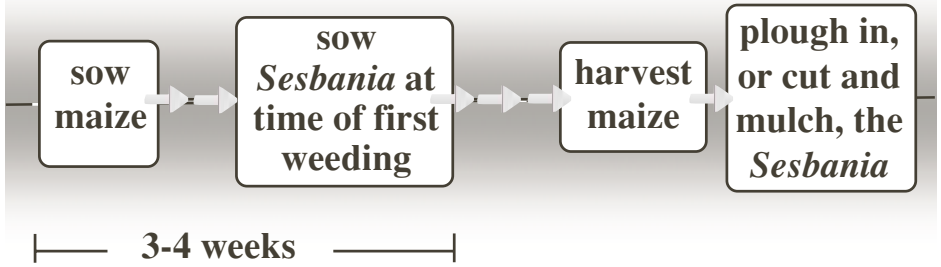
Other green manure types can be used instead of* Sesbania, *but they need to be tall plants, (like maize), for example sunhemp. See also velvet bean and maize, p. 18

Calendar for maize and *Sesbania*

Method 1.



Method 2.



Velvet bean and maize

In this method, velvet bean is grown as a green manure with maize. Velvet bean is sown as the maize is weeded for the first time.

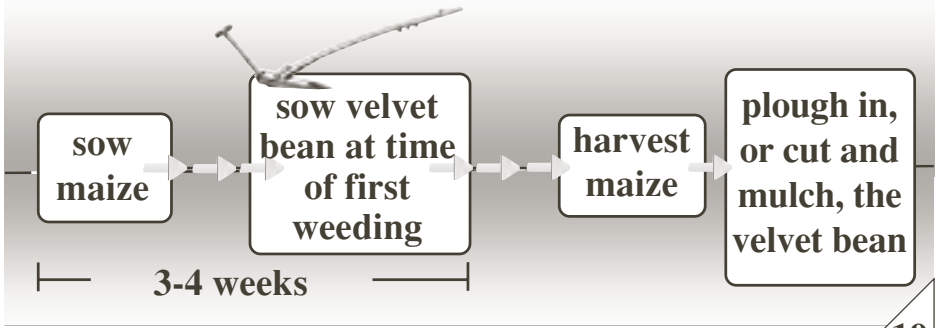
- Maize is weeded by hand or ploughed 3-4 weeks after sowing. At this time, sow velvet bean seed 50cm apart. The seed is covered with soil when weeding.
- The velvet bean will germinate quicker if it is soaked in water for 2 days before sowing. While soaking the velvet bean seed, change the water twice a day.

- The velvet bean is a climing type and will grow into a large vine. If it starts to smother the maize before the maize is harvested, it should be pulled off the maize plants onto the ground. After the maize is harvested, the velvet bean can be allowed to smother the standing maize stalks to put on extra biomass.
- After the maize has been harvested, the velvet bean is cut and ploughed in as the land is being prepared for the next crop, or cut and mulched if the land is to be fallow.

Velvet bean seed production

- Plant velvet bean seed on the field edge, under a suitable tree, and allow it to grow up the tree to produce seed. Don't let it climb on fruit trees as the large, thick vine can damage the fruiting of the tree.
- Velvet bean seed will be ready to harvest about 8-10 months after sowing.
- Velvet bean seed is not edible for people.Edible climbing beans can be used instead of velvet bean, such as lablab, Jack bean, etc. These can be allowed to produce a bean crop if timing is appropriate.

Calendar for maize and velvet bean



Mustard and Wheat

In the autumn compatible green manures can be sown with winter crops. It is difficult to grow green manures together with crops like wheat or barley, so they are usually grown before the grain crops.

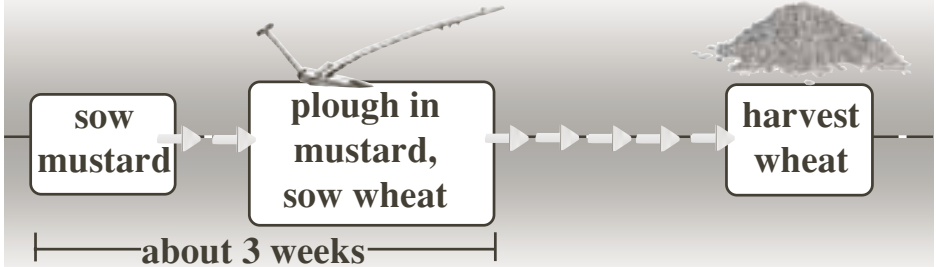
Timing

- The green manure can be sown while land is fallow, after harvesting the summer crop.
- After harvesting the summer crop, such as rice or maize, the land is ploughed as normal, and mustard is thickly sown.
- The mustard should be ploughed in as it starts to flower.
- Then the winter wheat (or any winter crop) is sown.

Instead of mustard, buckwheat or fenugreek can also be used in the same way as green manures.

Mustard is ploughed in at flowering time for use as a green manure. Here, wheat is then sown.

Calendar for wheat and mustard



There are many other types of green manure that can be used as well as the above examples.

"I sowed sorghum as a green manure. After a month I ploughed it in and planted potatoes, and got 3 times the production !"

Bhim B. Gautam, Gumi, Surkhet

Below is some information about which green manures have high amounts of particular nutrients

Type of green manure	Nitrogen	Phosphorus	Potassium
buckwheat		lots	
mustard		lots	
tobacco		lots	
Chenapodium	lots	lots	lots
Sesbania	lots		
beans	lots		

A story about Hurricane "Mitch"

In 1998 Hurricane Mitch struck Central America, especially Honduras, Guatemala and Nicaragua. Strong winds, torrential rain, landslides and floods killed over 10,000 people and left 300,000 others homeless.

Farmer Yuwan Aguirre pulls back the thick mat of biomass resulting from a velvet bean green manure crop. This has helped to protect againts soil erosion and raise production.

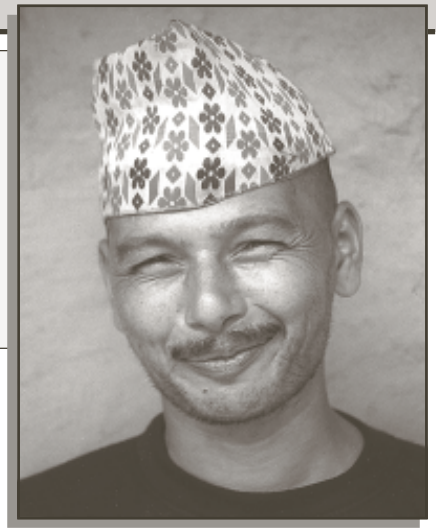
But in the south of the Lempira region there were no disasters. No landslides, no deaths, in fact 84 villages in the region produced 2000 tonnes of surplus grain. To explain these amazing facts, the government, along with local NGOs and farmers studied the area and found that the farmers there had been implementing sustainable, organic agriculture practices that had protected them from the dangers of natural disasters. Since the last 30 years, over 10,000 farmers in these villages had been implementing soil conservation, terrace improvement, agroforestry, green manure and integrated pest management strategies to protect the steep slopes in their areas. Because of this, even a huge natural disaster like Hurricane Mitch wasn't able to cause them any serious damage.

Since the beginning of their experiences, the farmers of Lempira have been sharing their lessons with local farming organisations and with farmers throughout the country and in neighbouring countries too.

Farmers' Experience

Mr Dambar Bahadur Regmi

From Nepal, Surkhet district, Gumi - 3, Mr Dambar Bahadur Regmi has grown green manures since 1995. Now let's hear about his experience.



Dambar Bahadur Regmi

" I've seen myself the benefits of growing *Sesbania* green manure with rice paddy. Ever since I started doing this, the production of rice has increased steadily. Land that used to produce 960kg of rice can now produce up to 1400kg, which is pretty good for this area. Also, I've spent less buying fertilizers from the supplier since using green manures. The soil has become softer and easier to plough, so you need to do less work and still get better crops. Rice that's grown this way tastes better, too, and the mill owner tells us that there's less husk and more grain in my rice and that of other farmers who've started using green manures. Now I want to try using other types of green manure as well as *Sesbania*. "

This chapter's author
Ms Hommaya Gurung
Coordinator, Himalayan Permaculture Group, Surkhet, Nepal

Read On !

Subjects Related to Green Manures

This book provides enough information to be able to grow your own green manures. However, this information is also linked to other methods. For extra benefits let's read, learn and practice from other related chapters.

Seed Saving chapter

This chapter gives information on methods to produce and store various types of quality seeds, including green manure seeds, at home.

Compost chapter

As well as green manure, animal compost is also useful for plant food, but needs to be produced in a well managed way. This chapter shows how to produce a quick rotting, good quality compost.

Kitchen Garden chapter

How to make and manage a home vegetable garden for permanence, ease and simplicity ? This chapter shows how to produce a wide range of fresh vegetables by doing less work for more production.

What is No-Till Farming ?

Fields not ploughed for 6 years, Sunrise Farm, Kathmandu, Nepal

In the 1960's a Japanese agricultural scientist called **Masonobu Fukuoka** started to ask himself how he could reduce the cost of his farming methods. He saw most costs in ploughing, weeding, fertilizing and transplanting paddy in his rice-wheat system. He spent the next 30 years experimenting to perfect his methods of reducing farming costs in these areas. But now, using his experience, we can develop similar systems in a much shorter time. His methods are also called **"farming of the sages"**, because of the deep spiritual base to his philospohy, and the fact that nature is regarded with godly respect. His methods are based upon natural systems, and farming practiced without harming nature.

Farming with nature can be practiced with any farming system, but the methods descibed in this chapter are particularly related to the **rice and wheat** system.

Why do No-Till Farming ?

There are 3 main reasons for ploughing:-

- to aerate the soil;
- to reduce weeds;
- to mix organic matter in the soil.

Masonobu Fukuoka

If we can achieve these needs without ploughing, then why plough ? This was Fukuoka's idea. A plough is never used in the forest, but the soil is always soft and fertile. In fact, the more you plough, the more ploughing is needed, as weed seeds are brought to the surface and germinate. Ploughing leaves the earth bare, leaving micro-organisms and nutrients to be dried out by the sun, washed away by the rain, and blown away by the wind. That's why it's difficult for farmers to get good production even after so much hard and expensive work ploughing, weeding, etc.

Farming without tillage does no harm to the environment. Without tillage, the natural soil life will keep the soil loose and fertile by itself, which also greatly lightens the farmer's work, and reduces cost.

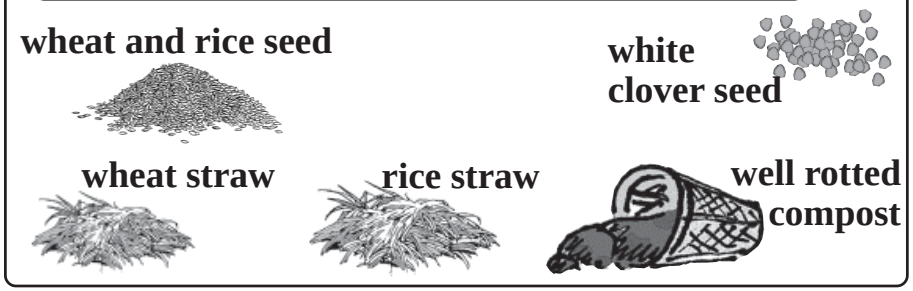
How to do No-Till Farming ?

There are examples of traditional no-till systems. One example is before cutting rice, lentils are sown and grown without ploughing.

In a good mulching system crops are grown without digging, and by using some green manures such as velvet bean, no-till systems have been developed. More information about these are given in the ***Mulching*** and ***Green Manures*** chapters.

In this chapter information is given about a no-till method of growing **rice** and **wheat**.

Materials Needed for No-Till Farming



This is the start of Fukuoka's method:-

① After harvesting summer rice, plough one last time.

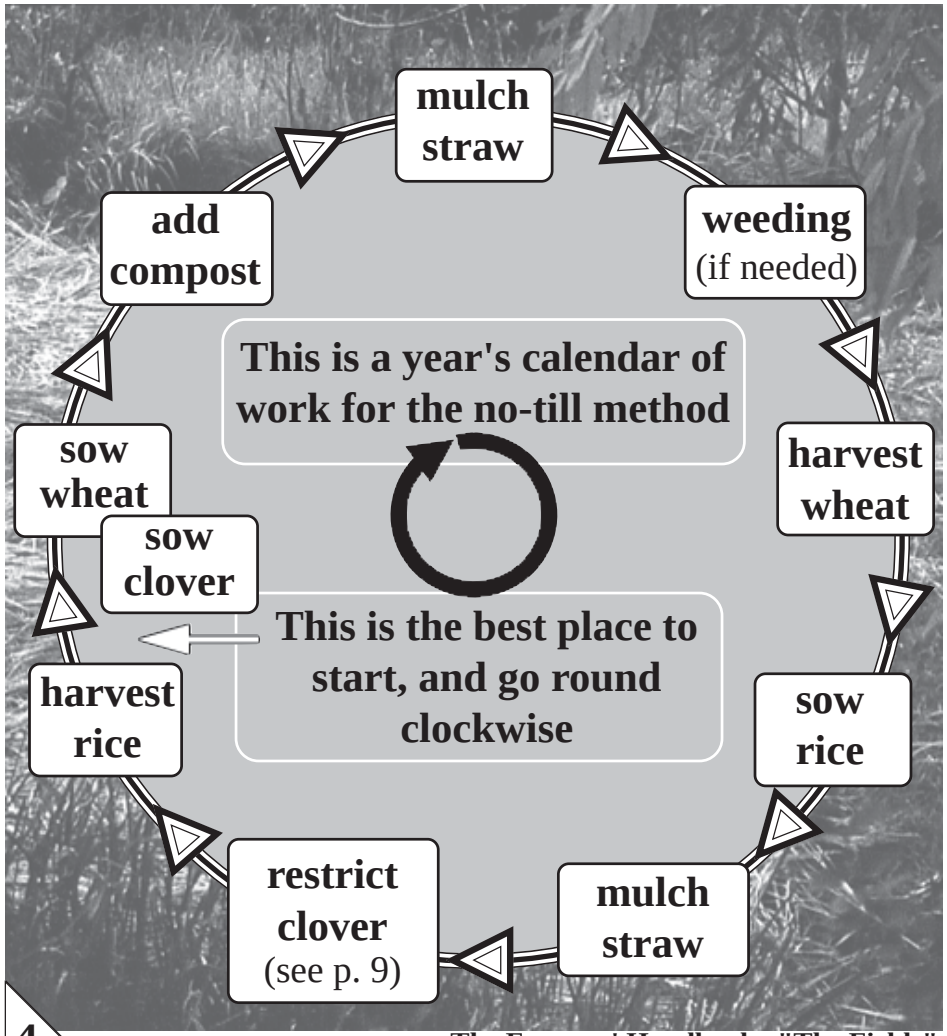
② Sow wheat seed.

③ Thickly sow clover seed.

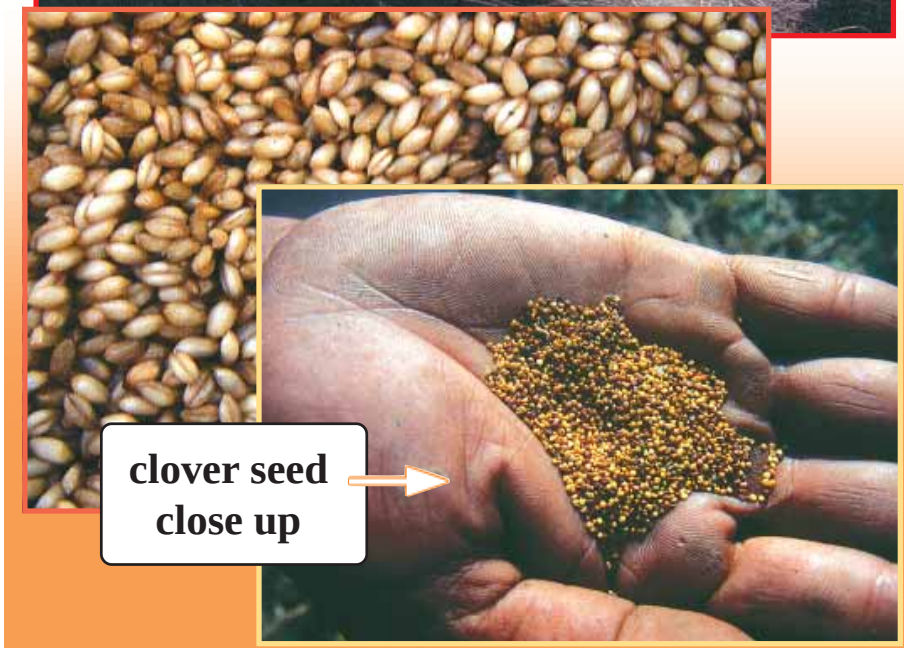
④ Mulch the wheat and clover with the straw from the rice crop.

In this way, the wheat and clover germinate together. Wheat grows up above the clover, and clover grows on the ground. Below the clover is the straw mulch.

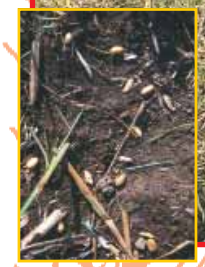
Clover works as a green manure. By covering the soil, it helps to smother weeds and conserve moisture. It also fixes nitrogen in the soil. Nitrogen made naturally like this does the same work as urea fertilizer.



Let's See how to do No-Till Farming



Sowing wheat



After wheat, sow clover

Spread a little compost

Cover everything with rice straw

Clover germinating in the wheat

This shows the wheat growing with clover underneath

Here the wheat is ripe and underneath the clover is green

After wheat is cut, sow rice and mulch with wheat straw

Close up of wheat and clover growing together.

After harvesting rice, the wheat is sown without ploughing.

Before sowing, soak wheat and rice seed and mix with powdered clay.

While mixing, spray with water

This makes a clay coat around the seed which protects it from birds. Another method is shown on p.10.

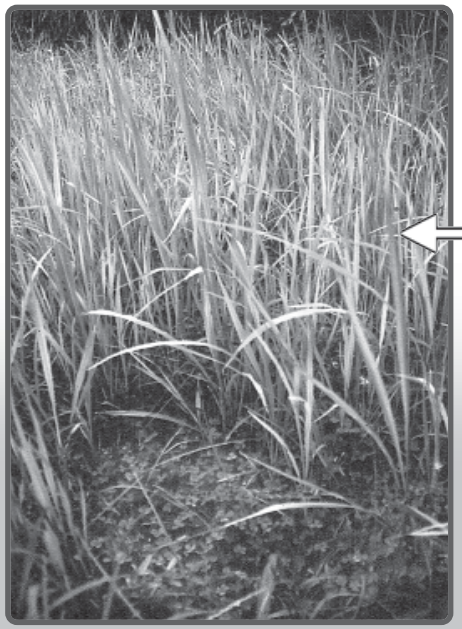
Maintenance

How to maintain a No-Till System

As the wheat ripens, any weeds should be removed. At first, more weeds will grow, but after the thick ground-cover of clover grows, and without tilling, weeds will reduce.

Sow rice after the wheat is harvested. As the rice grows, there is a danger that it will be smothered and prevented from growing by the thick ground cover of clover. There are 3 ways of preventing this :-

1. Flood the field for 10-12 days. This weakens the clover and the rice can grow through and above it. Then drain the water. The ground cover of clover will recover, and the rice will have grown away from its competition.



In the summer rice is flowering, while underneath clover is doing the weed control.

2. If there is a shortage of water as the rice is germinating, allow livestock to graze the clover. But only allow this once, for a short time, and then remove the livestock. They will eat down the clover, so the rice can grow up and away. The clover will again recover as the ground layer.
3. After sowing the rice, the clover can also be cut. It can be used as a fodder for livestock, or as a mulch. Then add the wheat straw mulch, and weed as necessary.

Another method of coating seed with clay. Here, clay is made into a thick paste, mixed with rice or wheat seed, and pressed through a 5mm seive.

Try your own research

There are many ways of working with nature to reduce work such as ploughing, weeding, etc. The most important thing is to understand the principles of the methods. Instead of wheat, barley or oats can be used. Timing will be different for different places and climates. It may be better to sow the rice before the wheat is cut, or sow wheat before rice is cut. This method may seem difficult at first, but this is no reason to give up. Try it out first on a small plot, and increase the area as experience grows.

Farmers' Experience

Mrs Sanumaiya Shrestha

Mrs Sanumaiya Shrestha lives at Sunrise Farm in Sita Paila-4, Kathmandu, Nepal. She has experience in no-till farming, so let's hear her story.

Mrs Sanumaiya Shrestha

" I really like the no till method. Wheat and clover are sown together and covered with the rice straw, which also helps to protect them from birds. Then, if there's no rain, we may need to irrigate. Rice is sown in just the same way, without having to raise the seedlings in a nursery. The day before sowing either rice or wheat, I soak the seeds to help them germinate quicker. As soon as rice is cut, I sow the wheat, and as soon as the wheat is cut, I sow the rice. Sometimes a little weeding may be needed, but not often. There's more weeds at the beginning, but much less later on. Now all the work of digging is saved. Before, we did all the digging and the yield was the same, and now we get the same yield without the digging. Doing less work to get the same yield must be a good method, isn't it? "

Read On !

Subjects Related to No-Till Farming

This book provides enough information for you to be able to try your own No-Till Farming. However, this information is also linked to other methods. For extra benefits let's read, learn and practice from other related chapters.

Agroforestry chapter

Only when there's a plentiful supply of fodder from the land can the straw from grain crops be used for mulch in a no-till method. In this chapter, read about how to integrate trees on farms .

Mulching chapter

Mulch keeps the soil covered, keeps weeds down and conserves water. This chapter shows how to mulch the soil while still growing other crops.

Green Manures chapter

By sowing green manures with crops, fertility is increased and with less work there are more benefits. Learn how in this chapter.

This booklet's author
Chris Evans, advisor,
Himalayan Permaculture Group, Nepal
www.designedvisions.com

Grihasthi Communications

What is Agroforestry ?

Trees with fields in between: plentiful, secure productivity

Agroforestry is a sysem where farm crops are mixed with trees to supply fodder, fuel, leaf litter, medicinal herbs, fruit, timber, etc.

Conventionally, farmers have only grown a single crop on one field. Also, there is a belief that crops cannot grow well in the shade of nearby trees, so trees will often be cleared from cropland. In the days when there was plenty of forest near to the village, there was no shortage of fuel, fodder, etc. But now, overcutting of fodder, firewood, timber, etc., and grazing live-stock, has destroyed the forests. So farm yields have become lower and lower. More landslides have been an extra problem. By planting agroforestry, farm needs for fodder, timber, fuel, etc. can be met as well as protecting the environment.

In this chapter, information is given on how to establish agroforestry, and how to manage it to increase farm yield.

Why do Agroforestry ?

Benefits from Agroforestry

- By planting agroforestry, yields of fodder, firewood, timber, fruit, herbs, etc. can be increased.

- Livestock needs are met more easily.
- The farm economy is stronger.
- Because daily needs of fodder, fuel, leaf litter, etc. are met from the land, the forest is used less, and so is conserved.
- Tree roots prevent soil from being washed away. Trees' leaves provide organic matter for soil organisms. This increases the fertility in the soil, and so trees have more nutrients to grow. Trees protect the soil, and the soil gives nutrients to the trees. This cycle works to protect soil life and natural fertility.

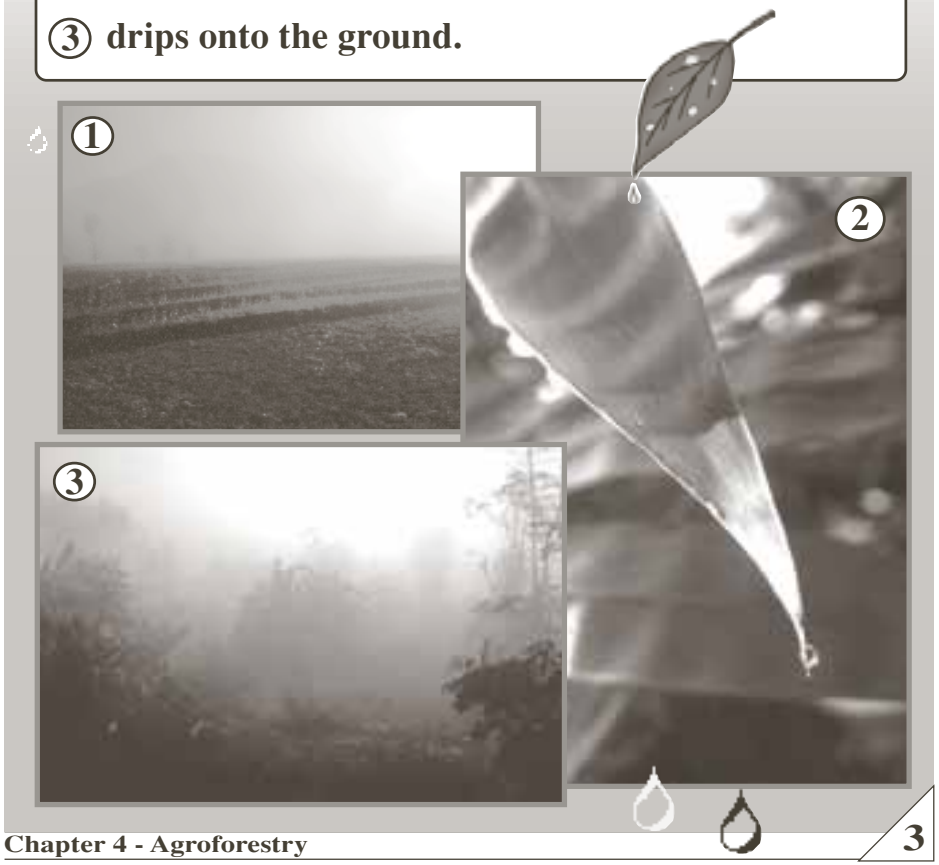
Agroforestry helps to make the homestead self reliant

- Trees protect the soil from the harmful effects of strong sun, wind and heavy rain, and conserve moisture in the soil.
- By producing daily needs of fodder, fuel, timber, etc. on the farm, less time is spent going to the forest.
- When agroforestry is on your own land then timber, fruit, herbal medicines, firewood, fodder, etc. don't need to be purchased. Livestock are also easier to raise for income, and overall the home economy is strengthened.

① With no trees, moisture in the air blows away.

② When trees are on the land, the moisture collects on the leaves, and

③ drips onto the ground.

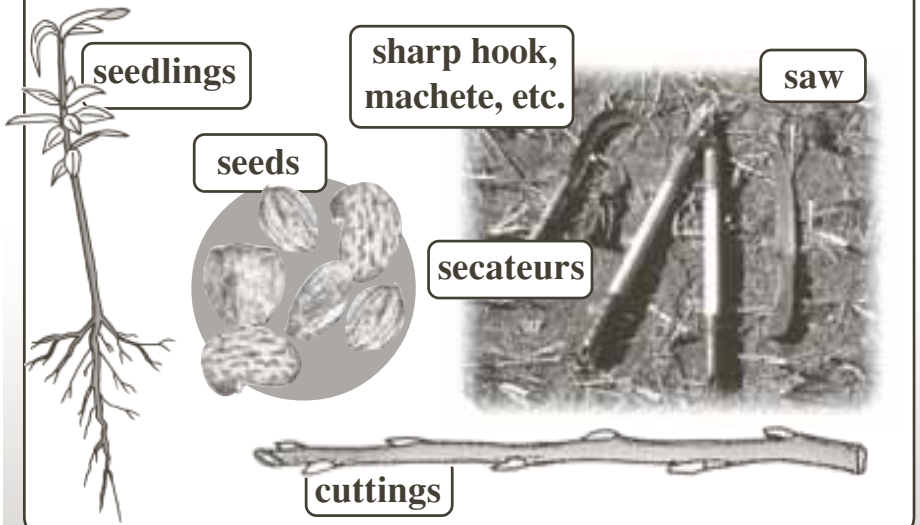


How to do Agroforestry ?

Where to grow Agroforestry ?

- on terrace risers and edges
- on the edges of fields and farm boundaries
- on the edges of paths
- according to the shape of the landscape

Materials Needed for Agroforestry



This Chapter's Authors :

Ms Hommaya Gurung

Mr Buvan Khadka

Himalayan Permaculture Group, Surkhet, Nepal

What type of tree to plant in agroforestry ?

Multi-purpose trees which give many benefits such as fodder, timber, firewood, medicine, bee forage, fruit, etc.

Trees with small leaves that don't overshade the land, e.g. *Lucaena, Flemengia, Acacia.*

Trees which drop their leaves in winter, e.g. mulberry, *Melia.*

Trees which don't compete with ground crops.

Trees which can be pruned to a desired shape, e.g. mulberry, *Lucaena, Bauhinia,* peach, plum.

Trees which have deep roots that aren't damaged by ploughing, e.g most legumes, *Melia.*

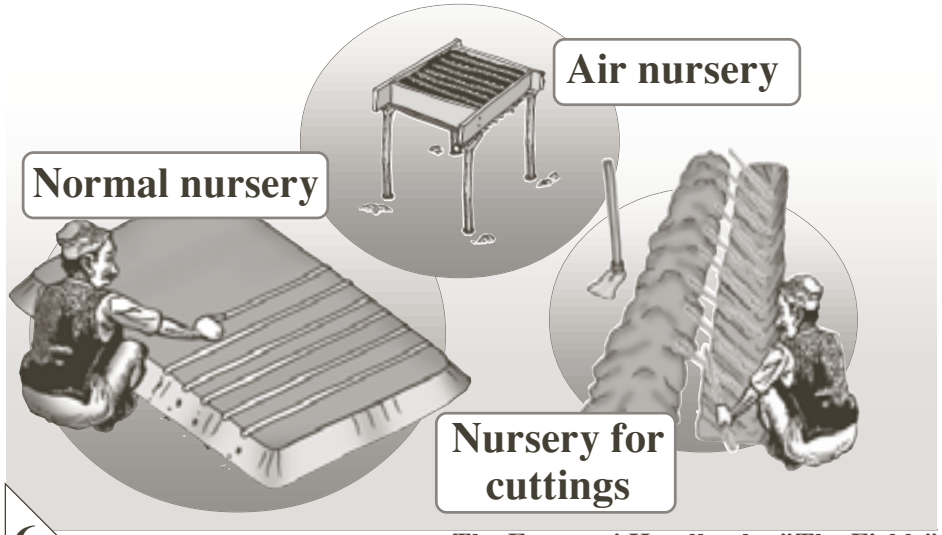
Plants which are good, nutritious fodder for livestock, e.g. napier grasss, most legumes, lemon grass, etc.

Nitrogen-fixing trees which increase nitrogen in the soil.

How are plants established in Agroforestry ?

- By planting **cuttings**, e.g. mulberry, napier grass, sugar cane, some *Ficus*;
- By raising **seedlings** in **nurseries**, eg. coffee, *Melia*, peach, etc. Trees with fast growing tap roots, such as *lucaena, bauhinia* (most legumes), tree cotton, papaya, walnut etc. are best raised in an **Air nursery.** For more information about this, see the chapter ***Air Nursery*.**
- By planting **root slips**, e.g. broom grass, cardamon, lemon grass, comfrey, vetiver grass, etc.;
- protecting seedlings naturally regenerated on the land;
- By **air layering**, e.g. orange, pomegranite, guava;
- By **direct sowing**, e.g. sunhemp, *Sesbania*.

It is easy to grow many of the useful, good quality and multi-purpose plants needed for agroforestry by yourselves, on your own farm. Once you've decided the types of plant needed, the seeds or cuttings need collecting at the right time. Then they can be raised in the appropriate nursery, at home.



Design of Agroforestry Systems

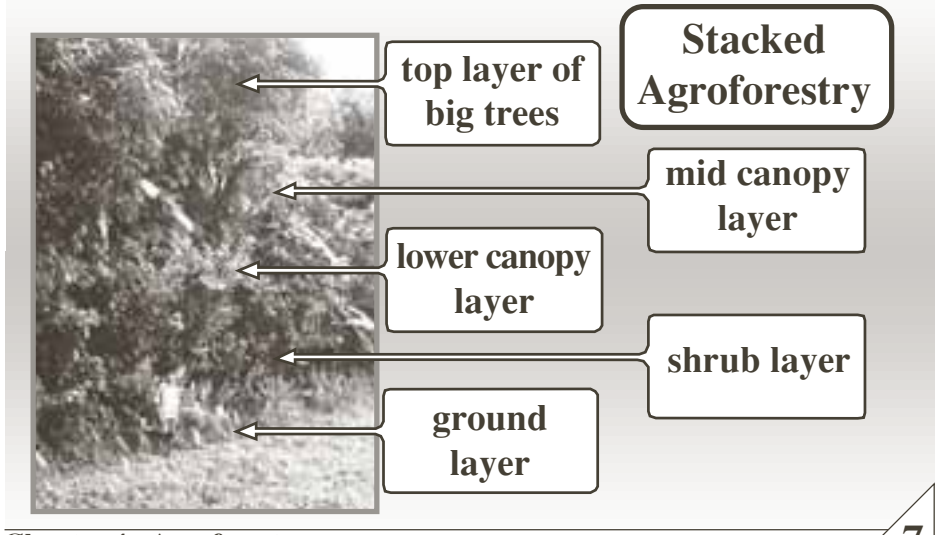
The following principles need to be applied when planning and establishing a farm or a community agroforestry system.

- **Diversity**

  Just as there are many types and sizes of tree and shrub mixed in a forest, so our agroforestry should also be made up of a wide range of species, to make them sustainably most productive.

- **Layers *(stacking)***

  In the forest, all plants are different. Some are small, some tall, some middle sized - this is called **stacking**. A stacked system means that more productive plants can fit into a smaller space without competing. For example, in the ground layer, pineapple and lemon grass can be grown. Above them, napier grass, sugar cane and coffee can grow. Above them, *Lucaena*, mullberry and tree cotton can grow. Even higher still, papaya, pear and peach can be grow. Highest of all, *Melia, Dalbergia*, Neem, and other timber trees can grow. They will also serve as a useful windbreak.

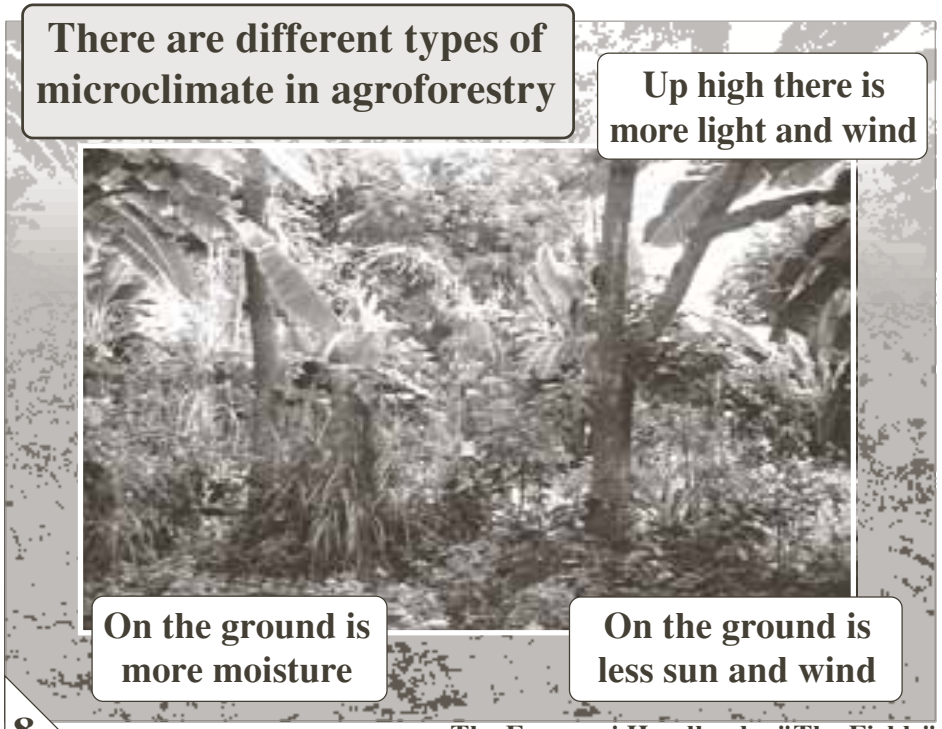


• Beneficial Relationships

It is important to consider the relationship between the species in different layers of agroforestry, and the field crops. Without a good relationship between the field crops and the tree systems, some crops may not grow well, such as in the shade. Then, companion plants can be used. For example, mustard and maize do not grow well close to tree crops. But taro, cardamon, ginger and tumeric do grow well, and they can tolerate both the trees and field crops. So by planting the companion crop in between, the best yields from all can be assured, without competition and drop in yield.

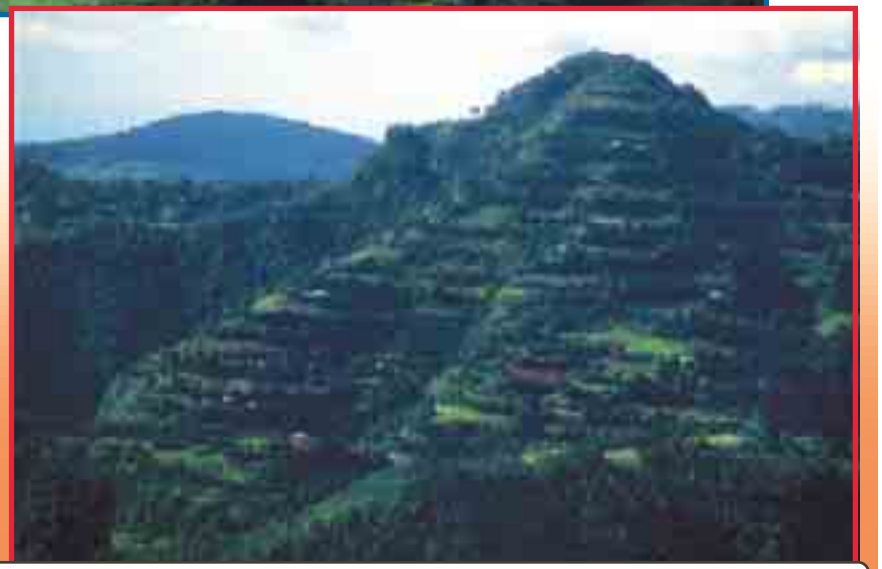
• Microclimate

The climate inside and around the agroforestry system is different to the surrounding climate. There are areas of different moisture, temperature, and light levels. These are called **microclimates.** Species need selecting according to their need.

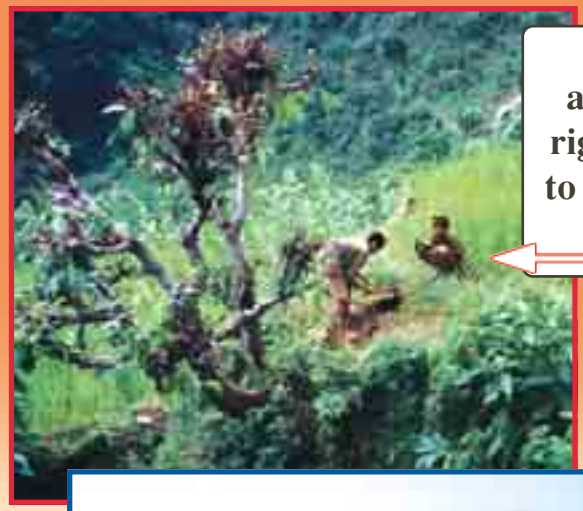


Let's See how to do Agroforestry

Areas with agroforestry and forest are productive, protected in a sustainable way.

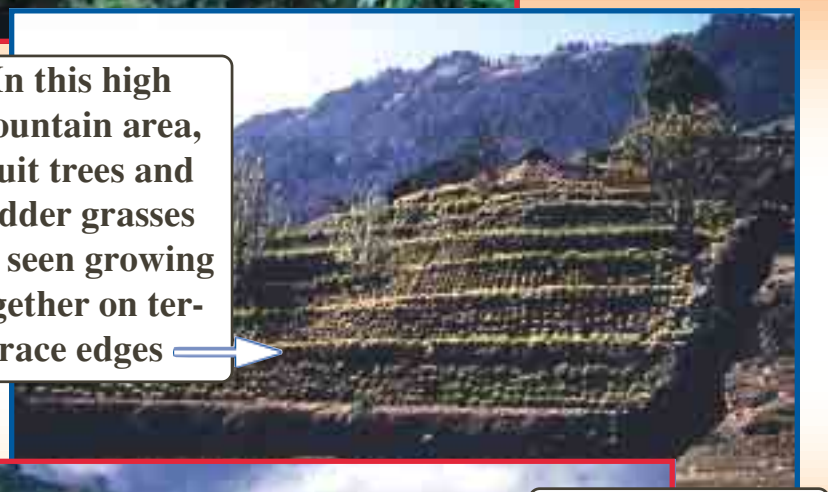


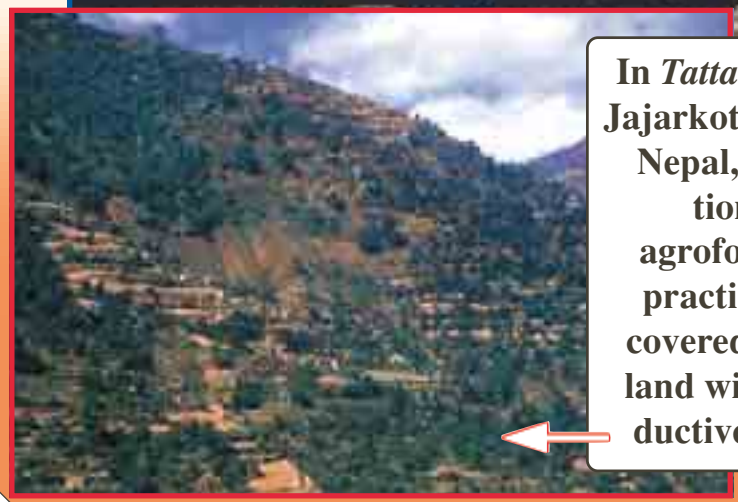
On steep slopes, farming with the plough is difficult. But with agroforestry on the terrace edges, the risk of erosion is less, and extra benefits of fodder, fuel, timber, etc. can be produced close to the village.



When starting agroforestry, the right species needs to be planted in the right place

In this high mountain area, fruit trees and fodder grasses are seen growing together on terrace edges





In *Tatta* village, Jajarkot district, Nepal, traditional agroforestry practice has covered farmland with productive trees.

By planting tumeric between trees and crops, competition is reduced.

By digging a ditch between lines of trees and crops, the tree roots are cut. This also stops the trees competing with the crops

The ditch is also used for irrigation and collecting leaf biomass

A 2 year old agroforestry, showing "stacking" of different species

People say that crops can't grow in the shade of trees, but here the wheat is growing well !

The same land a year later

Competition between the trees and maize is seen here. The solution to this problem is given on pages 11 and 21.

This picture shows various types of small and large trees and shrubs planted together

The branches of *Dalbergia* are being pruned to produce good timber.

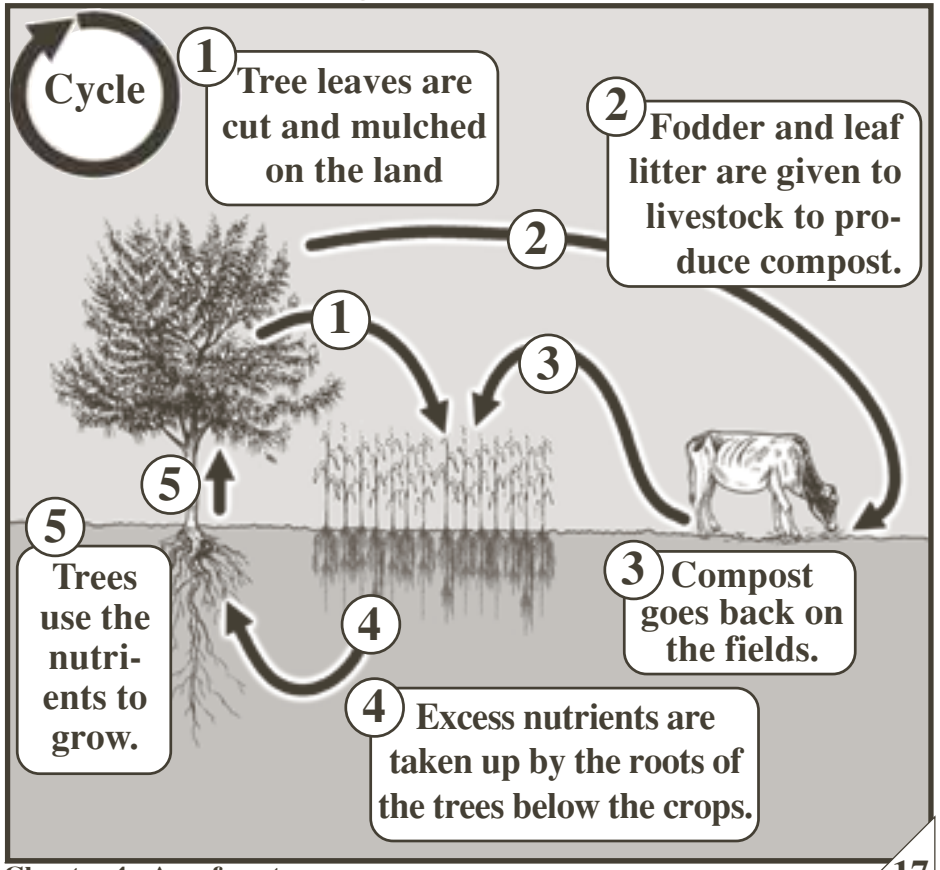
A third of the trees' top branches are left, and the remaining are pruned.

Lots of fire-wood can be produced on your own land by agroforestry

Plenty of fod-der and litter can also be pro-duced at home. This saves much time and labour.

- **Cycling**

The benefits of extra production and soil improvement from agroforestry are the result of cycling. This cycle needs to run continuously. Livestock are fed and bedded with fodder, straw, etc. from the agroforestry, and compost is returned to the fields. Leaf biomass can also be cut and mulched directly to the land. Work like this should be done regularly. If the cycle isn't completed, the trees will use all the moisture and fertility, and the soil will become depleted of nutrients for the crops. As a result, crop production can decrease, and farmers will lose out. So to manage agroforestry sustainably and productively, it is essential to run this cycle.



Maintenance

How to maintain Agroforestry

Management after establishing agroforestry

To manage agroforestry, the trees and shrubs should be cut from time to time. Any dead or useless branches and trunks should be cut and removed for use. So, management of agroforestry is mainly **harvesting** of products. Collection of fodder, leaf litter, firewood, etc. is beneficial to the trees, as well as to the annual crops. If this work isn't done in the right way, the agroforestry system will not help to increase production and benefit the land. So it is very important to manage agroforestry in the right way.

Agroforestry planted on terrace edges provides nearby fodder. The fodder can be fed to livestock or mulched directly on the land.

Timing of pruning in agroforestry

(a) Winter **(b) Summer**

Deciduous trees, which drop all their leaves at one time, are best pruned over winter. Evergreen trees are best pruned in the summer. Some of these can be pruned twice a year. In the winter, crops need more sun, and in the summer they need good air movement. So many trees and shrubs, especially those which cause more shade, should be pruned at these times so they provide production as well as to provide good conditions for the annual crops, based on their needs, and the needs of the tree crops.

Things to consider when pruning

- Use sharp tools;
- Don't split the bark;
- Try not to leave wounds on the sunny side of trees;
- Prune small branches and deformed trunks of timber trees;
- Prune fodder and biomass plants low down in the winter, and higher up in the summer.

Management for mulch and leaf litter

The leaves of *Adhatora, Melia*, castor, etc. make excellent mulch. Such trees and shrubs can be cut at least twice a year. Depending on the trees and crops around, they can be cut low down, or higher up. The plants should be able to sprout again after cutting.

Here *Lucaena* planted in agroforestry is cut and the leaves mulched directly on the land.

Fodder grass management

Fodder grasses planted or regenerated in the agroforestry should be cut to feed livestock, or mulched directly on the land. This should be done in a way which doesn't harm the crops.

Fodder tree management

Fodder trees should not be allowed to grow straight up. They are managed by cutting once or twice a year to produce maximum biomass. They should be cut according to the season to provide shade or sun, according to the needs of the field crops. They can be fed to livestock, or mulched directly on the land.

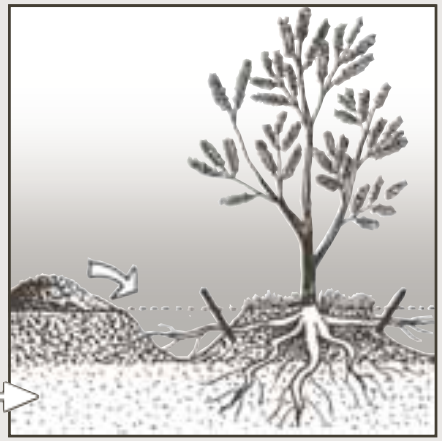
Management for firewood

Trees grown for fruit, timber, biomass or fodder will also provide firewood when they are pruned. Dead, diseased or damaged trees and branches should be regularly removed and can be used for firewood.

Timber management

Trees planted for timber should be allowed to grow up straight. The top one third of the tree should be left uncut, while the lower two thirds pruned of all side branches. The pruning should clean, otherwise disease can enter the wounds. When large branches are cut, plaster the wounds with fresh cow dung. Pruning can take place once or twice a year.

This diagram shows a method to control the growth of tree roots. By digging a trench along the line of trees, the roots are prevented from competing with crops. See also the picture on p.11.



Farmers' Experience

Mrs Belmaya Rana

From Nepal, Surkhet district, Gumi - 3, Ratadada village, and a member of "Hariyali" women's group Mrs Belmaya Rana has done agroforestry on her own land. Now let's hear about her experience.

Mrs Belmaya Rana

"At first we had hard times without the knowledge of agroforestry. We had to go far for fodder and firewood. This wasted a lot of time. I learned about agroforestry from the Homestead Programme (JPP) and designed my land. I've planted mulberry, *Lucaena, Bauhinia,* fruit trees, chillies and lots of other plants. In all, there are 56 species of useful trees and shrubs in my agroforestry system. The trees are all arranged in layers, all species are mixed up together. Before, 60kg of the mustard I grew was used to trade for chillies. Now I grow enough of both and have extra of both to trade. Now I have time to cut fodder as well as doing the housework. There's enough fodder on my own land for my 4 goats and 4 cows. I grow enough fruit for the family, and sell extra for cash. The trees don't affect the rice, but it did affect the mustard and maize, so I planted taro, ginger and tumeric against the trees in some parts, and dug trenches to cut the tree roots in others. "

Read On !

Subjects Related to Agroforestry

This chapter provides enough information for you to be able to grow your own agroforestry system at home. However, this information is also linked to other methods. For extra benefits let's read, learn and practice from other related chapters.

Nutrition chapter
Nutritious plants can also be grown in agroforestry

Improved Stove chapter
Agroforestry produces nearby fuel for the stove

Home Nursery chapter
Plants for agroforestry can be produced easily at home

Seed Saving chapter
How to produce various types of good quality seed at home

Fruit production chapters
Easy methods of producing, planting and managing fruit trees

Forest Management chapter
Forest is protected by using agroforestry to supply farm needs

Integrated Pest Management chapter
Grow plants in agroforestry which help in pest control

Mulching chapter
Produce plenty of biomass for mulching to conserve soil

Liquid Manure chapter
Grow plants to make liquid manure to control farm pests

Compost chapter
Nearby fodder and biomass makes making compost easier

Living Fence chapter
A living fence is agroforestry on the farm boundary

Kitchen Garden chapter
Agroforestry helps protect and supply the kitchen garden

Beekeeping chapter
Many plants for bee food can be grown in agroforestry

Livestock management chapter
Agroforestry crops make keeping livestock much easier

What is an Integrated Orchard ?

Kamal Pun (right) and his orchard, Jajarkot

An orchard is a planted and managed area of fruit trees. A well managed orchard will give benefits to people's health, their income, and the environment. There are ways of improving an orchard with small inputs which can greatly increase its productivity. To get more benefits, the orchard should be managed in a sustainable way. To get more production and easy maintenance, the orchard should be like a forest. The orchard can be rich, fertile and sustainable, just like a forest. One of the forest's qualities is its diversity. So our orchards should also contain a great variety of plants, and then they can be more productive and sustainable, like the forest.

So, an **integrated orchard** is a diverse mix of fruit and multi-purpose plants growing together. In this chapter,we show how to design and manage an integrated orchard for quick and sustainable production.

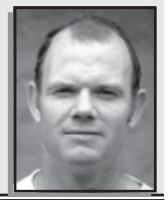
Why make an Integrated Orchard ?

Benefits of the Integrated Orchard

- Other trees can be planted in between the fruit trees;
- These other trees can provide fodder, fuel, timber, medicines, nectar, vegetables and other useful products;
- More production from less land;
- Soil and water conservation;
- Degraded land can be regenerated;
- Pests and diseases are more easily and cheaply controlled;
- Farm production increases annually;
- There's a quick return on investment;
- As well as cash income, the integrated orchard also provides many basic resources for other farming systems.

Conventional farming education usually recommends an orchard of one variety. In a mango orchard, there are only mango trees, and in an apple orchard, only apple trees. Planting in this way leaves much wasted space in between the trees, and much work goes into maintaining these empty spaces. But if the spaces are ploughed to grow annual crops, then the fruit trees' roots may be damaged and production will be lower. So the answer is to plant perennial crops of useful trees and shrubs in between the fruit trees.

This booklet's author
Chris Evans, advisor,
Himalayan Permaculture Group, Nepal
www.designedvisions.com

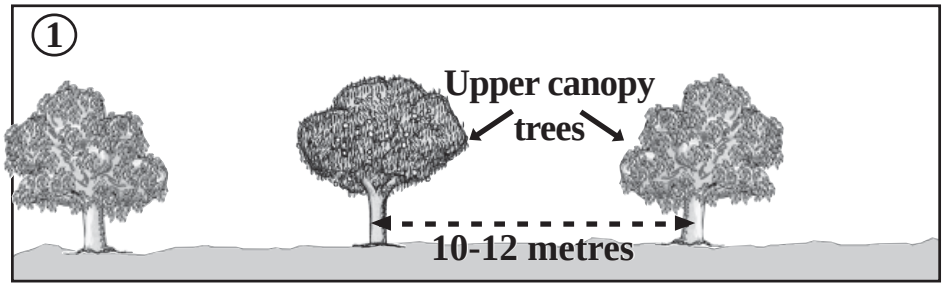


How to make an Integrated Orchard ?

Species' selection and planting design

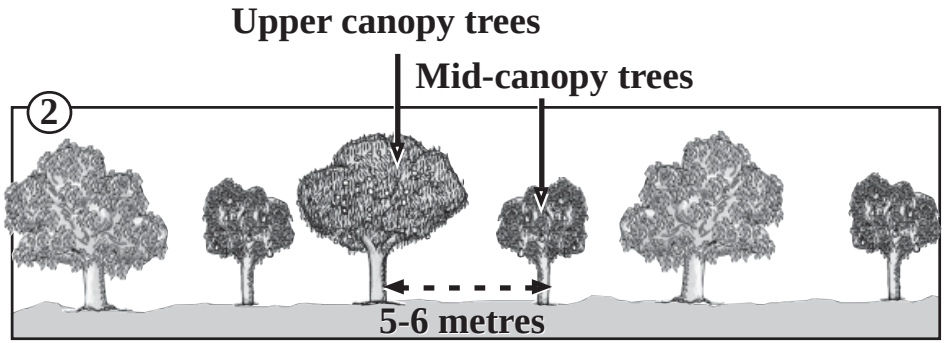
Good quality species should be chosen for the orchard. Species should be appropriate for the climate and landscape. The size of the different plants when they are mature should also be considered. According to size, 4 or 5 layers of trees and shrubs can be recognised :-

① **Upper canopy trees** :- these are the biggest trees, and usually take the longest time to produce fruit. They are also usually the longest lived. Fruit trees in this group include mango, jackfruit, avocado, walnut, chestnut, butternut, pecan, etc. Multi-purpose trees include soapnut, neem, toon, mauwa, etc. These trees should be planted 10-12 metres apart.



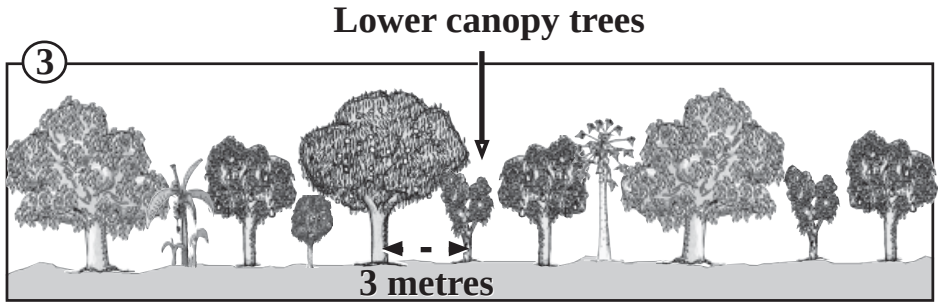
But planting trees at this spacing leaves 10-12 metres of space in between, which is wasted if nothing else is planted. Farming tilled crops may damage the trees when they are ploughed. So it is best to plant smaller trees in between.

② **Mid-canopy trees :-** apple, pear, peach, plum, apricot, persimon, cherry, etc. can be seen as mid-canopy trees. They can be planted 5-6 metres apart, in between the upper canopy trees. They will fruit sooner than the bigger trees, and usually do not live so long.



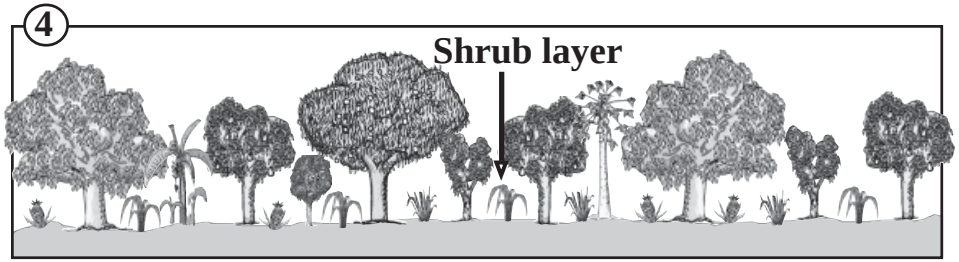
But even planted like this, 5-6 metres of lend is left empty. Other trees can still be planted in between.

③ **Lower canopy trees :-** orange, lemon, banana, custard apple, sea buckthorn, coffee, papaya, mulberry, etc. are small trees. They can be planted in between, 3 metres apart.

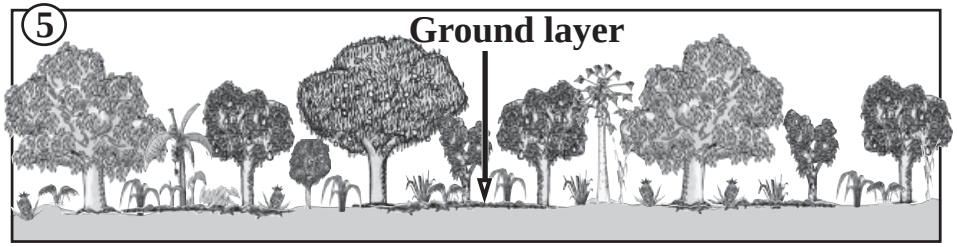


But even 3 metres is a lot of empty space. Even smaller shrubs can be planted in between.

④ **Shrub layer :-** After the smaller trees, shrubs like pineapple, cardamon, napier grass, lemon grass, blackcurrant, gooseberry, etc. have their turn. They can be planted 1-1.5 metres apart. They are fast to produce, and only live a few years.



⑤ **Ground layer :-** finally, as a ground cover to increase productivity even more, various types of sweet potato, taro, beans, peanuts, clover, comfrey, ginger, tumeric, etc. can be planted. Wild plants like wormwood and nettle can also be encouraged. They help to make the soil fertile. But the groundcover plants may need controlling if they harm the young trees. When the trees are bigger, climbing plants such as grapes, passion fruit, jasmine, yam, pepper and rattan can be planted. But these should not be allowed to climb on the fruit trees, or they will reduce the trees' fruiting ability.

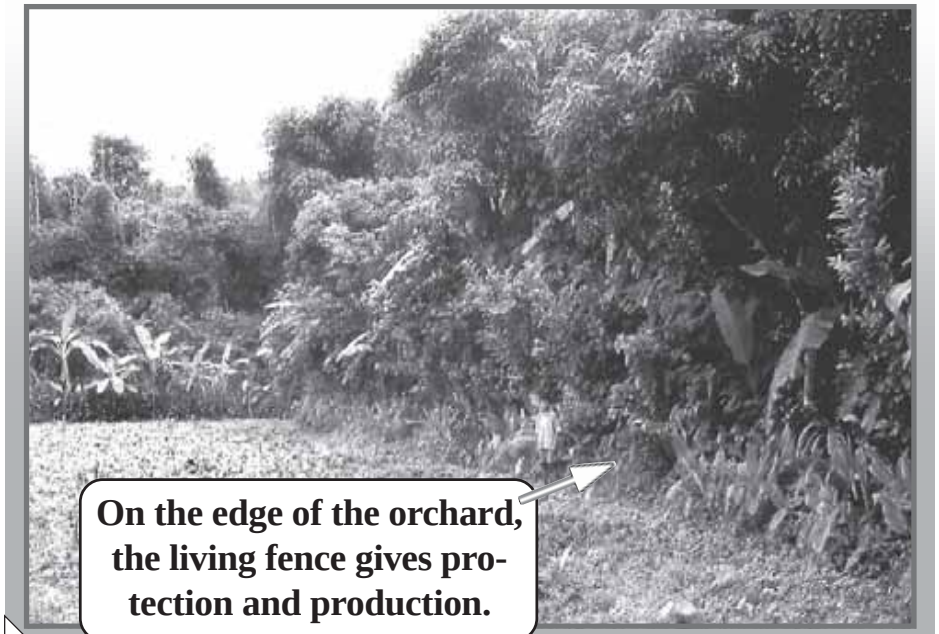


Note :- These pictures show how small and large trees and shrubs can be designed into the integrated orchard. When establishing the orchard, plants can either be planted all at the same time, or gradually, as time and labour allow.

Protecting the orchard

The orchard needs fencing to protect against livestock. Temporarily, thorny branches such as *Acacia*, blackthorn, wild blackberry, sea buckthorn, etc. can be cut and made into a fence. A **living fence** of planted trees and shrubs gives other benefits, and is a more productive and longer-term way of protecting the orchard.

A living fence, or hedge, can be made of thorny species such as cactus, sisal, wild pear, hawthorn, some of the *Acacias*, *Prosopis*, sea buckthorn, honey locust, etc. Some can form a fence within 2-3 years, and give other products, too. Fodder, firewood, fruit, medicines, nectar, etc. can all be gathered from the fence. After several years, even timber for construction can be produced. The chapter ***Living Fence*** gives more information about this.



On the edge of the orchard, the living fence gives protection and production.

Let's See how to make an Integrated Orchard

The integrated orchard looks like a forest, but the trees and shrubs have more use.

Farmers visit to learn the methods

Above is fruit, below ginger, tumeric, pineapple, etc. all producing benefits

On big trees, vine plants such as pepper, betel, grape and passion fruit can climb up.

Marigolds are seen planted in the ground layer. These were planted to help with pest control, and now self-seed.

No space is empty in the integrated orchard

Maintenance

How to maintain an Integrated Orchard

For an integrated orchard planted in this way, maintenance is mainly harvesting. The succession of production from the orchard is described below.

1st year :- sugar cane, various vegetables, fodder grass from weeding.

2nd year :- the above, plus banana, cardamon, ginger, tumeric, broom grass, currants, etc. start producing.

3rd year :- all the above, plus pineapple, coffee, papaya, sea buckthorn, etc. start to produce.

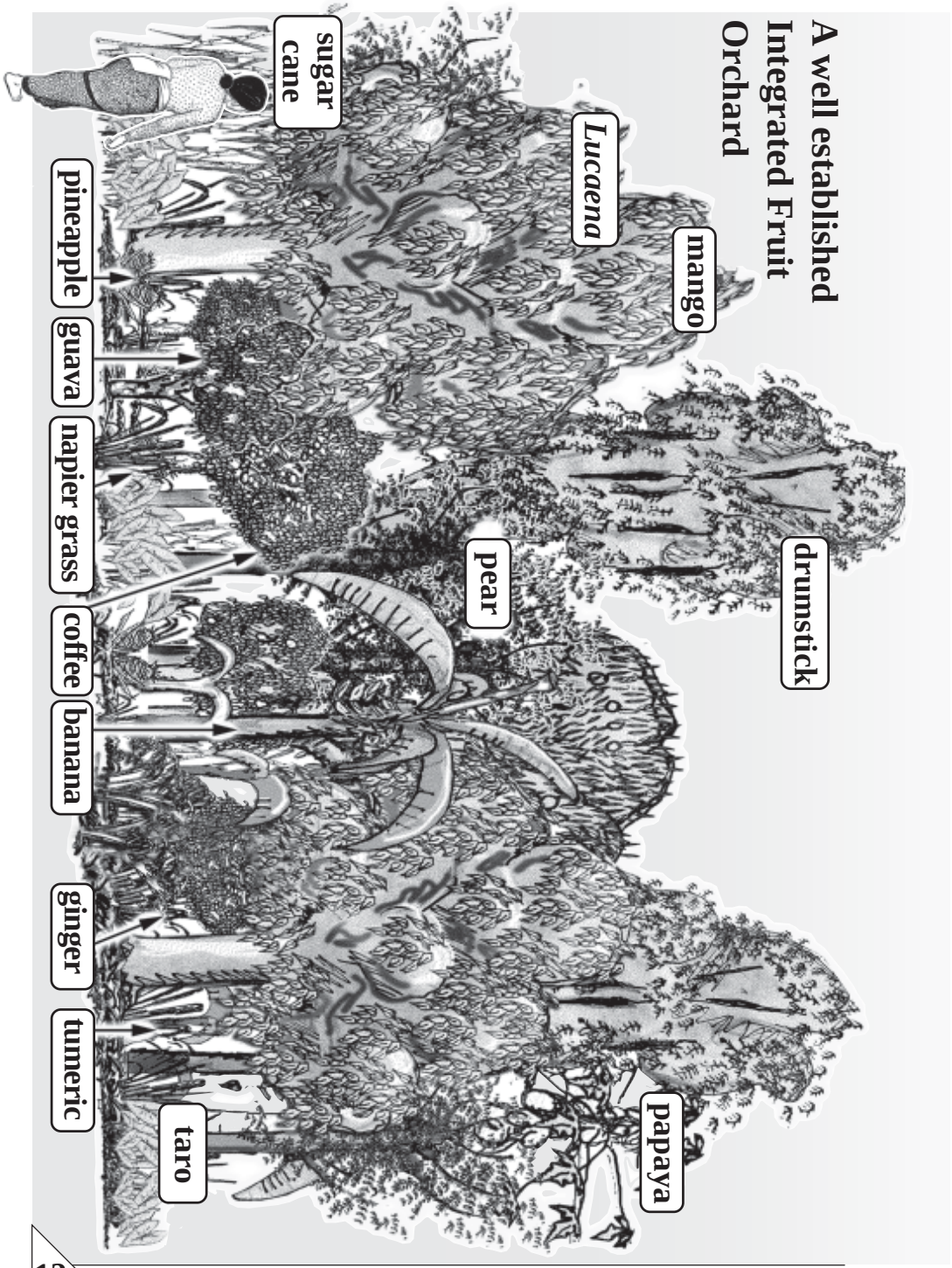
4th year :- all the above, plus grafted apple, peach, plum, apricot, pear, orange, etc. start to produce.

5th year :- all the above, plus grafted mango, walnut, lychee, chestnut, etc. start to bear fruit.

Trees that have grown from seed will produce fruit more slowly, such as soapnut, butternut, hazel, etc. They will start to produce fruit after 8-10 years.

Not just fruit trees

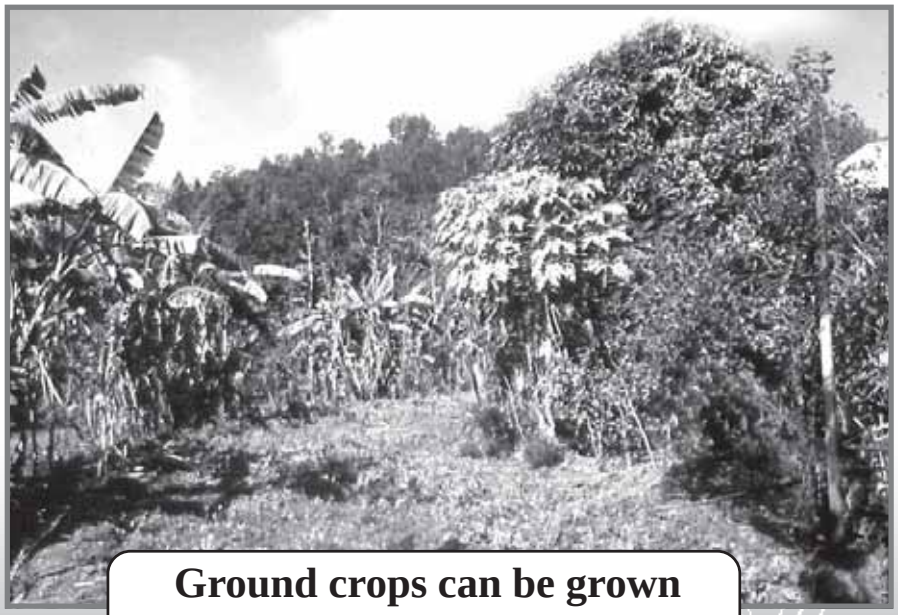
All the above species produce fruit. But once the shape and size of the tree is understood, any type of useful and multi-purpose tree or shrub can be fitted into any of the layers. Plants for fodder, timber, herbal medicines, fibre, etc. can be added to provide their particular type of benefit, according to the land and the needs of the farmer or community.



Tillage in the orchard

If annual crops are needed to be grown between the fruit and multi-purpose trees, the trees can be planted in lines spaced wider apart, as in the photo below. This is the same basic design as for an **agroforestry** system. Terrace improvement is also a result. But you should not plough near the roots of the fruit trees.

When the trees are bigger, livestock can be grazed in the area from time to time. Because the integrated orchard is made up of many layers of multi-purpose trees, there is a high production from a small space. By planting in this way, production will gradually increase as time goes on.



Ground crops can be grown between the lines of trees and shrubs of the integrated orchard. There are more than 50 species of plants in this picture.

Farmers' Experience

Mr Kamal Pun

From Jajarkot district, Dandagaun - 3, Kalpat village in Nepal, Mr Kamal Pun has planted an integrated orchard on his own land. Now let's read about his experiences.

Kamal Pun

"Since I took training in how to make an integrated orchard, I've been making my own orchard at home. My land is steep and dry, and was a bare grazing area for everyone's cattle. I made a design and began planting seedlings by layer. Now, I have mango, banana, orange, papaya, grapefruit, coffee, peach, plum, apricot, lychee and many more. On the ground are pineapple, napier grass, lemon grass, and others. I have grain crops and fruit, and both produce well. I also grow seedlings for sale. I keep livestock, and there's enough fodder from the orchard to feed them from the many types of local fodder trees that are planted there. Before, there was no production from this bare slope. But last year I earned almost $1000 from my farm. I've been able to pay off all my loans, buy cloth, medicine, etc., and still have some left to invest. Now I want to buy another piece of land with the income. This orchard has been seen by many local farmers as a model. I've been teaching them how it's done - they come from many villages in the district."

Read On !

Subjects Related to the Integrated Orchard

This book provides enough information for you to be able to design and maintain your own integrated orchard. However, this information is also linked to other methods. For extra benefits let's read, learn and practice from other related chapters.

Five Chapters on how to make various Nurseries

For planting a variety of plants in an integrated orchard, different types of nursery are needed to grow them. Information on how to build and manage the home nursery, fruit nursery, air nursery, hot bed and leaf pots is given in these chapters.

Grafting, Budding, Stone Grafting, Top Grafting & Air Layering chapters

Information about various easy methods to grow tasty and good-yielding fruit varieties at home for planting on the farm are given in these chapters.

Fruit Tree Planting chapter

After raising good seedlings in the fruit nursery, if they're not planted well all the work can go to waste. Information on more productive planting is given in this chapter.

Agroforestry chapter

Planting trees on farmland can bring farmers many benefits. But you can't plant any type of tree, nor anywhere. This chapter gives information on how to plant trees without affecting farm yield.

A-frame chapter

An easy method of mapping out contours for soil and water conservation on sloping land is descibed in this chapter.

Fruit Nursery chapter

How to grow root stock from local wild fruit seed for grafting and budding apple, peach, plum, apricot, walnut, etc. on your own land.

Living Fence chapter

The orchard also needs a fence. By planting a fence made of trees, the production from the orchard can be increased even more. This chapter gives information about making and managing a living fence.

What is Fruit Tree Planting ?

Comfrey and garlic as companion plants under a young apple tree

Fruit is a store of goodness. It is juicy, tasty and nutritious, and it holds vitamins essential for our health and well being. So it's our duty to plant fruit trees. All over the world people have planted fruit trees, since early times. Even if people have only a small piece of land they show interest in planting fruit trees. But if you don't have the skills and knowledge to plant and care for fruit trees they can die, or at best be less productive. So all the effort that went into acquiring and planting fruit trees goes to waste.

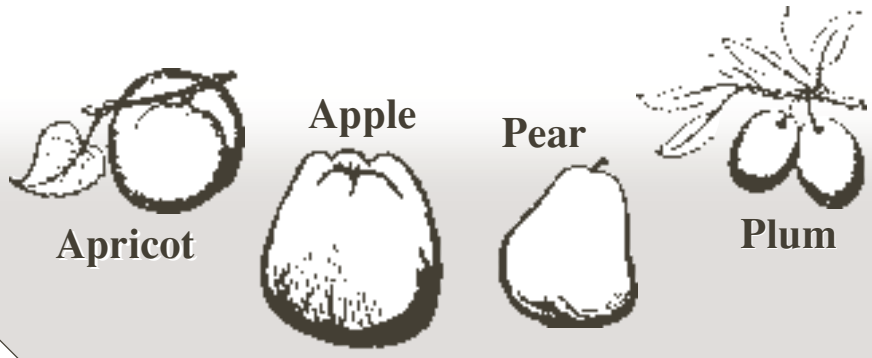
In this book we can learn about how to plant and maintain fruit trees to get the best production using local resources and with minimum work.

Why plant fruit trees ?

There are many types of benefit from fruit, for example:-

- it is tasty and nutritious;
- if you eat fruit after a meal the food is easier for the body to digest;
- fruit is like wealth which you can sell or exchange;
- after you plant a fruit tree it only requires a small amount of maintenance, and will last for many years (it is perennial);
- because they are perennial, fruit trees help to protect the soil and the environment.
- fruit trees give nectar to bees, give firewood from pruning, habitat for birds and wildlife, and many other benefits.

In order to get these benefits, the first important thing is to plant the fruit tree well. Only then will fruit trees give their benefits to people and the community.



How to plant fruit trees ?

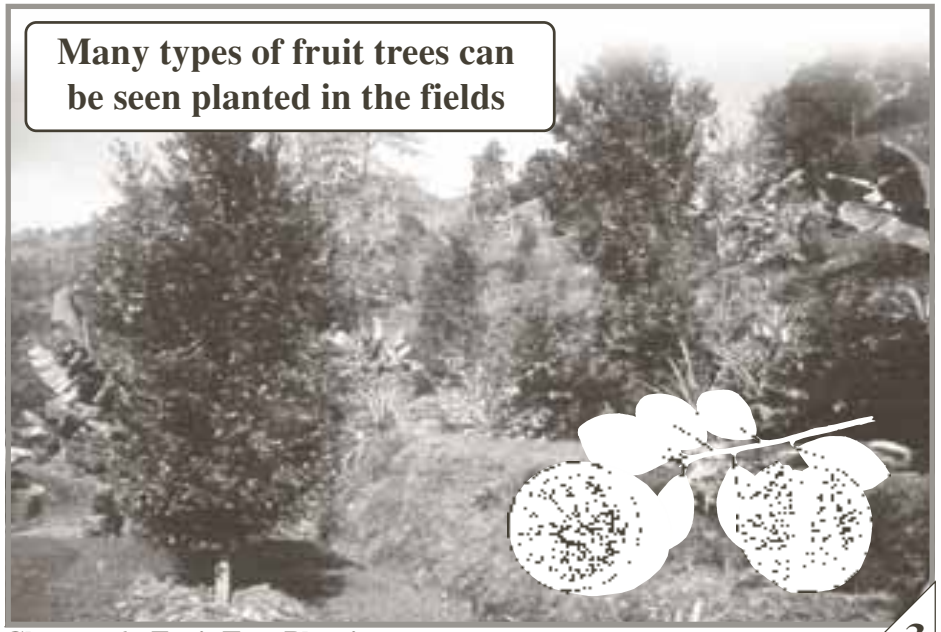
Choosing the right places to plant fruit trees

When selecting where to plant a fruit tree, you need to consider the following needs:

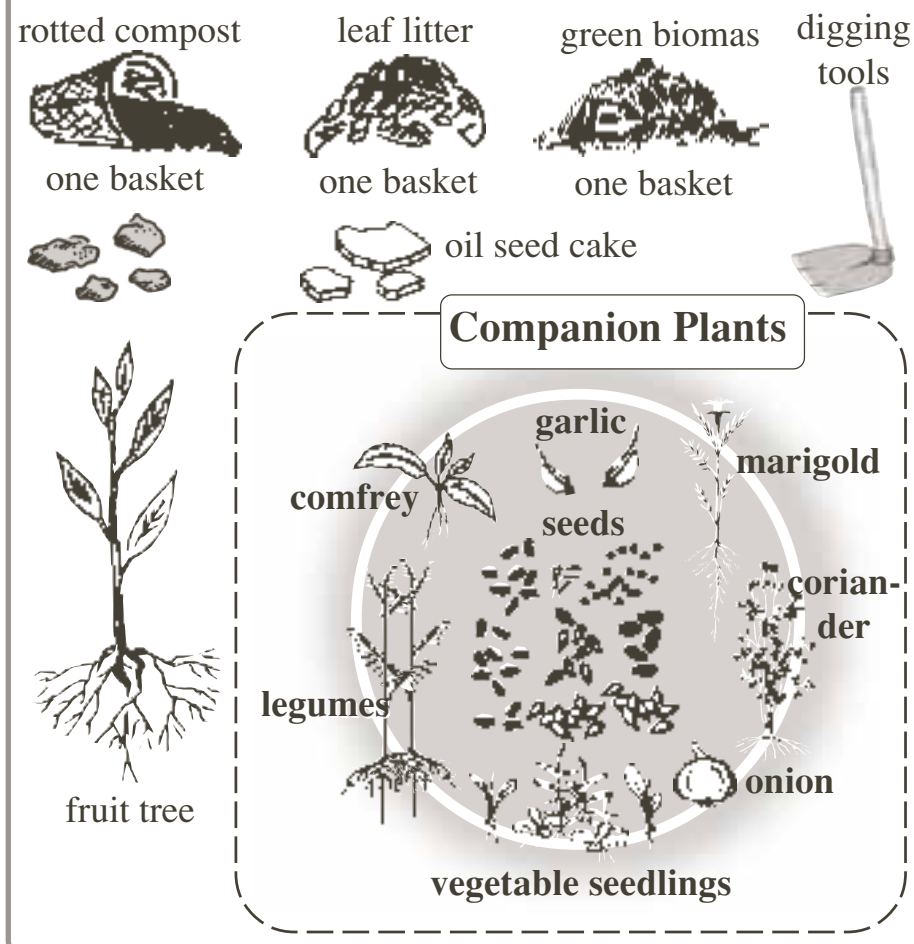
- protection from animals
- easy maintainance
- shelter from the wind
- enough room to grow
- suitable good soil

Below are good places to plant fruit trees:

- in old pit latrines
- on the edge of the house's yard
- terrace edges
- on the edges of fields



Materials needed to plant a fruit tree



Preparing the Pit

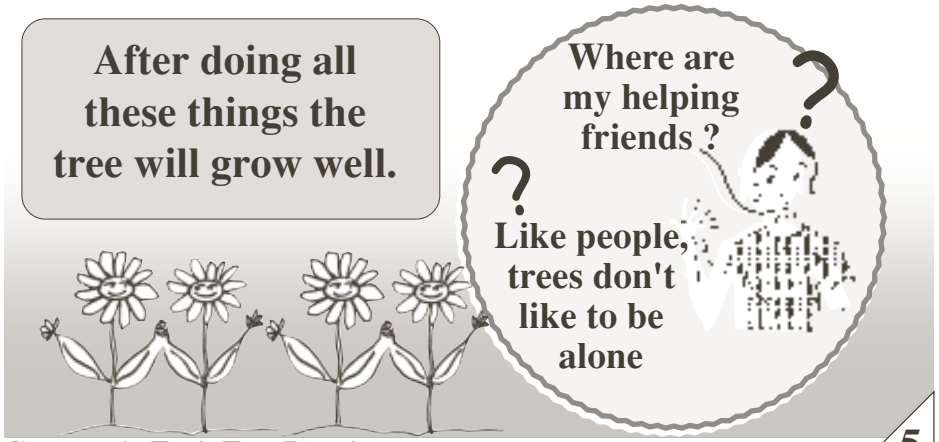
If you're planting the fruit tree in an old pit latrine, then your pit is already prepared. If not, you need to select a good place and dig a pit. The pit should be at least 3 feet deep (if you have deep soil, then 4 feet is even better). The pit should be 3 feet wide.

In the bottom of the pit, put 6-8 inches of green biomass, then cover it with soil that has been dug out of the pit. Then put a 12-18 inch layer of semi-decomposed biomas mixed with un-rotted animal compost and soil. Then put in a layer of well rotted compost mixed with soil. All the dug soil should be put back in the pit until it is heaped above the pit, which is now ready for planting.

If you have a problem with ants or termites, mix oil seed cake (such as mustard) with the soil. One part of cake should be mixed with 10 parts of soil.

Planting the Fruit Tree

When you plant the fruit tree in the prepared pit, first remove as much soil and compost as is needed for the size of the roots. The roots should be open, and point downwards. When the soil has been returned around the roots and filled in, tread on the soil to press it down. Around the pit make a shallow trench to collect water. Lastly, put down rotted compost covered with mulch. If you don't have enough biomass, use rocks to cover the soil.



Companion Planting

Various plants can be planted around the fruit tree which help it to grow even better and give more production. This is called ***companion planting***.

Garlic, onion, marigold, basil, mint, lemon grass, nasturtium, comfrey, coriander, fennel, dill, tansy and wormwood are some examples of companion plants. There are many benefits of planting them with the fruit tree.

Benefits of Companion Planting

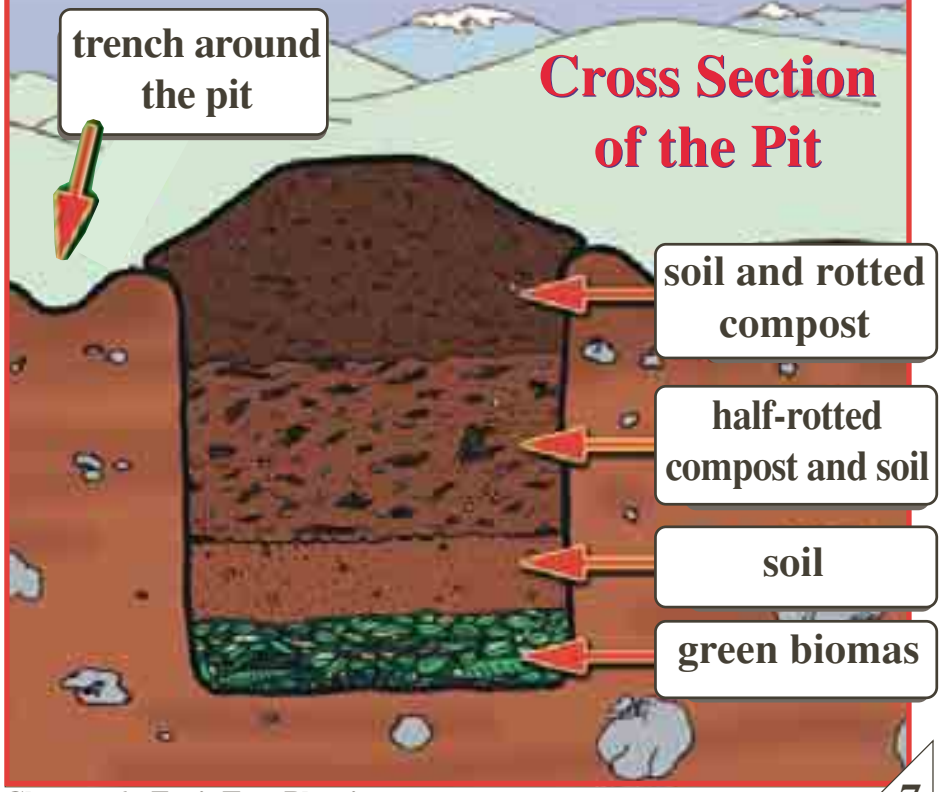
- Companion plants help to protect from harmful pests
- They attract beneficial insects
- They produce vegetables, herbs, nectar for bees, etc.
- They can be cut and used as a mulch
- They can be stacked densely in different layers
- They help to balance the environment
- They help to conserve soil moisture
- They help to prevent weeds from growing

Companion planting helps the fruit tree, but doesn't take much extra work

Let's See how to plant fruit trees

The pit should be one metre wide and at least one metre deep.

2

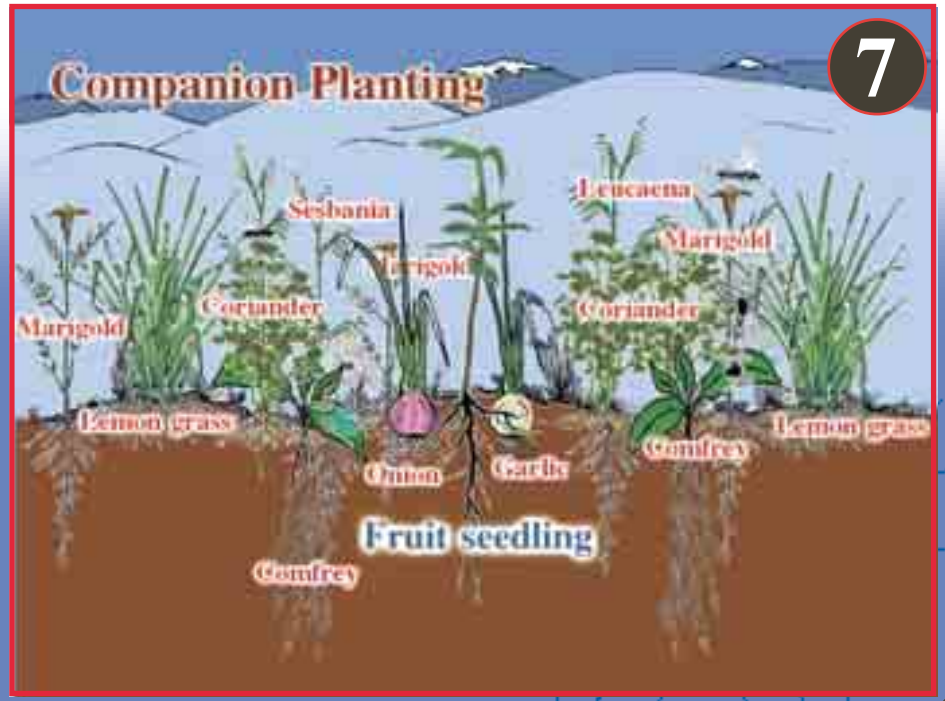


Make a trench around the pit to collect water.

Trim off the fruit tree's long roots.

Don't squash the roots while planting the fruit tree.

Pull the tree upward as you fill in the soil so that the roots all point downward.



Maintenance

How to Care for the Fruit Tree

What the Fruit Tree needs :-

- **Protection from damaging pests**
- **Fertility**
- **Water**

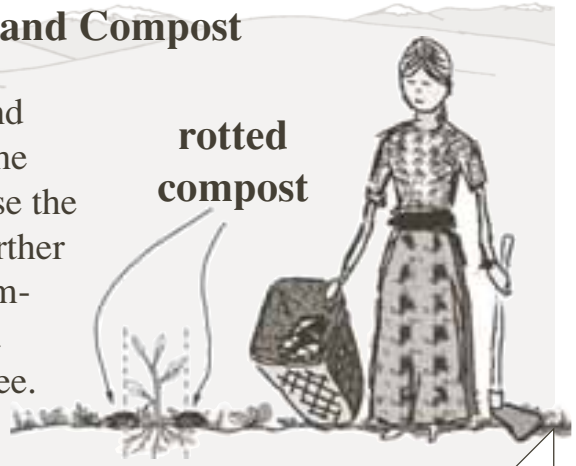
Companion planting also helps to provide these three needs. However, extra maintenance brings extra yields.

Compost:- It's good to provide compost once a year, in early Spring.

Water:- If there's a rainy season, and if the fruit tree is dormant over winter, you don't need water then. But if there is a dry season when the tree is growing and fruiting, irrigation will make a big difference.

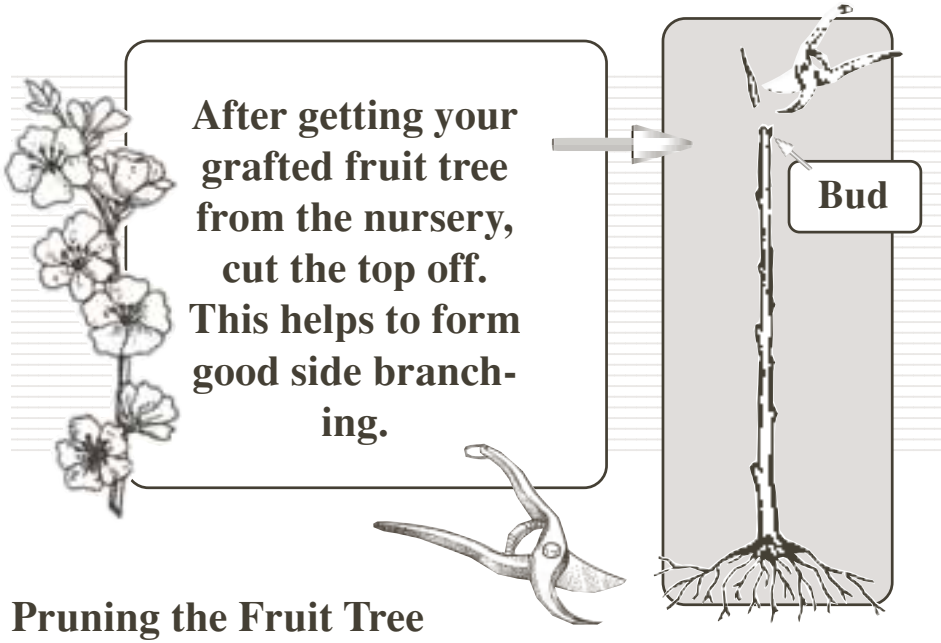
Where to put Water and Compost

Don't put water and compost right next to the stem of the tree, because the roots that feed grow further away. So water and compost need to be put in a circle away from the tree.



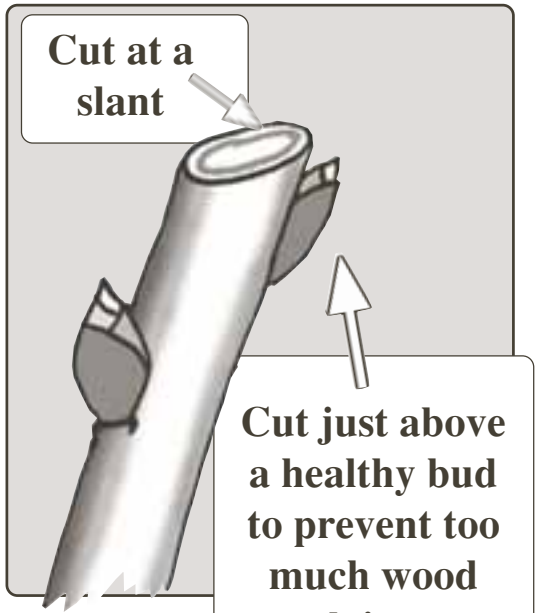
Each year as the tree starts to grow, put compost around under the drip line.

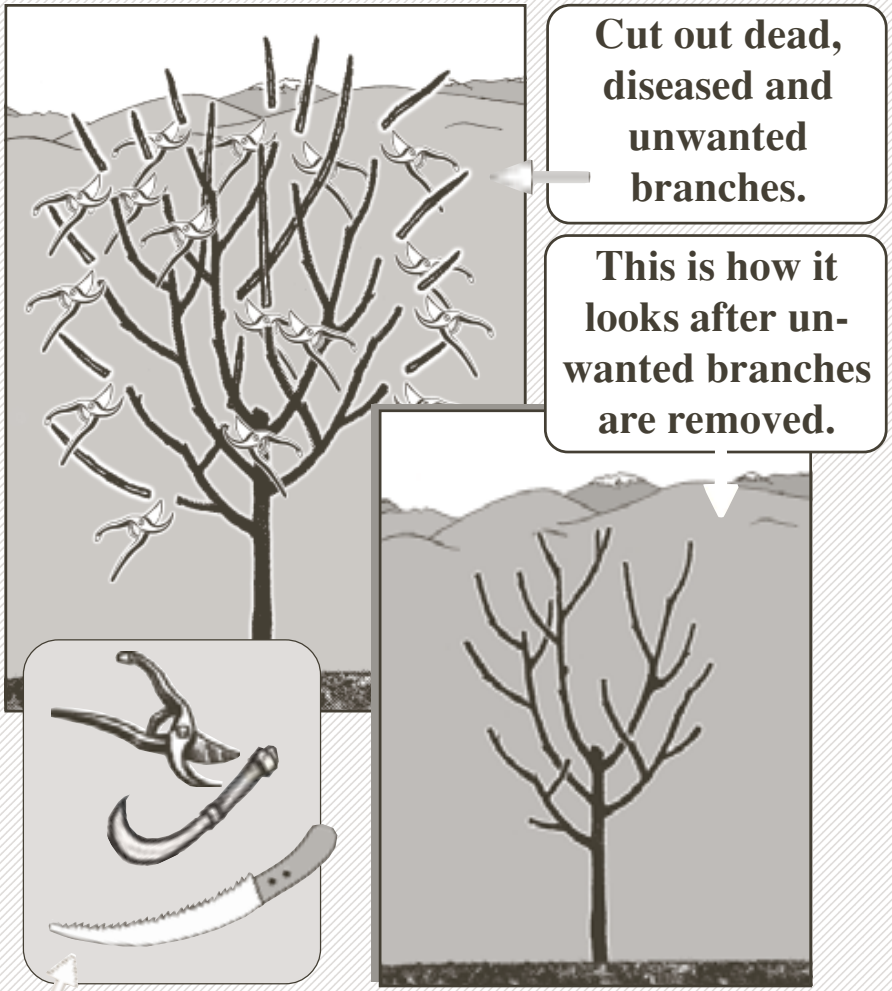
After getting your grafted fruit tree from the nursery, cut the top off. This helps to form good side branching.



Pruning the Fruit Tree

To keep your fruit tree healthy and giving the best production, branches should be pruned once a year when the tree is not growing (it is dormant). Dead or diseased branches should be cut immediately. Any branch touching another, or competing for light and space, should be cut. Use a sharp tool for this. After cutting large branches, cover the wound with fresh cow dung.





A good way of irrigating young fruit trees is given in the "Introduction to Fruit Production" chapter.

Farmers' Experience

Mr Dil Bahadur Bucha

From Ratadada village, Gumi - 3, Surkhet, in Nepal, Mr Dil Bahadur Bucha has had plenty of experience at planting fruit trees. This is what he says.

Dil Bahadur Bucha

"You can get good production from planting fruit trees on empty land. And you don't have to plant every year like grains, but you can still get production each year. Fruit trees are good for keeping bees, so you can get more honey too. I dig a pit a metre wide and a metre deep and in that mix biomass and then good, rotted compost as the pit is refilled. It's important that the roots of the fruit tree are well spaced and pointing down as you plant it. If you get air on the roots the tree can die, so stamp the soil well down on top. I mulch with waste biomass and put rocks on top. That way the moisture is kept in the soil, and I don't need to water so much. Around the pit I plant comfrey and lemon grass for future mulch, so I need less compost. There are lots of benefits from fruit trees, you can even plant pineapple underneath. Now I have mango, pear and peach growing, and the lime is starting to fruit."

Read On

Subjects linked to Fruit Tree Planting

To see how to integrate fruit tree planting with other techniques, read these chapters in the Farmers' Handbook.

Fruit Nursery chapter

In this chapter learn how to make a nursery and grow your own fruit rootstock at home for grafting and budding.

Integrated Fruit Orchard chapter

You can plant many varieties of trees to get more production, and faster too. This is explained in this chapter.

Agroforestry chapter

Farmers can get lots of benefits from planting trees on their land, but you can't just plant them anywhere. In this chapter, learn how to integrate trees without affecting your crop production.

Pit Latrine chapter

A fruit tree grows best if planted in a big pit. If you have an old pit latrine to plant in, you can double the benefits. In this chapter learn how to make a hygienic, cheap and productive pit latrine.

What is Top Grafting ?

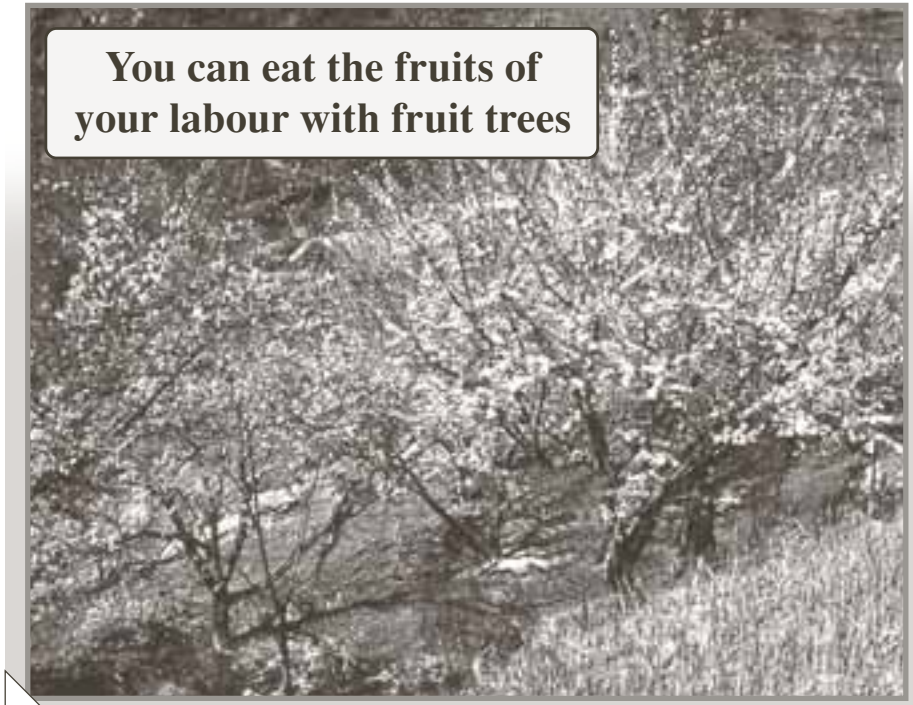
Many people would like to plant fruit trees, but often can't find good types. Sometimes the seedlings may cost too much, if you have limited income. But difficulty in finding good fruit trees shouldn't stop you trying to get them - the solution to the problem can be found. Raising rootstock seedlings in the nursery may take 2-3 years. After grafting, it will take a few more years before they bear fruit. So let's learn an even easier way to grow grafted fruit trees. This is called ***Top Grafting*** (or top *working)*.

Pear, top grafted onto a wild pear tree

Top grafting is a method of grafting cuttings (scion) from improved fruit trees onto appropriate types of wild trees which are already growing in the fields and forests, without needing a nursery. This method is very cheap and easy, and produces good quality fruit trees which give fruit quickly.

Why do Top Grafting ?

- You can grow fruit trees on your own land
- You don't have to make a nursery
- Many types of less useful wild fruit species can be made into improved varieties
- Trees will fruit sooner and give more fruit than otherwise
- Waste resources can be made into useful ones;
- Fruit trees can be grown easily in the forest

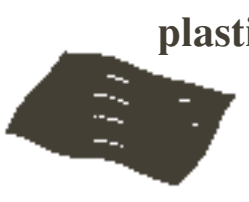


How to do Top Grafting ?

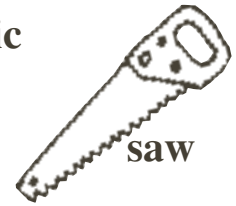
Materials Needed to do Top Grafting

rootstock

Healthy, disease free, wild fruit trees are called *rootstock.*



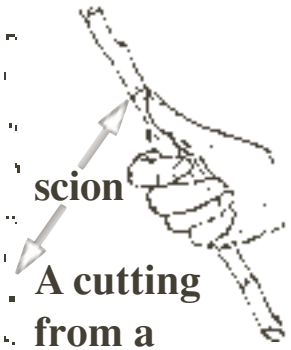
plastic



saw

sharp tools

secateurs



scion

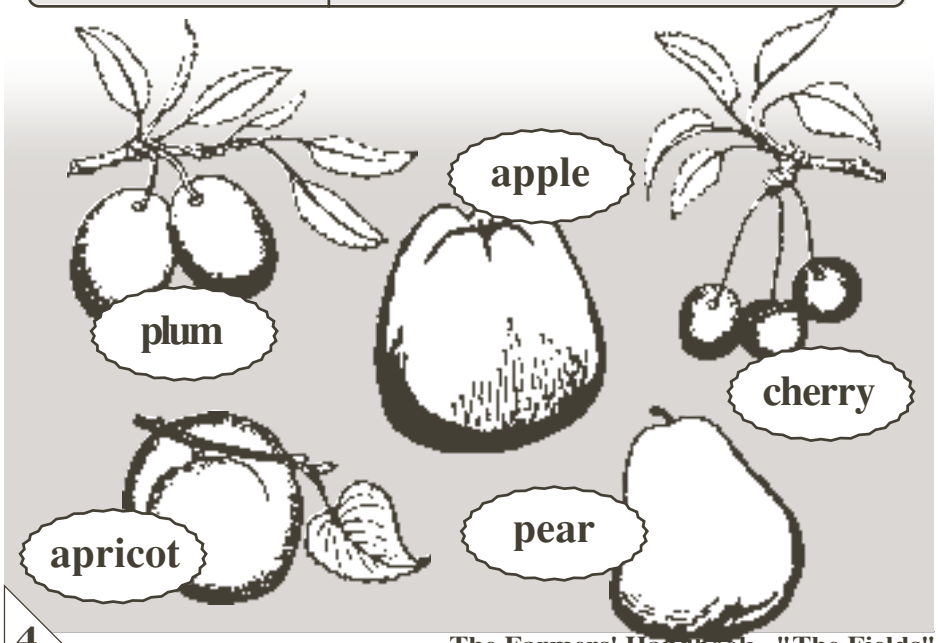
A cutting from a good fruiting tree is called a *scion.*

knife

The methods of top grafting are very similar to that of grafting. But while grafting is normally done in a special fruit nursery, top grafting can be done directly on the farmland or in the forest, wherever the appropriate wild fruit trees are found.

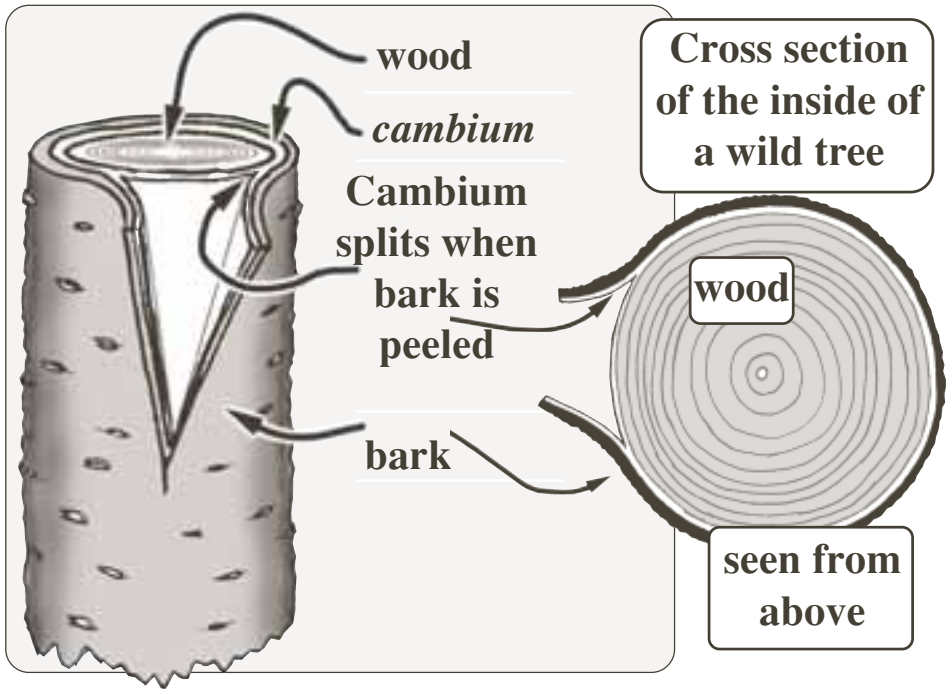
Which types can you top graft onto ?

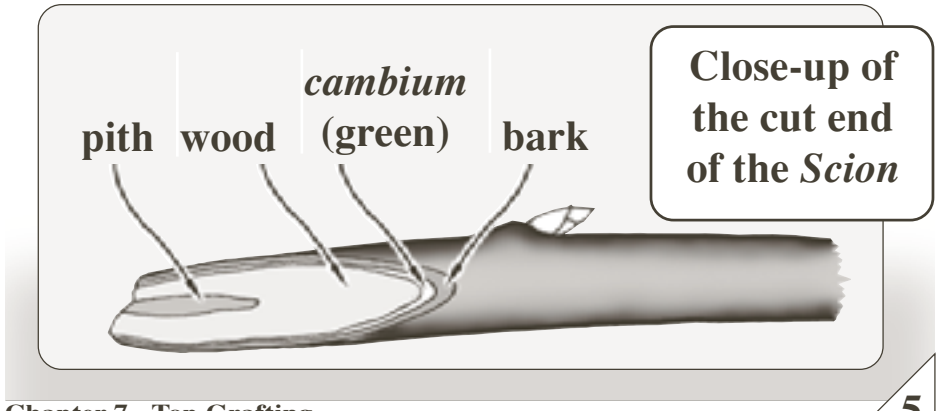
Local Type	What to graft
Local peach	peach, plum, apricot, almond
Wild pear	pear
Wild apple (crabapple)	apple
Wild cherry	cherry

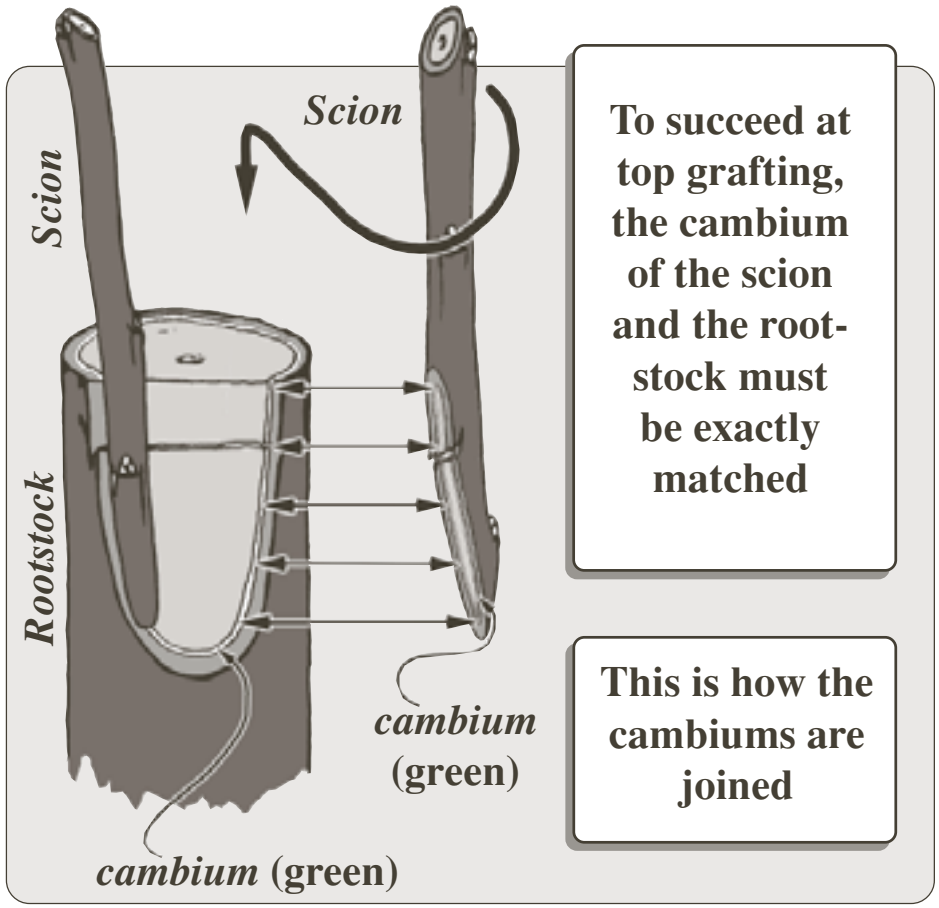


How does grafting work ?

All plants have tiny channels which take water and nutrients up to the leaves and down again. These channels are inside the bark but outside the woody part of the stem. They form a greenish band around the stem called the ***cambium.***







To succeed at top grafting, the cambium of the scion and the root-stock must be exactly matched

This is how the cambiums are joined

Where to Top Graft ?

On farmland, grazing land, or in the forest, wherever there are suitable wild fruit trees, such as wild peach, wild pear, wild apricot, etc.

When to Top Graft ?

Top grafting is usually done when trees have lost their leaves, in the winter. In lower, warmer places this may be in January (Northern Hemisphere). In higher, colder places this may be February or March. It is best to top graft about 2-3 weeks before new leaves sprout on the trees.

Top Grafting Method

1. Selecting and preparing the rootstock

- Top grafting can be done on any appropriate local wild fruit tree. The tree should be strong, healthy and free of disease.
- After selecting the tree to graft onto, clear away brush and weeds from around the base, and cut off any small branches growing from the base.

- Cut down the tree anywhere between 4 inches up to 3 feet high above the ground, according to need and the shape of the land.
- The cut should be straight and clean.

2. Choosing and selecting the scion

The scion is selected from a good fruiting tree. The scion is about pencil thickness, or the thickness of your little finger.

3. Grafting the scion

There are 3 ways to graft shown in this chapter. They are shown with photos on the following pages.

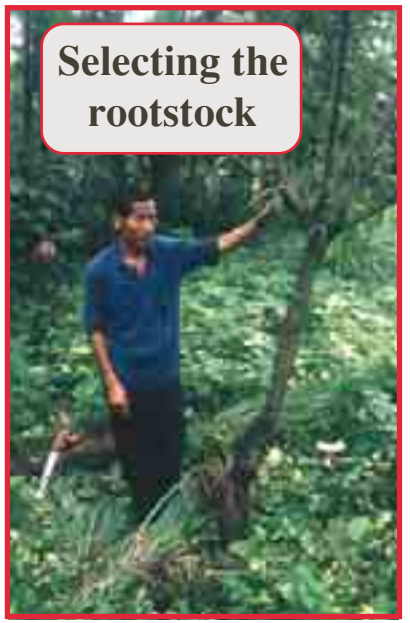
4. Binding the graft

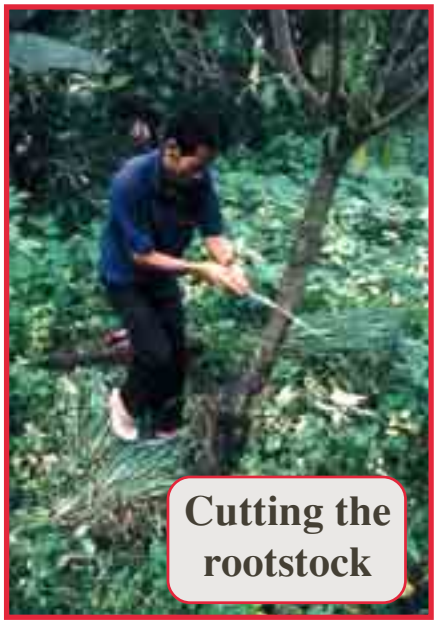
Plastic is used to bind the scion to the rootstock so air and water can't get into the graft. If a very large rootstock is used, a separate piece of plastic is needed to cover the cut section while the scion is bound. This is shown on page 11, photos 6 and 7.

Let's see the 3 methods of top grafting

On the next 7 pages, 3 methods of top grafting are shown. The first method is called ***bark top grafting***, and is on the first 4 pages. After this, the second method is called ***tongue top grafting***, and is shown on 1 page. The third method is called ***split top grafting*** and this is shown on 2 pages.

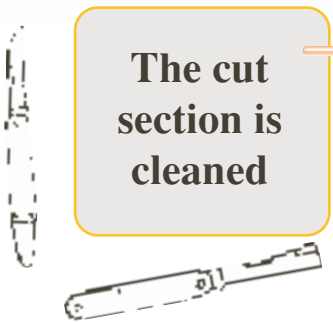
Let's See how to do Top Grafting





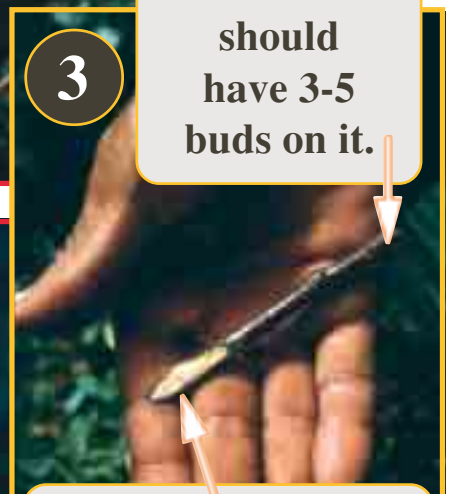
Method 1.

Bark Top Grafting



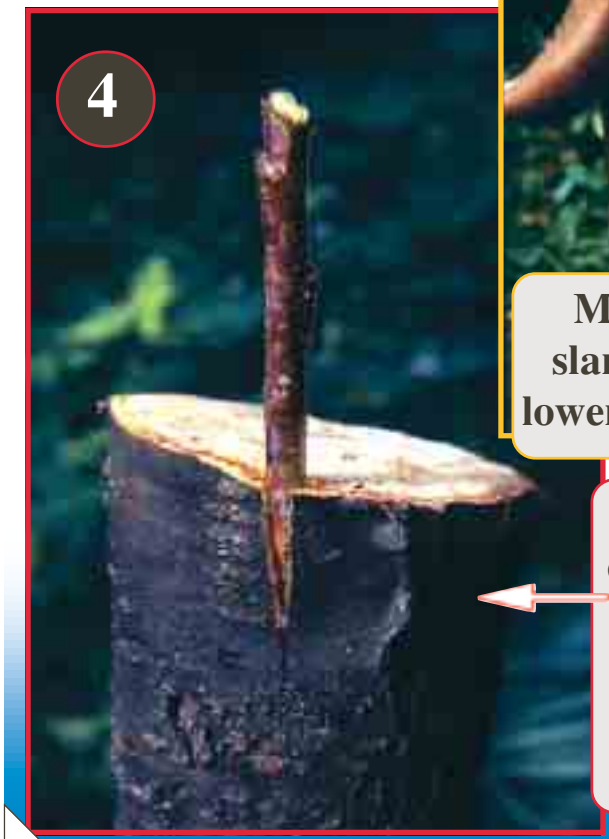
The cut section is cleaned

From the top, make a 1-2 inch long vertical cut in the bark.



The scion should have 3-5 buds on it.

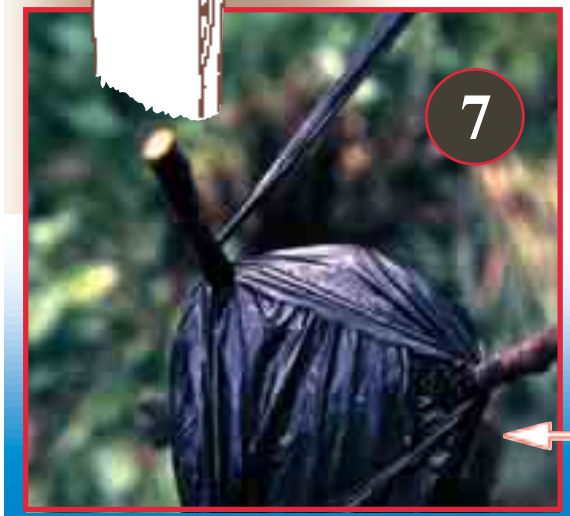
Make a 1-2 inch slanting cut on the lower end of the scion



Insert the cut end of the scion into the bark through the vertical cut on the rootstock.

On a big rootstock, 2, 3 or more scion can be grafted.

Spread a piece of plastic over the top, and bind the scion onto the rootstock with another piece.



Bind tight so air and water cannot get in.

Finally put another piece of plastic over the top, and bind this on as well.

This shows where care is needed to bind well

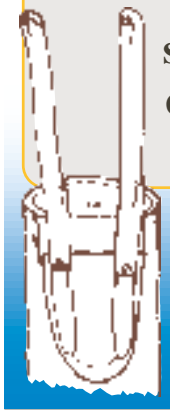
Now, grafting work is finished on this tree.

When the rootstock is small, as here, only one scion should be grafted.

Method 2. Tongue Top Grafting

The cut on the root-stock and the scion are both slanting and an inch long. In the centre ofeach cut edge, make a small nick (tongue). These 2 nicks will insert into each other to hold the graft.

The *cambium* layer under the bark of the rootstock and scion should be exactly aligned (see p. 5,6)

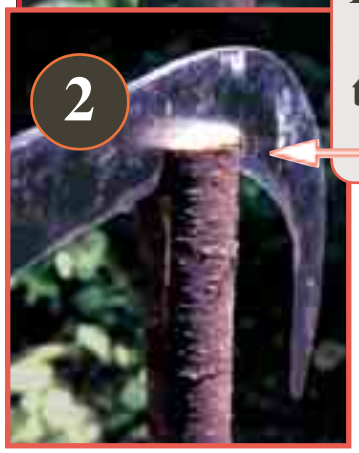


Bind the graft with plastic, as in the other methods.

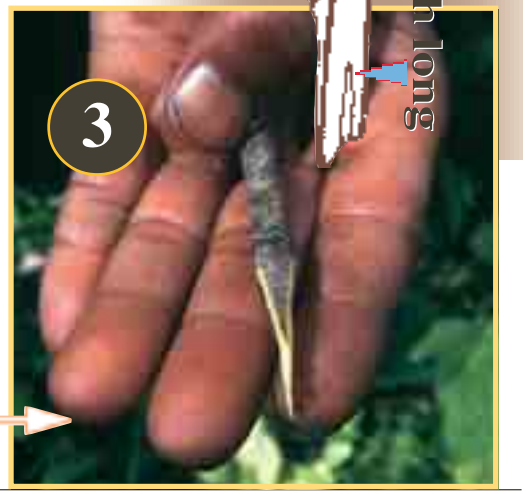
Method 3.
Cleft Top Grafting

Make a cleft in the middle of the cut stem.

the cut is 1 inch long

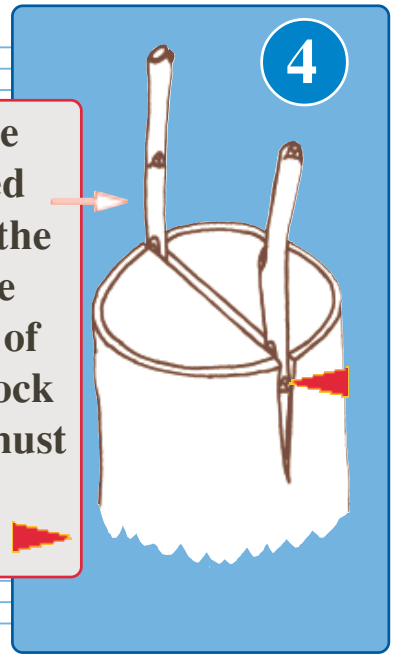


Place a sharp tool in the cleft, taking care not to split the stem.



Make an inch-long cut on both sides of the scion .

Insert the sharpened scion into the cleft. The cambium of the root stock and scion must be exactly matched.



Finished top grafting

Bind the graft with plastic, as in the other methods.

After Top Grafting is successful

An improved pear grafted onto a wild pear rootstock has sprouted well. After 4 months, the plastic is removed. The seedling is protected from livestock.

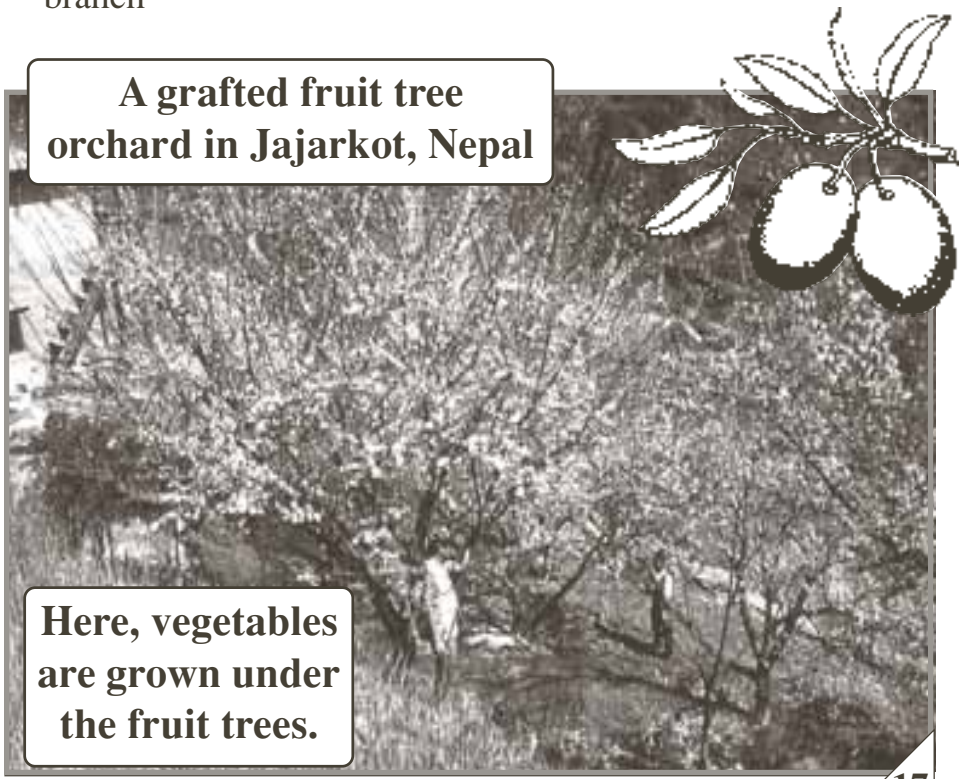
Apricot, 2 years after it was grafted onto a local peach

Maintenance

How to maintain a top grafted seedling

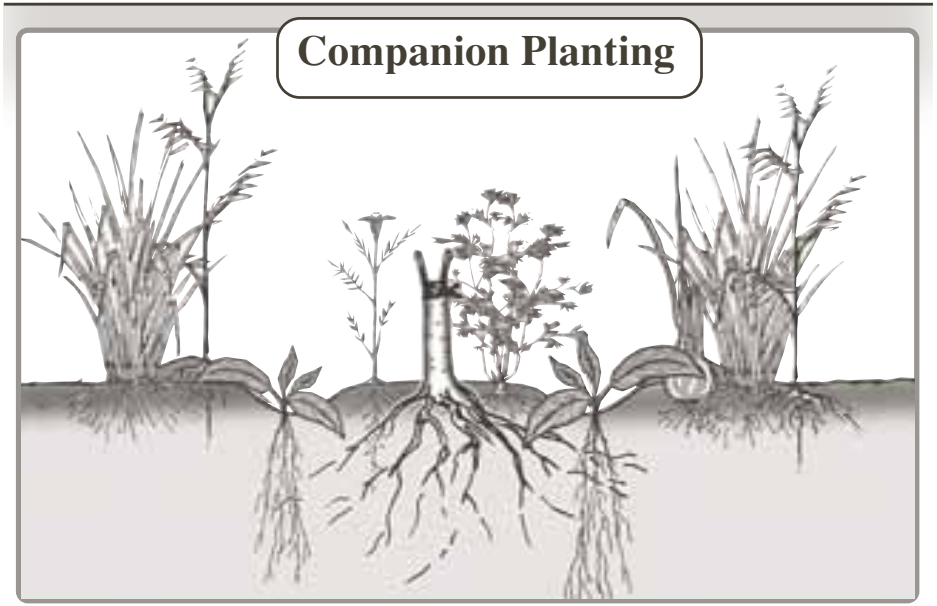
Aftercare for the grafted tree

- Protect the grafted tree from livestock
- Make a round trench around the plant, and use this to give water and compost. Water as necessary, whenever possible
- Mulch thickly around the stem
- Plant companion plants around the tree
- Pinch or cut off any branches that sprout below the grafted branch



A grafted fruit tree orchard in Jajarkot, Nepal

Here, vegetables are grown under the fruit trees.

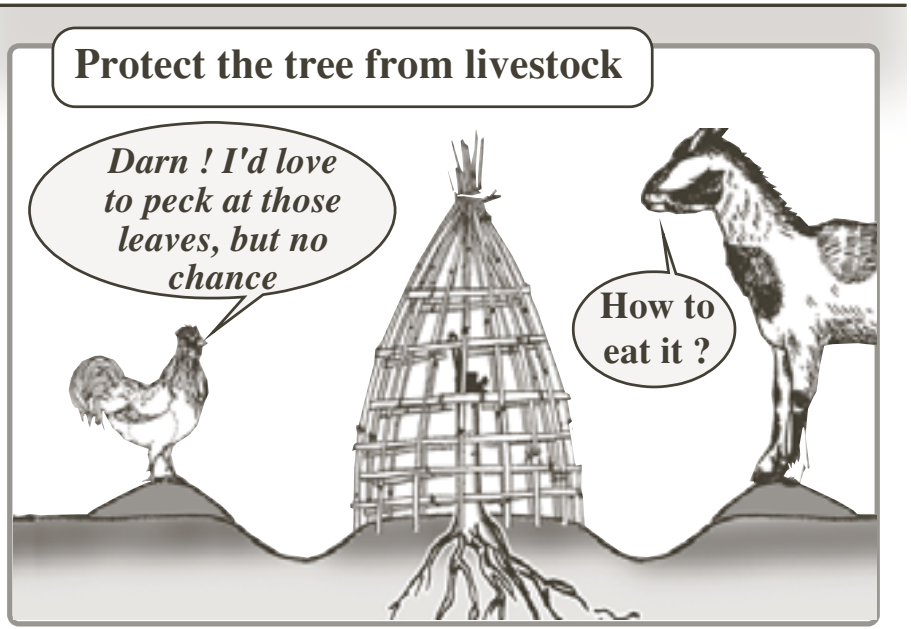


Various plants, such as garlic, onion, marigold, basil, mint, lemon grass, comfrey, coriander, fennel, dill and worm-wood can be planted around the fruit tree, which help it to grow well and give better production.

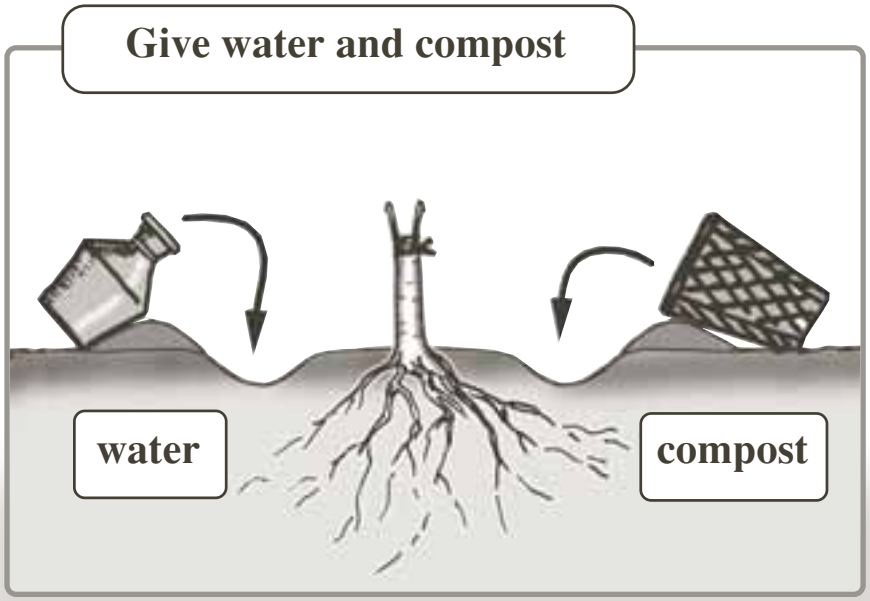
Benefits of Companion Planting

- Companion plants help to protect from harmful pests
- They attract beneficial insects
- They produce vegetables, herbs, nectar for bees, etc.
- They can be cut and used as a mulch
- They can be stacked densely in different layers
- They help to balance the environment
- They help to conserve soil moisture
- They prevent too many weeds from growing

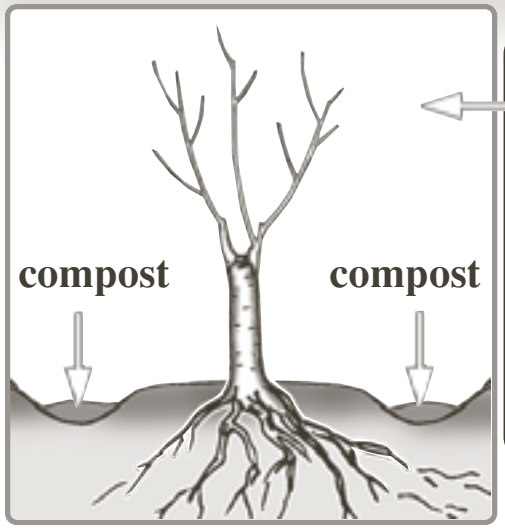
There is more information about this in the *Fruit Tree Planting Method* chapter



Make a small trench around the grafted tree.
Use this to give water and compost as needed.

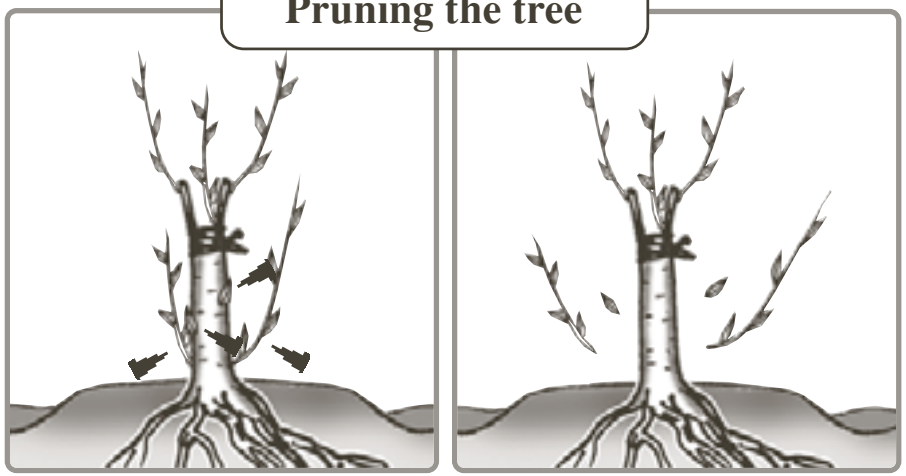


Maintenance needed each year



Now your fruit tree can grow well. To help it more, prune it once a year in the winter. Give it a basket of compost at the same time.

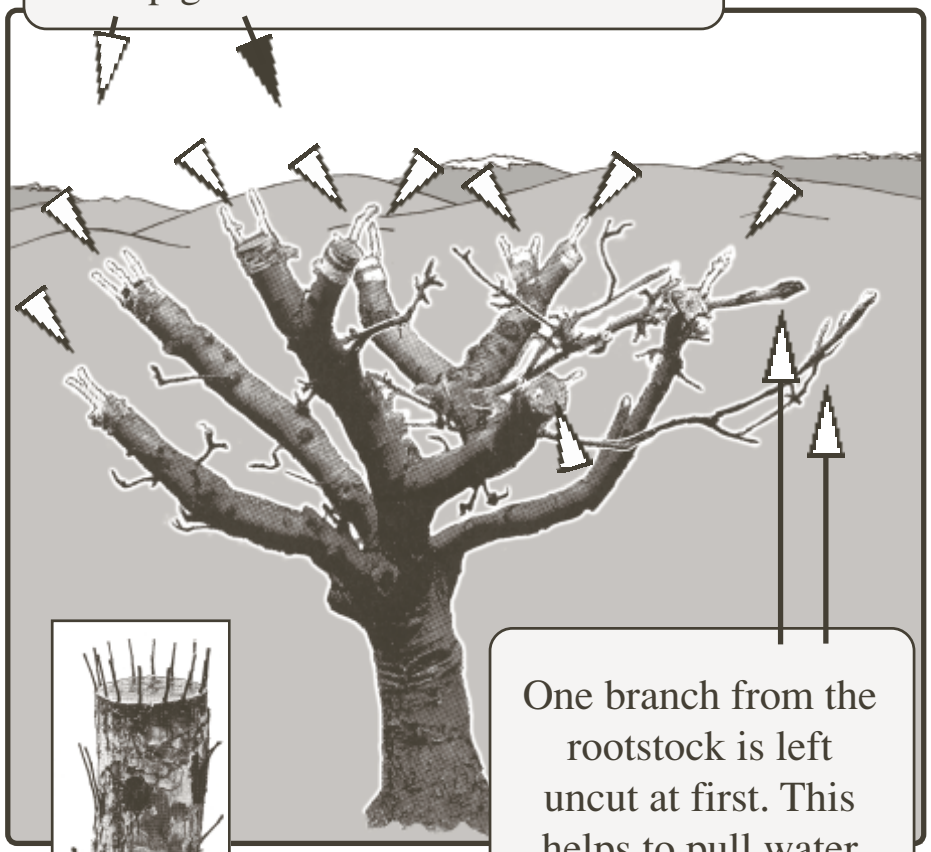
Pruning the tree



Remove any branches that sprout from the rootstock. More information about pruning is given in the ***Fruit Tree Planting*** chapter.

On a big tree, many scions can be grafted

Top grafted branches are shown



Many scions can be grafted onto a trunk in this way.

One branch from the rootstock is left uncut at first. This helps to pull water and nutrients from the roots for the new grafts. After the grafts have sprouted well, this branch can be cut off.

Farmers' Experience

Mr Tek Bahadur Khadka

From Jajarkot district, Khalanga -5, Pokhora village in Nepal, Mr Tek Bahadur Khadka has done plenty of top grafting. Now let's read about his experiences.

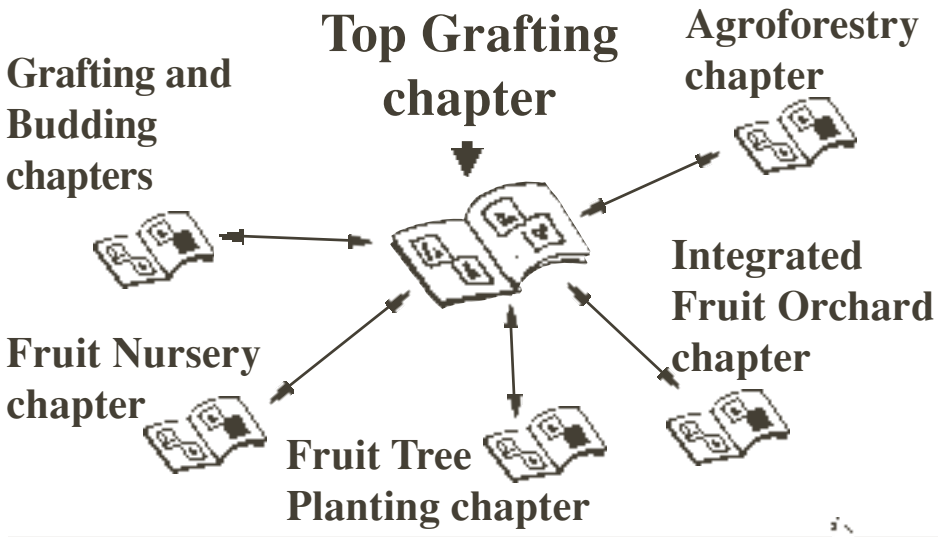
Tek Bahadur Khadka

"I work for the Homestead Programme (JPP) in 6 VDCs of Jajarkot district. At first I didn't think this method would work, but after training and starting work, I like it a lot. I now teach this in the villages. I started by top grafting pear onto the wild pear that grows here. At first we used to cut these wild pear down as we thought they were useless. Now we top graft them and have made a fruiting orchard out of the forest. Before, you'd see just a few pear trees in the village. Now there are hundreds of trees, and everyone knows how to do top grafting - even in places where I've never been to teach. And it turns the wild pear into a useful tree. You don't have to buy fruit seedlings, and they fruit quickly. Everyone likes the method in the villages, it's so easy. You don't need any strange tools, and can do it in your own village area."

Read On !

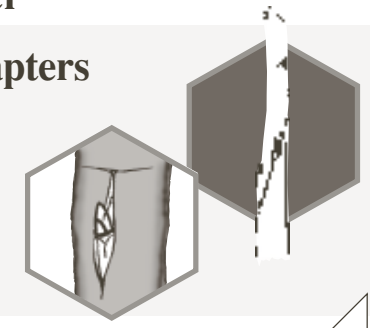
Subjects Related to Top Grafting

This book provides enough information for you to be able to do your own top grafting on fruit trees. However, this information is also linked to other methods. For extra benefits let's read, learn and practice from other related chapters.



Grafting and Budding chapters

Information about various simple methods to grow improved fruit varieties at home for planting on the farm are given in these chapters.



Fruit Nursery chapter

In this chapter learn how to make a nursery and grow your own fruit rootstock at home for grafting and budding.

Integrated Fruit Orchard chapter

Information is given in this chapter about how to plant fruit trees with various other multi-purpose trees to give more and quicker benefits for less work.

Fruit Tree Planting chapter

After raising good seedlings in the fruit nursery, if they're not planted well all the work can go to waste. Information about fruit tree planting is given in this chapter.

Agroforestry chapter

Planting trees on farmland can bring farmers many benefits. But you can't plant any type of tree, nor anywhere. This chapter gives information on how to plant trees without affecting farm yield.

What is Air Layering ?

Hommaya Gurung plants a guava seedling made by air layering.

Everyone likes to eat tasty fruit. And everyone who plants an orchard looks forward to tasting the fruits of their work. It is our responsibility to plant fruit trees, which give the family nutrition as well as increasing farm production. So people want to plant fruit trees, even those with just a little land. There are many ways that farmers can grow good quality fruit trees at home at very low cost. The more methods are known, the more choices farmers have to improve their farm production.

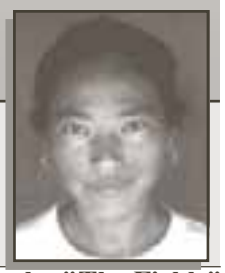
In this chapter we talk about another easy and successful method of propagating fruit trees, which is called ***Air Layering.*** Air layering is a simple way of propagating fruit tree seedlings from their branches.

Why do Air Layering ?

There are 2 problems with planting fruit trees from seed. The first is that a tree grown from seed willl take a long time to produce fruit. It may take 8-10 years. The second problem is that although the seed may be taken from a very good tree, producing excellent fruit, the new tree may not produce good fruit. By air layering a tree, we can guarantee that it will produce fruit sooner, and the fruit will be as good as the tree from which the branch was taken.

Species which can be Air Layered

Most of the citrus varieties - orange, lemon, lime, grapefruit, kumquat, etc. Also, pomegranite, lychee, guava, star fruit, custard apple, plum, and pear. There may be other varieties that you know in your local area.



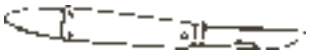
This Chapter's Author
Mrs Deumaya Rana
Dahachaur-4, Surkhet.

How to do Air Layering ?

Time to do Air Layering ?

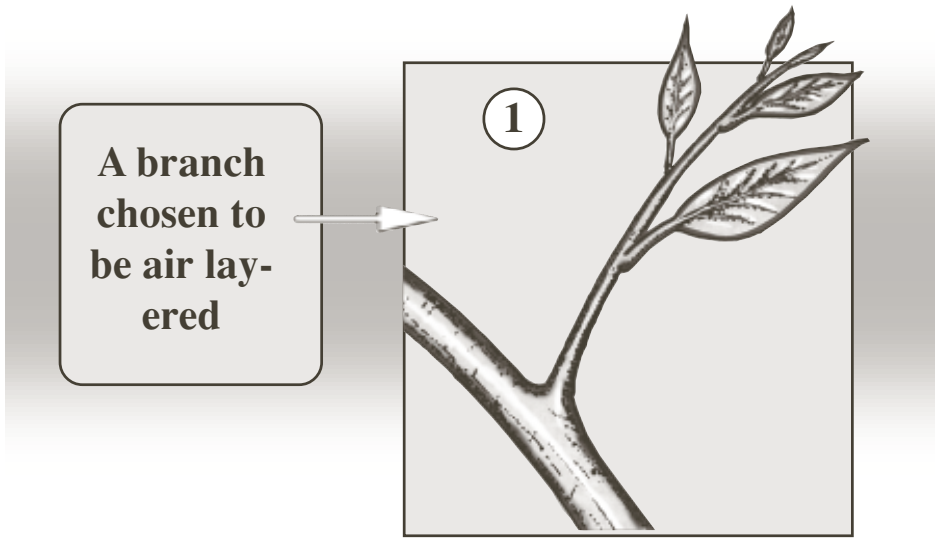
In low-lying, hotter climates, air layering can be done from late winter through to spring. The higher and cooler you go, normally the later air layering can be done. The season can go on through spring and even into early summer. The time to do air layering is normally the same time as when fruit trees start to grow new leaves.

Materials Needed to do Air Layering

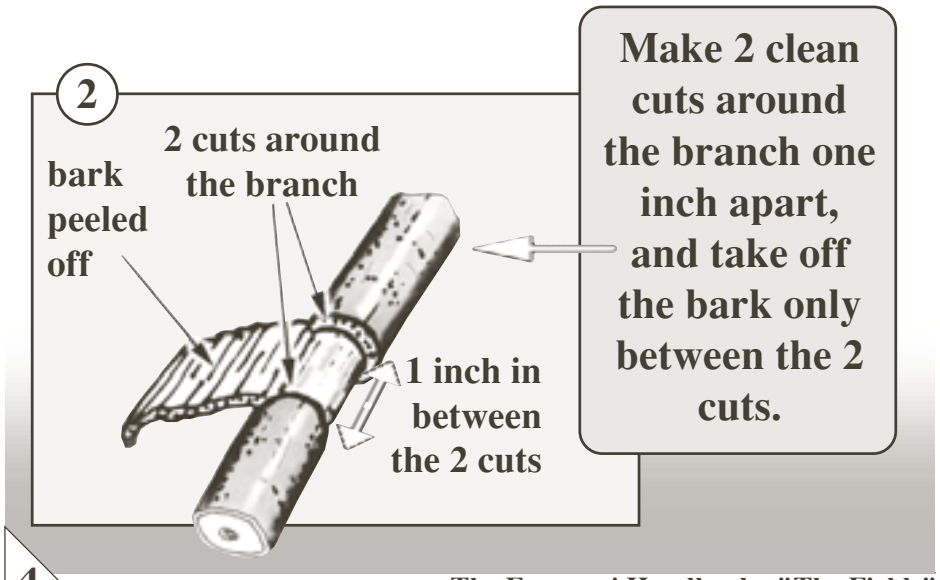


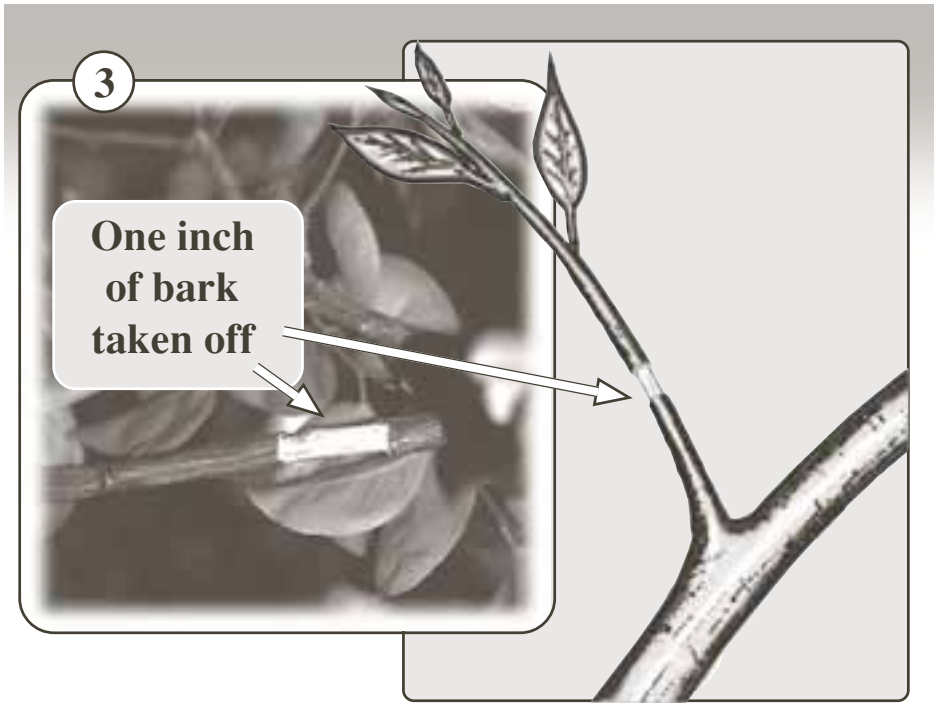
Choosing the branch to air layer

The branch to be air layered should be healthy and free of disease, and at least one year old.

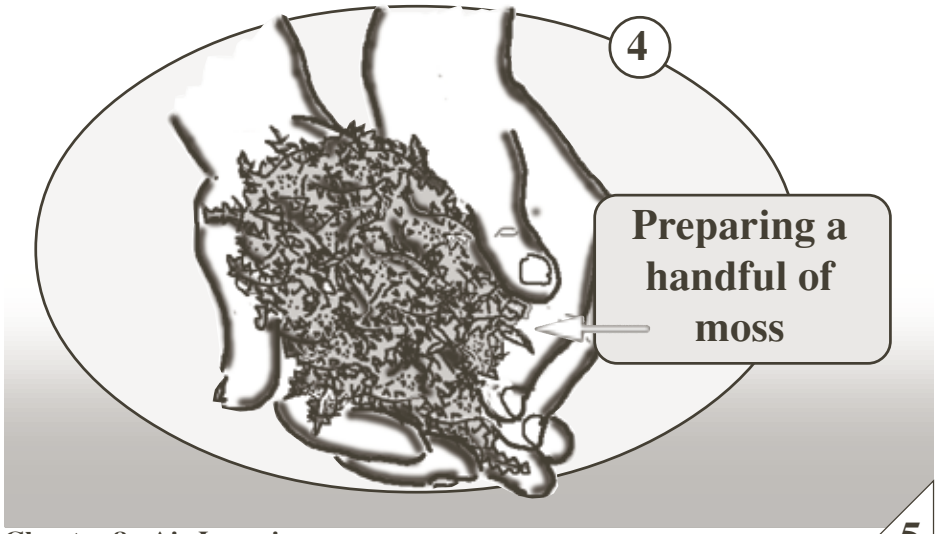


Then, away from the tip, cut the bark from around the stem of the branch.



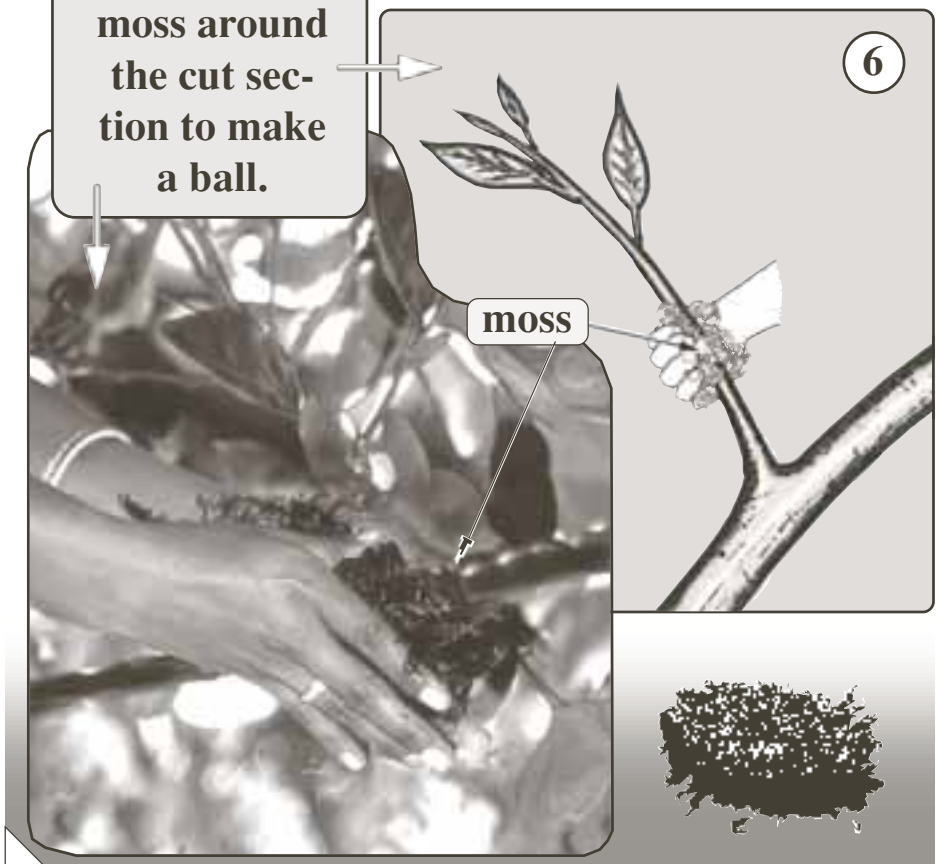


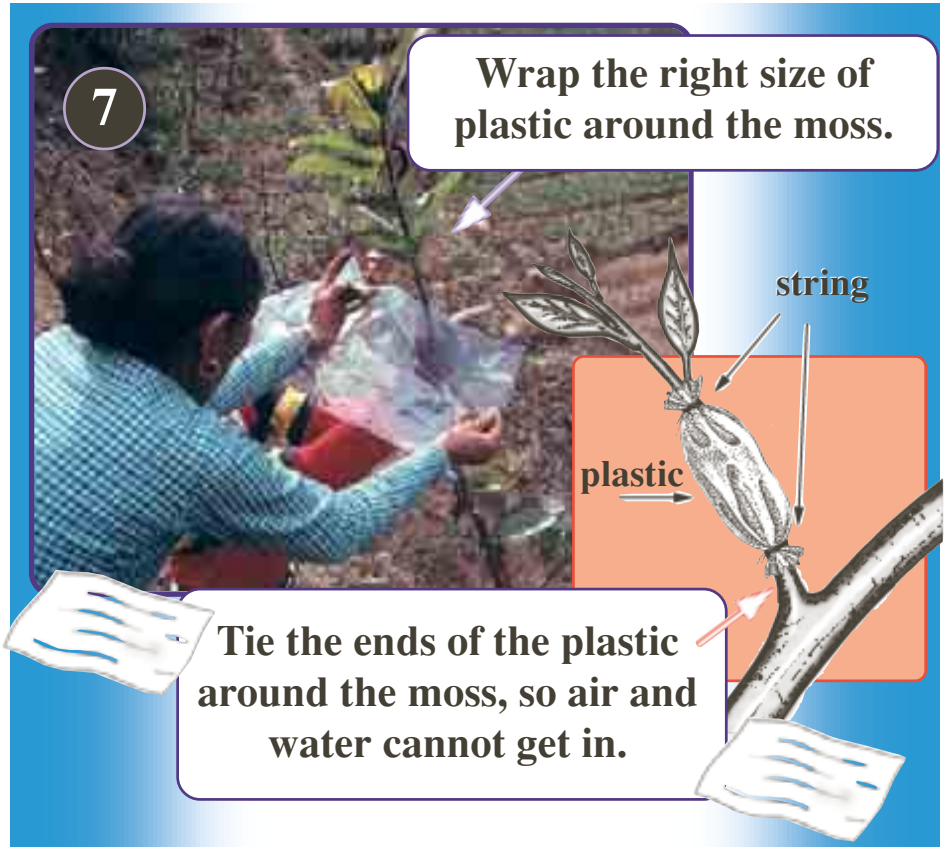
After removing the bark, wrap around a handful of tree moss, or a ball of soil mixed with ash and cow dung.



Spread out the moss between the hands.

Wrap the moss around the cut section to make a ball.





When air layering, always make sure the end of the plastic is pointing down, otherwise water can get in, and the air layering may fail.

The branch is then planted in the summer, 6-8 weeks after binding.

9

Inside the plastic, white roots can be seen.

10

Roots seen as the plastic is removed

roots

This branch is ready for planting

11

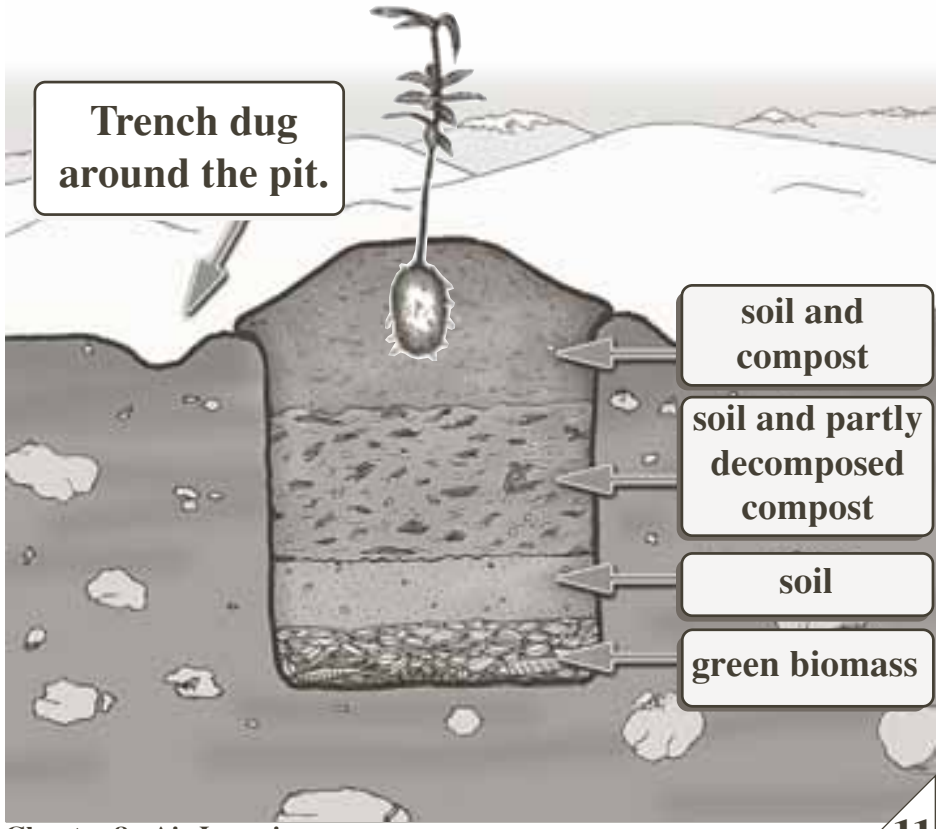
To plant the air layered branch, cut the branch just below the moss ball

12

Before cutting and transplanting, make sure the place to plant the seedling is prepared

Planting the branch

- Dig a pit a metre deep and a metre wide.
- Fill the pit as shown in the picture below.
- Carefully plant the new seedling, taking care not to damage the roots, and cover with soil just above the moss ball.
- Put a thick mulch around the seedling.
- Water well into the ditch around the pit.
- Plant companion plants around the seedling, such as garlic, onion, marigold, comfrey, basil, coriander, nasturtium, wormwood, tansy, lemon grass, etc. More information about this is given in the ***Fruit Tree Planting*** chapter.



Companion Planting

After planting the seedling, mulch it well and plant suitable companion plants around it.

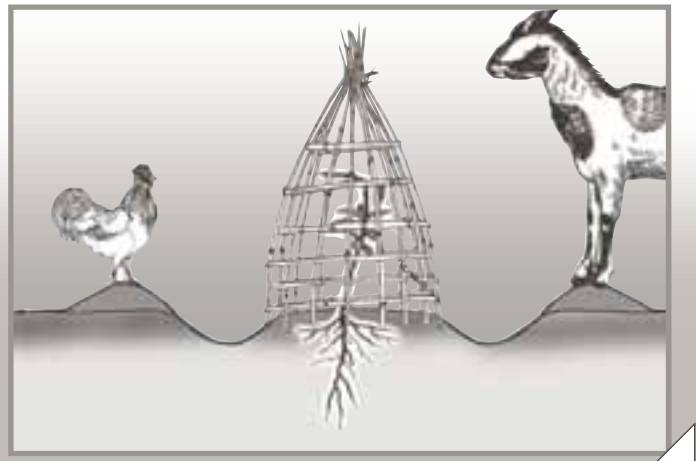
Maintenance

How to care for an air layered seedling

Put water and compost only in the trench around the seedling

A good way of irrigating the seedling is given in the ***Fruit Tree Planting*** chapter.

Protect the seedling from livestock.



Farmers' Experience

Mrs Pabisara Gharti

From Nepal, Surkhet district, Gumi - 6, and a member of "Peoples's Awareness" women's group, Mrs Pabisara Gharti has experience with Air Layering on her own land. Now let's hear about her experience.

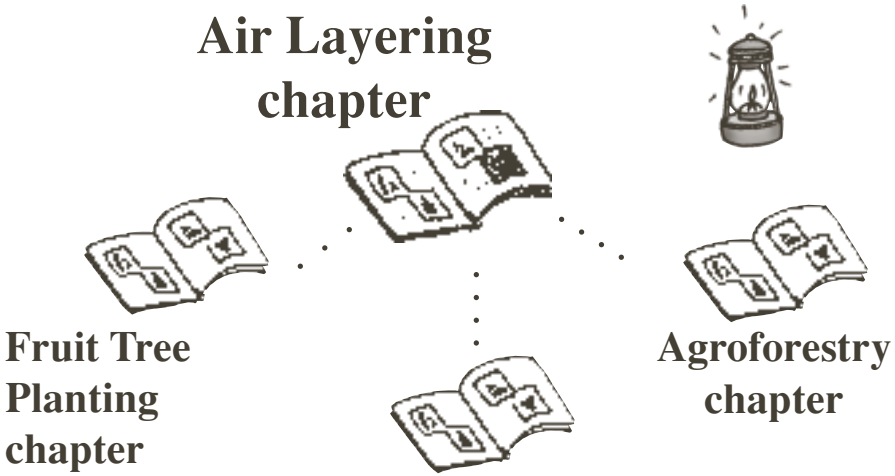
Mrs Pabisara Gharti and her air layered orange

" I learned about air layering from the Homestead Programme (JPP). To make the cutting, I peeled the bark from around the branch, covered it with a ball of moss, and wrapped it in plastic. Easy. Roots grow from the cut section in about 2-3 months. Then, I cut the branch and planted it with its new roots. I made the air layering in February, and planted it out in June. A seedling made in this way fruits much quicker than when planted from seed. I found this method easier and more successful than other methods, so we've been planting lots of fruit trees made this this way, and will be planting more this year. Why shouldn't everyone do this type of work, that is easy and gives good benefits ? "

Read On !

Subjects Related to Air Layering

This chapter provides enough information for you to be able to do your own Air Layering on fruit trees. However, this information is also linked to other methods. For extra benefits let's read, learn and practice from other related chapters.



Related Subjects

Fruit Tree Planting chapter

After raising good seedlings in the fruit nursery, if they're not planted well all the work can go to waste. Information about more productive planting is given in this chapter.

Integrated Fruit Orchard chapter

Information on how to plant fruit trees with various other multi-purpose trees to give more and faster benefits for less work is given in this chapter.

Agroforestry chapter

Farmers can get many benefits from planting trees on their land, but you can't plant them just anywhere. In this chapter, learn how to integrate trees on the farm without affecting your crop production.

What is a Bamboo Cutting ?

Mrs Myasu Garanja's bamboo, which she planted from a cutting

Bamboo is an extremely useful plant which has been used for hundreds of years in society. When its shoot is young, it can be eaten as a vegetable. When the stem is strong, it can be used to build houses. That's why there's a Nepali saying that goes "when young, a vegetable; when mature, a house". In the villages, they also say that bamboo can be used for anything, except as a plough share. The traditional way of propagating bamboo is by digging up the root and transplanting a section to a new place. But this involves a lot of difficult work, takes much time, and many other plants can be damaged as it is transplanted.

So in this chapter, we show an easy and quick way of propagating many more bamboo than was previously possible.

Why make a bamboo cutting ?

Planting a bamboo from cuttings gives more benefits from less work. In less time, many more cuttings can be planted, saving work for farmers.

The traditional way of digging up bamboo with its roots causes damage to other plants, and much soil needs to be moved. So by using cuttings, this damage is also prevented.

Benefits of Bamboo cuttings

- It's a quik and easy method
- With less work, many cuttings can be planted
- One bamboo branch can make many cuttings
- The original clump isn't damaged by making cuttings

This Chapter's Author

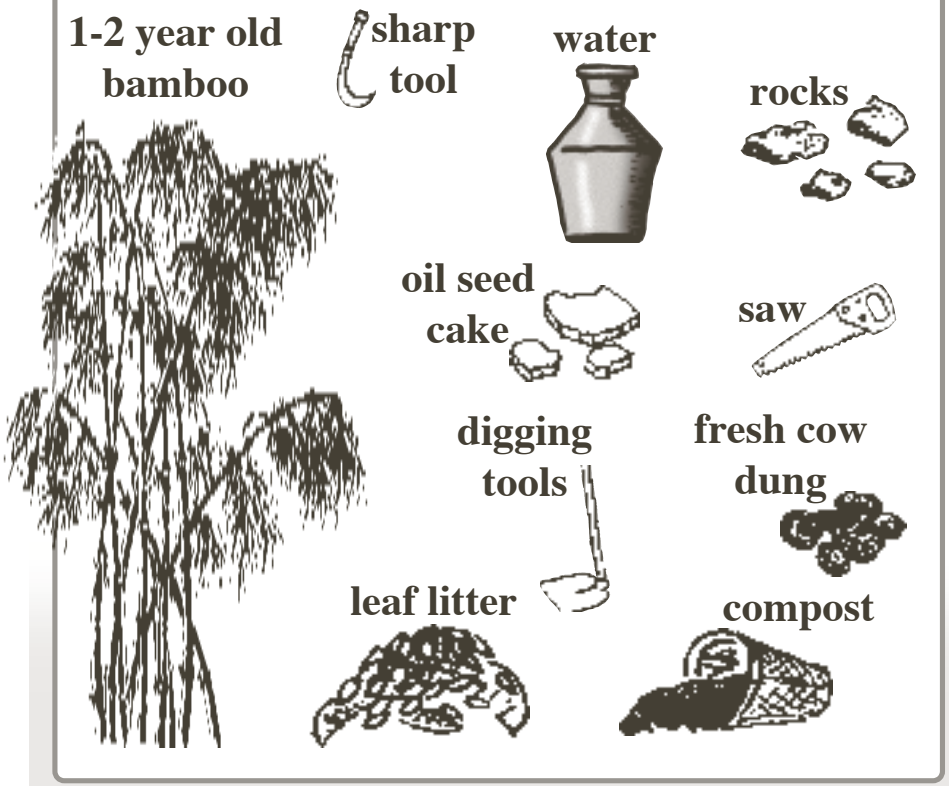
Mr Laxman Rana
Community Service Group,
Dahachaur 4, Surkhet, Nepal

How to make a bamboo cutting ?

Which bamboo can be used to make cuttings ?

There are many types of bamboo, from hot, tropical, low lying areas to cold, high altitude areas. Most types can be used, except cane bamboo, and bamboo which has only a very small hole, or no hole in the middle.

Materials Needed to make bamboo cuttings



Things to consider when selecting the cutting

- the bamboo should be between 1-2 years old
- the bamboo should be healthy and free of disease

Time to plant

In hotter, lowland areas, cuttings are taken from mid-winter (mid January in N.Hemisphere) for up to 1 month. In hilly, cooler areas, the time starts up to one month later, until late spring (April).

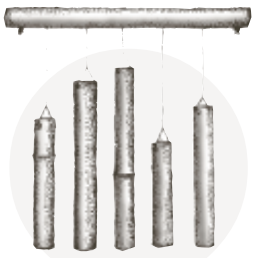
Length of time to sprouting

A successful cutting will sprout within 3 months.

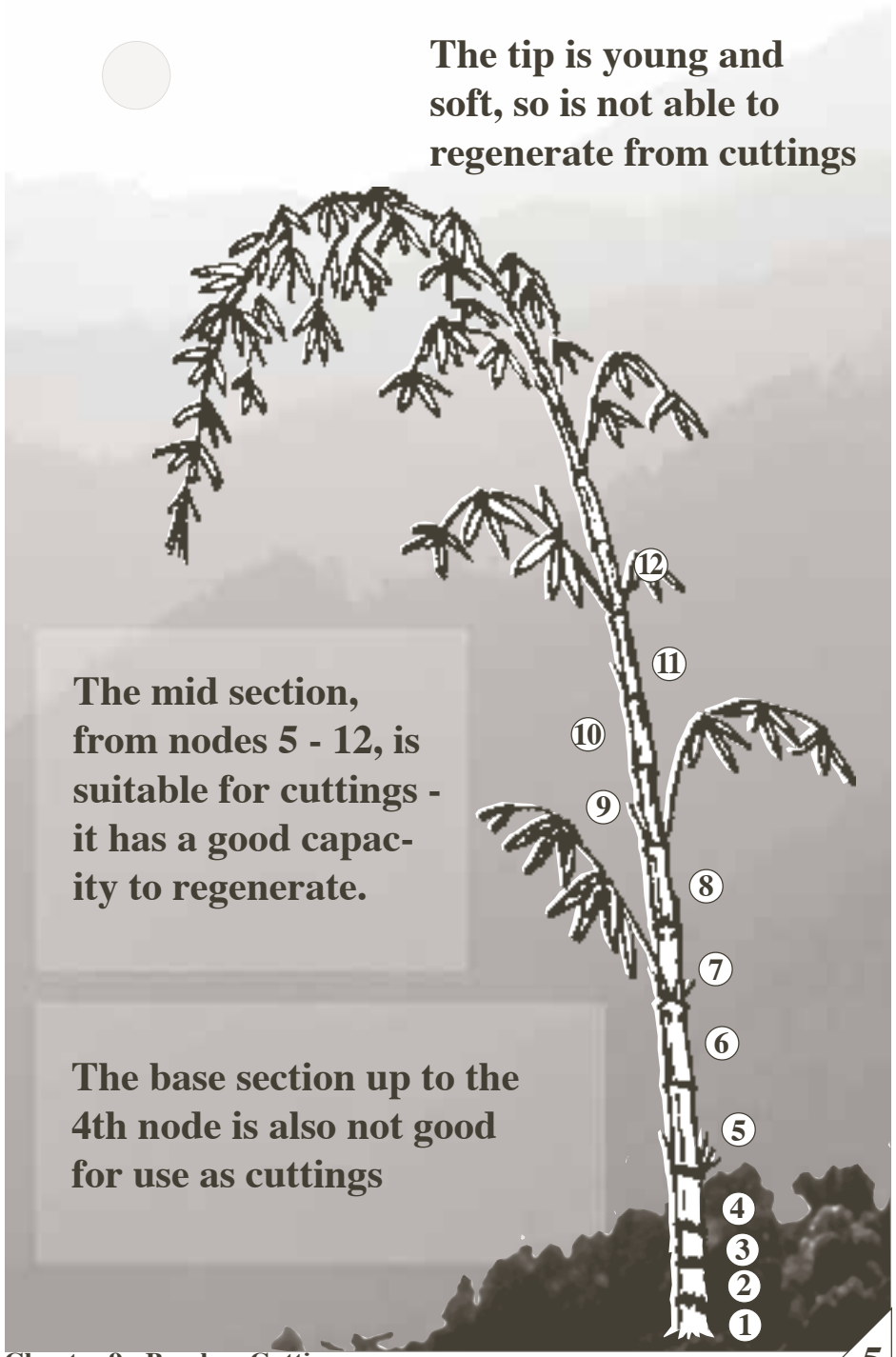
Method of cutting

Considering the above points, the first stage is to select the bamboo for cutting.

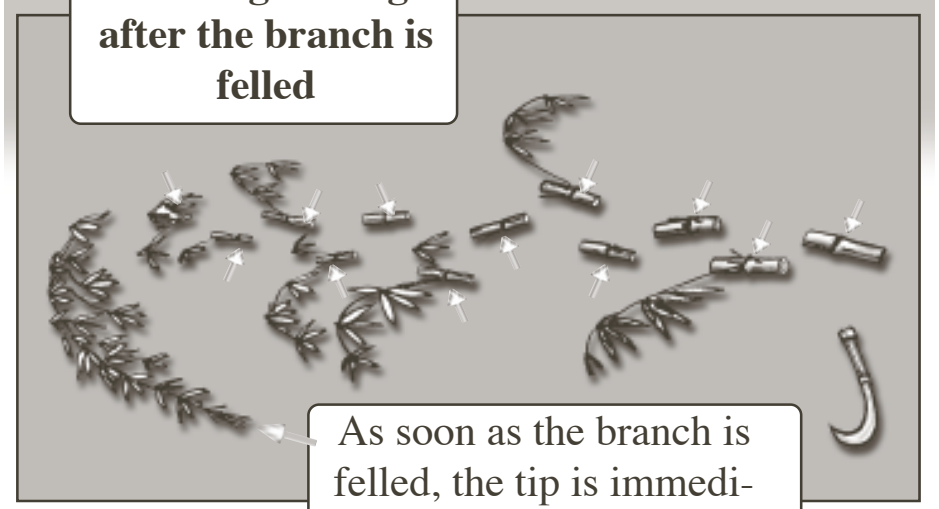
Things to consider when cutting the bamboo



- Be careful not to damage the chosen bamboo as you fell it
- Also be careful not to damage nearby bamboo stems
- Use sharp tools (axes, machete, hook, etc.)
- As soon as the branch is felled, immediately cut off the tip from 1 inch diameter, otherwise this drains its capacity to regenerate
- Use the base and tip for something else



Selecting cuttings after the branch is felled



As soon as the branch is felled, the tip is immediately cut off

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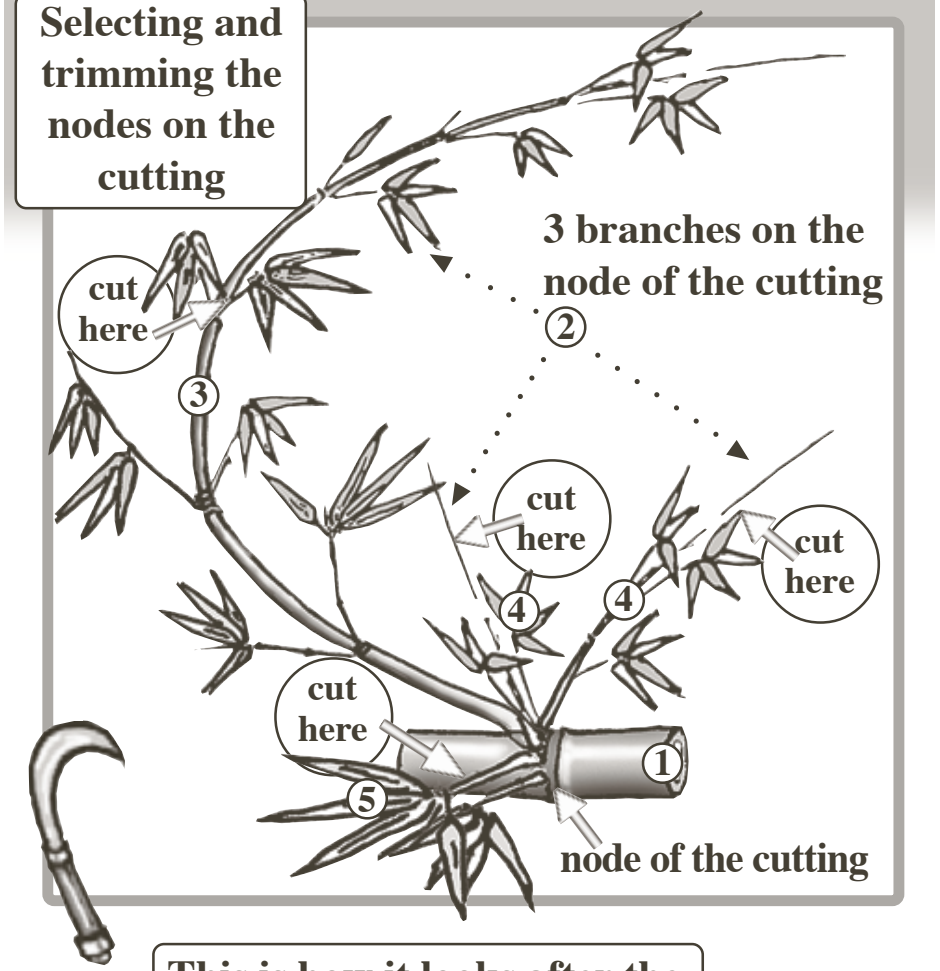
Selecting and trimming the nodes on the cutting



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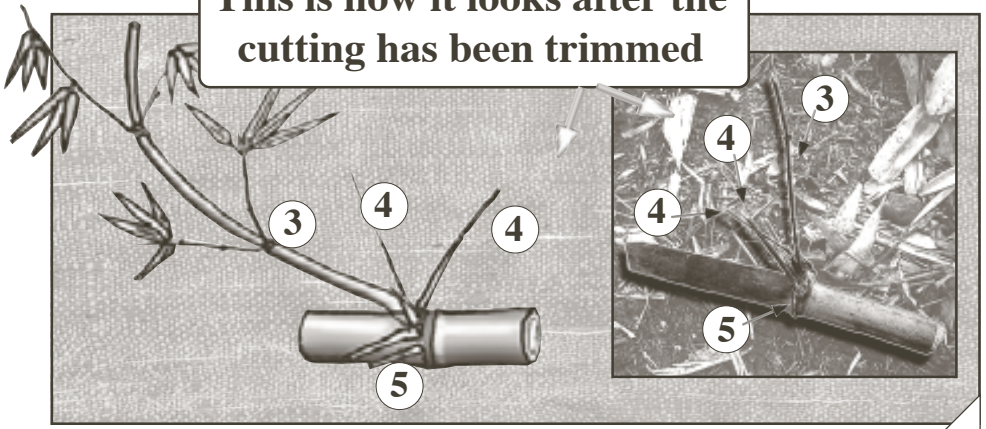

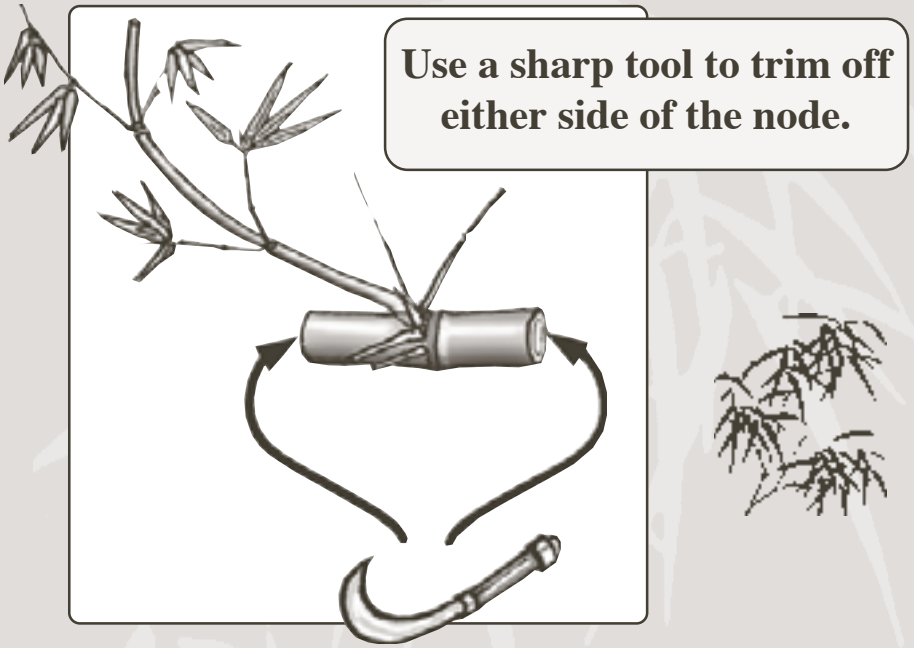

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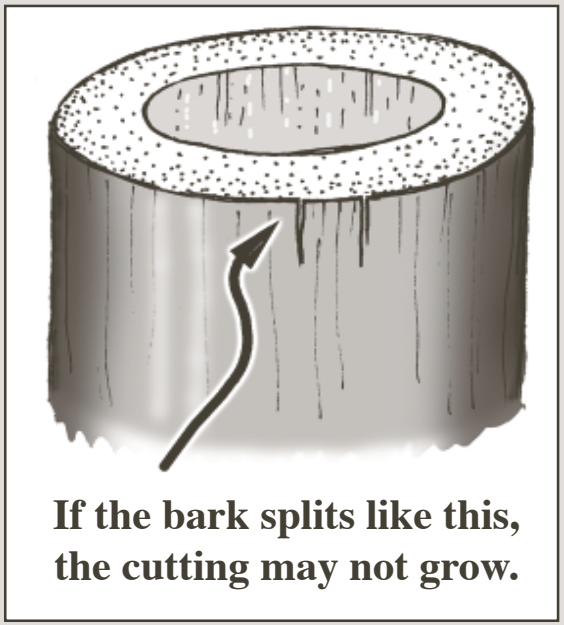

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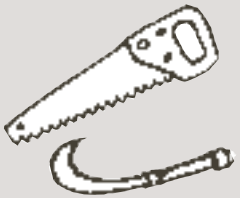
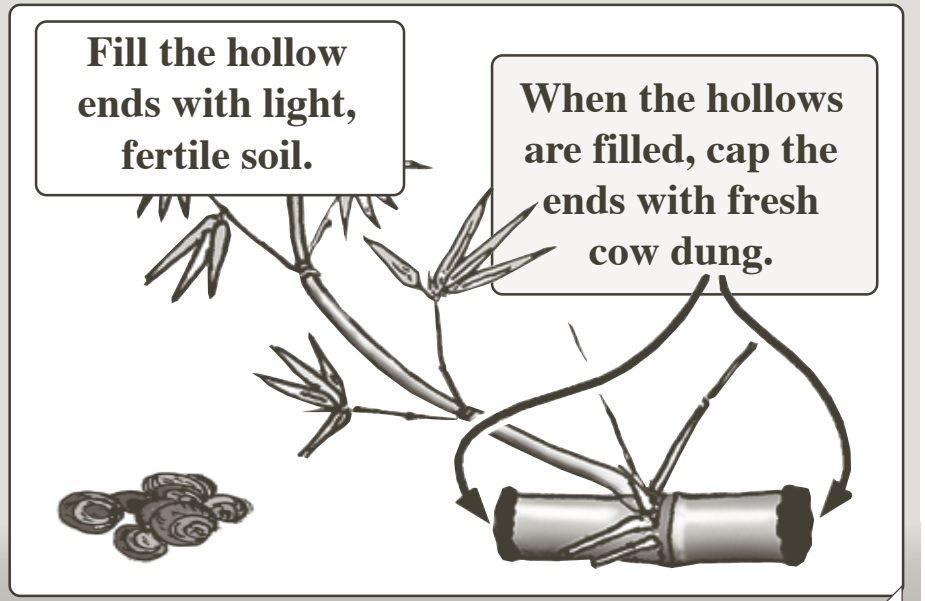


Fill the hollow ends of the cutting with soil and compost. If there is a risk of termites, mix oil seed cake with the soil to fill the hollows. Use one part of oil seed cake to 5 parts soil or compost mix. This will protect the cutting against termites, ants and other soil-living pests.



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- It can also be planted in the fence, river banks, in gulleys and areas of soil erosion.
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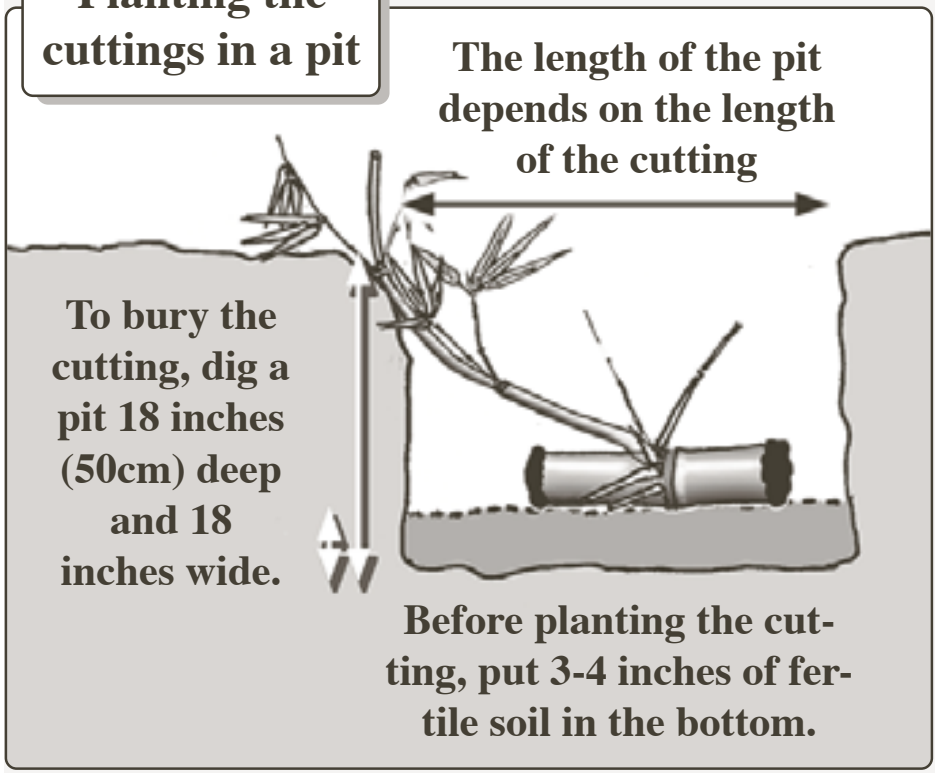
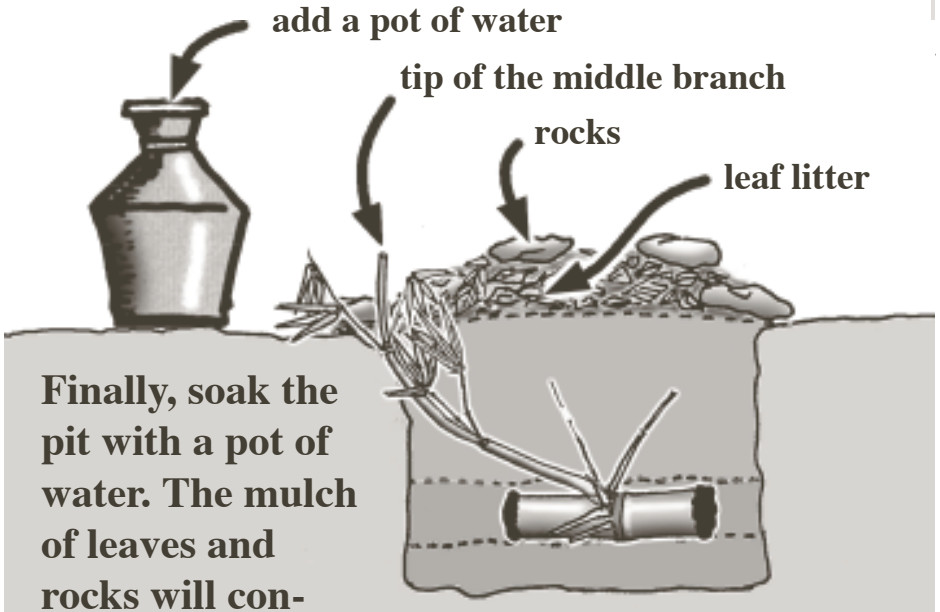


If there's a risk of termites, mix oil seed cake with the fertile soil in the bottom of the pit

Then fill in the pit with soil. Leave the middle branch of the node sticking out of the pit a few inches.

Then mulch the pit with leaf litter and cover with small rocks.



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Finally, soak the pit with a pot of water. The mulch of leaves and rocks will conserve moisture. Even so, it's best to water the cutting 2-3 times a week in the dry season, if possible.

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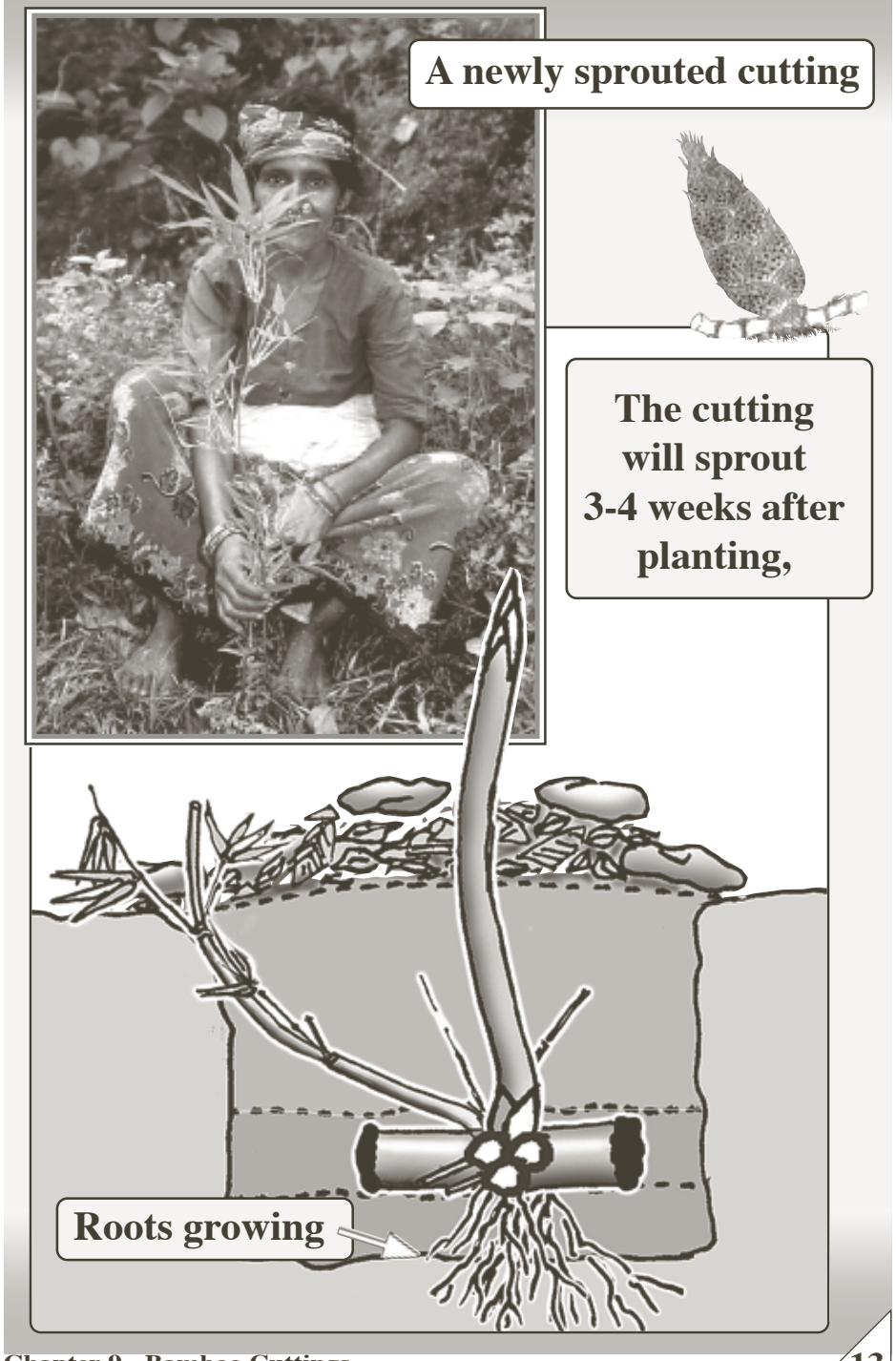

Maintenance

How to maintain a bamboo cutting

- The cutting should be protected from livestock. People also shouldn't step where the cutting is planted.
- Water the cutting 2-3 times a week if possible.
- The bamboo grown from cuttings can be harvested for use after it is 3 years old.

Uses of bamboo

- Important household items like baskets, winnowing trays, etc. are made from bamboo
- Craft industries using bamboo provide many people with employment
- Local bamboo can replace timber and plastics bought in from the outside, which helps to make the community more self reliant
- This also saves money
- It's using a local resource
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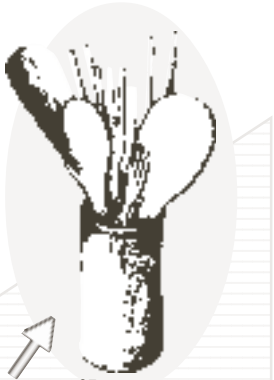
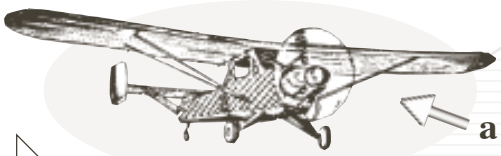
- Once planted, bamboo lasts many years
- From the cradle to the grave, bamboo is an essential part of daily life



bamboo utensils



a plane made from bamboo

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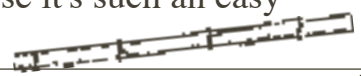

Read On !

Subjects Related to Bamboo Cuttings

This book provides enough information for you to be able to make your own bamboo cuttings. However, this information is also linked to other methods. For extra benefits let's read, learn and practice from other related chapters.

Bamboo Cuttings chapter

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Bamboo is very useful for soil conservation. In this chapter, we describe the nature of soil, how to protect existing soil, and show how to regenerate damaged soil making it into into productive land again.

Planting bamboo, as well as other useful trees and shrubs, helps to protect the land as well as providing many other important benefits. Information about planting and maintaining a living fence is given in this chapter.

What is a Bamboo Cutting ?

Mrs Myasu Garanja's bamboo, which she planted from a cutting

Bamboo is an extremely useful plant which has been used for hundreds of years in society. When its shoot is young, it can be eaten as a vegetable. When the stem is strong, it can be used to build houses. That's why there's a Nepali saying that goes "when young, a vegetable; when mature, a house". In the villages, they also say that bamboo can be used for anything, except as a plough share. The traditional way of propagating bamboo is by digging up the root and transplanting a section to a new place. But this involves a lot of difficult work, takes much time, and many other plants can be damaged as it is transplanted.

So in this chapter, we show an easy and quick way of propagating many more bamboo than was previously possible.

Why make a bamboo cutting ?

Planting a bamboo from cuttings gives more benefits from less work. In less time, many more cuttings can be planted, saving work for farmers.

The traditional way of digging up bamboo with its roots causes damage to other plants, and much soil needs to be moved. So by using cuttings, this damage is also prevented.

Benefits of Bamboo cuttings

- It's a quik and easy method
- With less work, many cuttings can be planted
- One bamboo branch can make many cuttings
- The original clump isn't damaged by making cuttings

This Chapter's Author

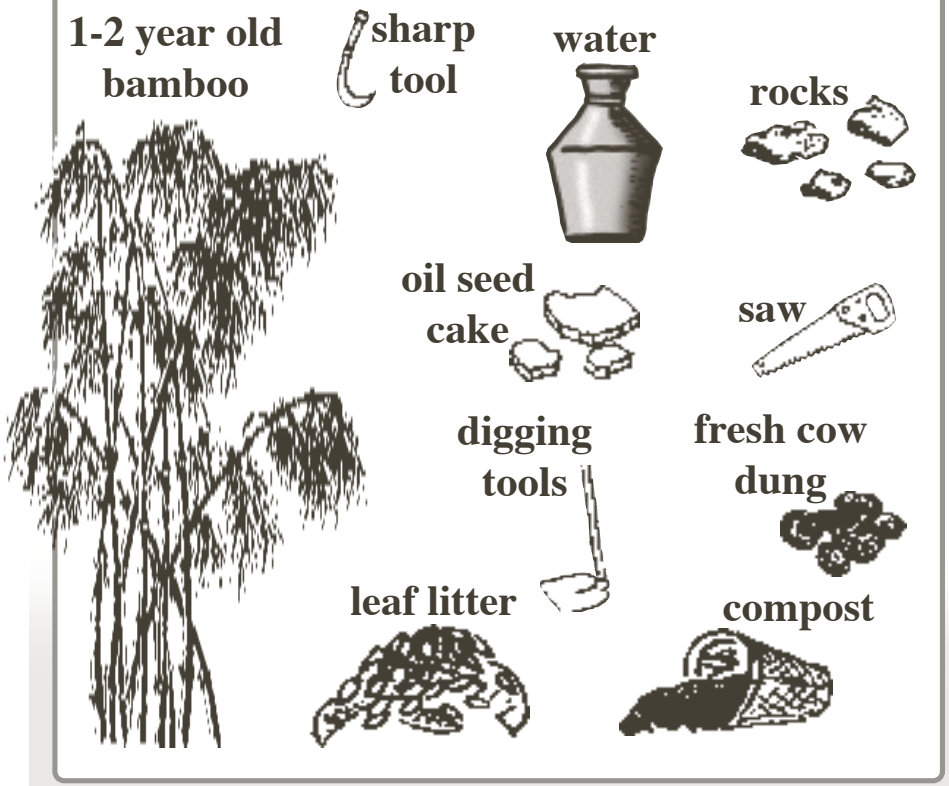
Mr Laxman Rana
Community Service Group,
Dahachaur 4, Surkhet, Nepal

How to make a bamboo cutting ?

Which bamboo can be used to make cuttings ?

There are many types of bamboo, from hot, tropical, low lying areas to cold, high altitude areas. Most types can be used, except cane bamboo, and bamboo which has only a very small hole, or no hole in the middle.

Materials Needed to make bamboo cuttings



Things to consider when selecting the cutting

- the bamboo should be between 1-2 years old
- the bamboo should be healthy and free of disease

Time to plant

In hotter, lowland areas, cuttings are taken from mid-winter (mid January in N.Hemisphere) for up to 1 month. In hilly, cooler areas, the time starts up to one month later, until late spring (April).

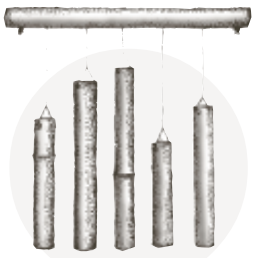
Length of time to sprouting

A successful cutting will sprout within 3 months.

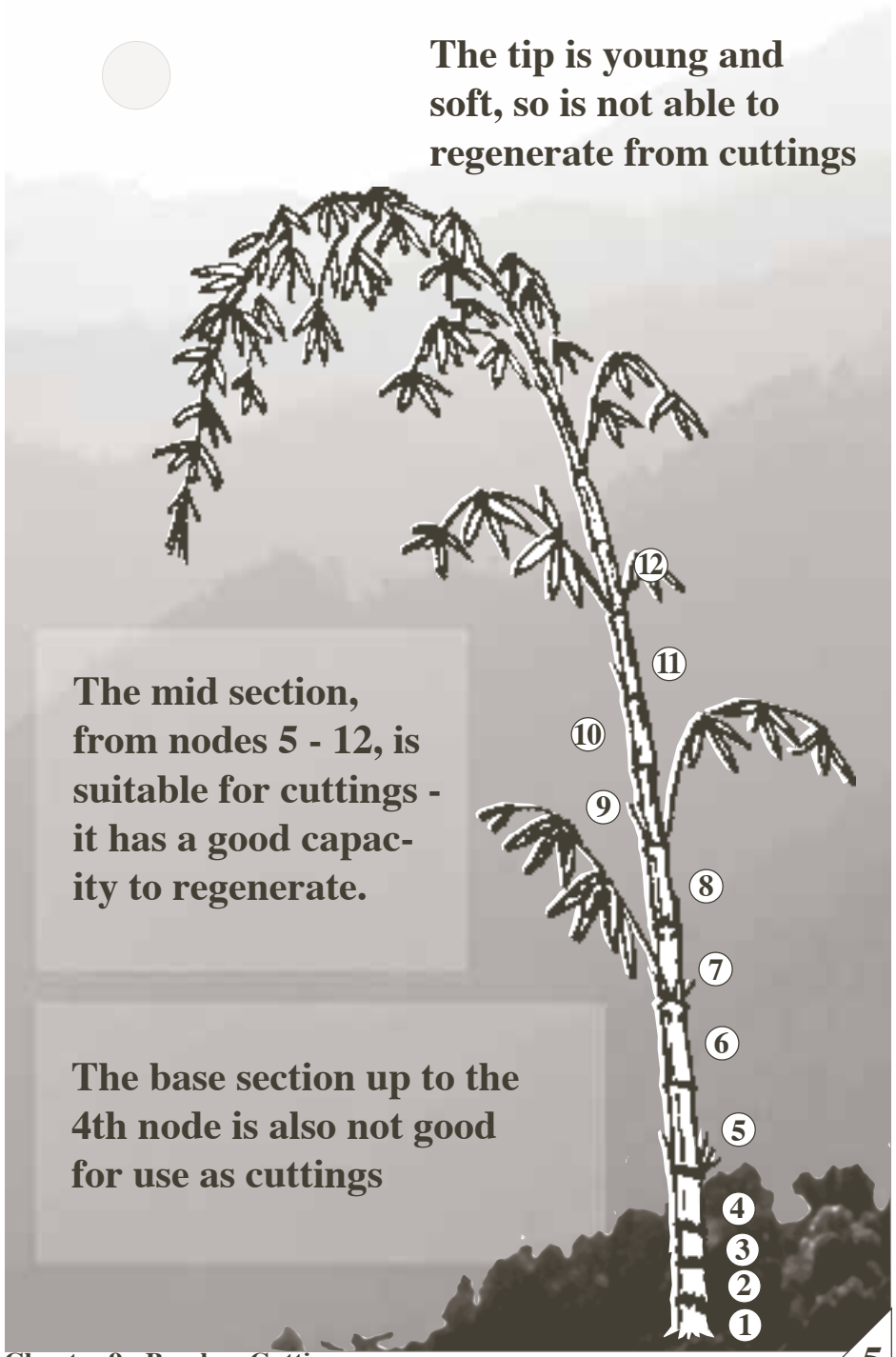
Method of cutting

Considering the above points, the first stage is to select the bamboo for cutting.

Things to consider when cutting the bamboo



- Be careful not to damage the chosen bamboo as you fell it
- Also be careful not to damage nearby bamboo stems
- Use sharp tools (axes, machete, hook, etc.)
- As soon as the branch is felled, immediately cut off the tip from 1 inch diameter, otherwise this drains its capacity to regenerate
- Use the base and tip for something else



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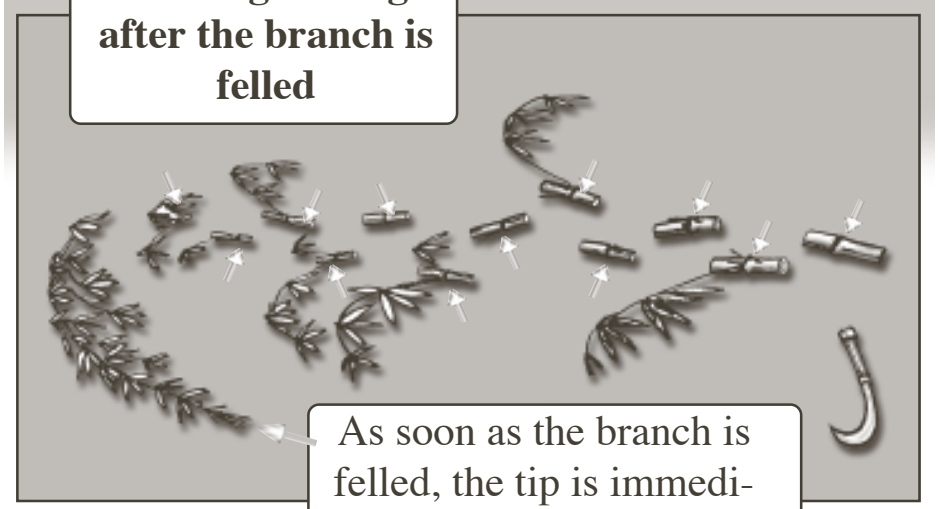

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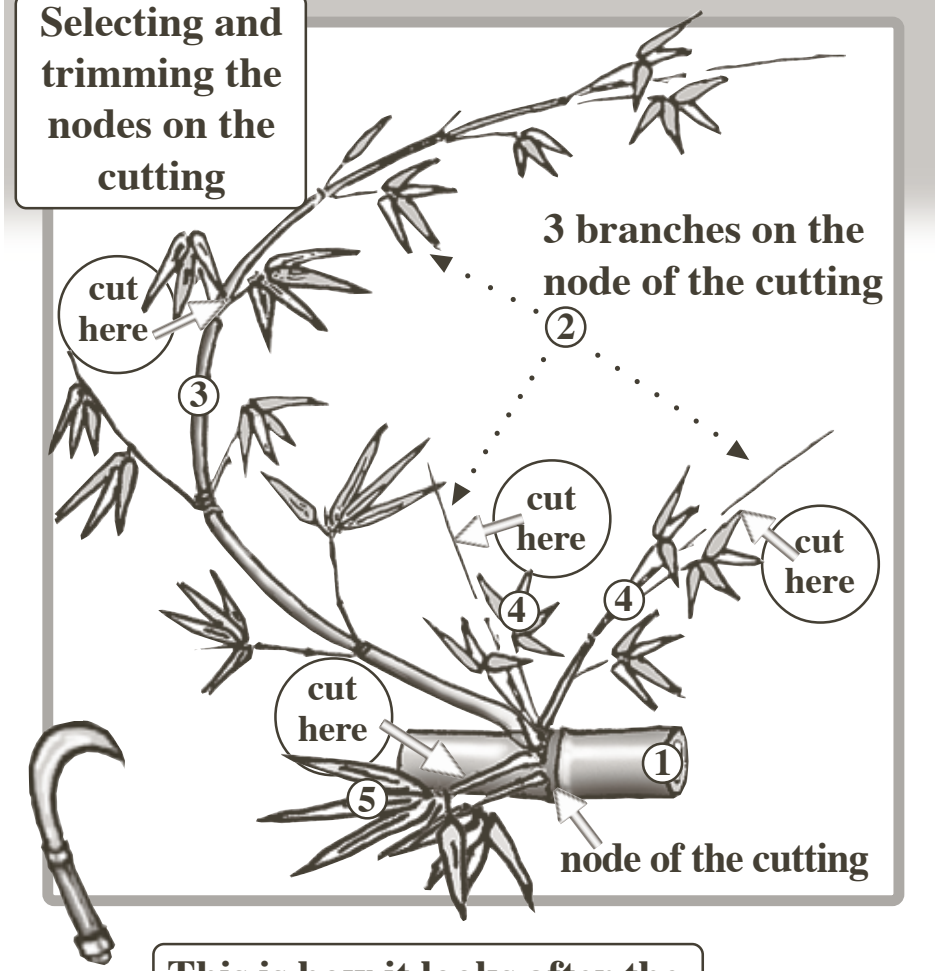

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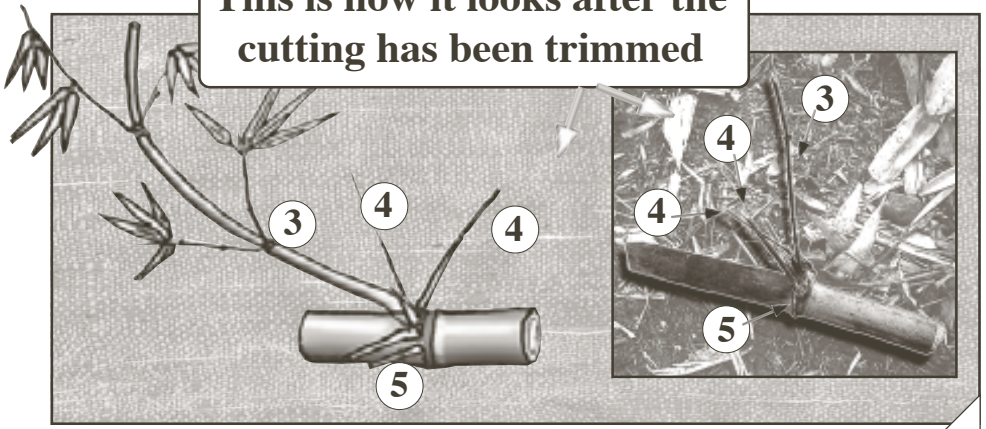

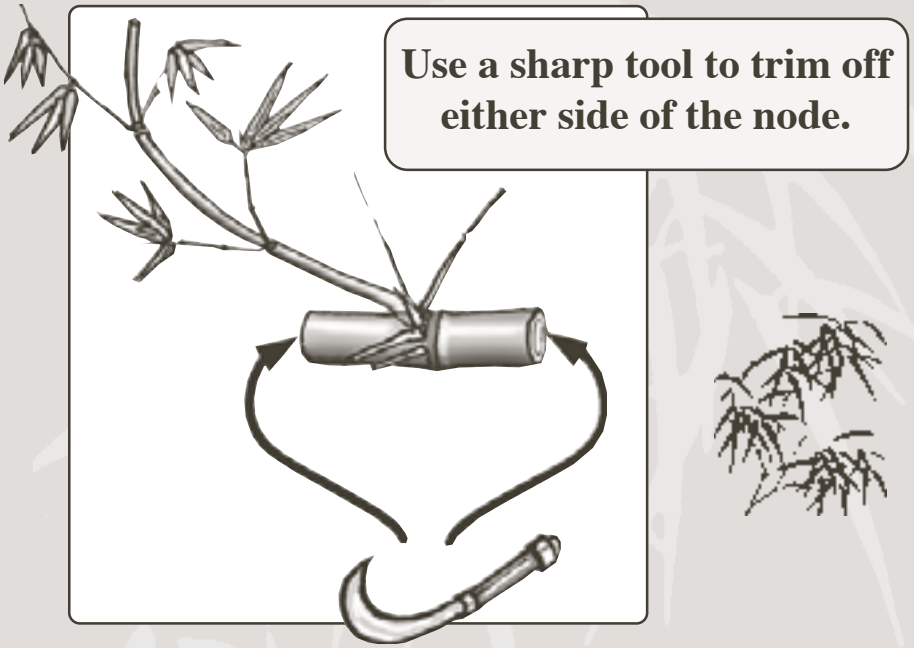

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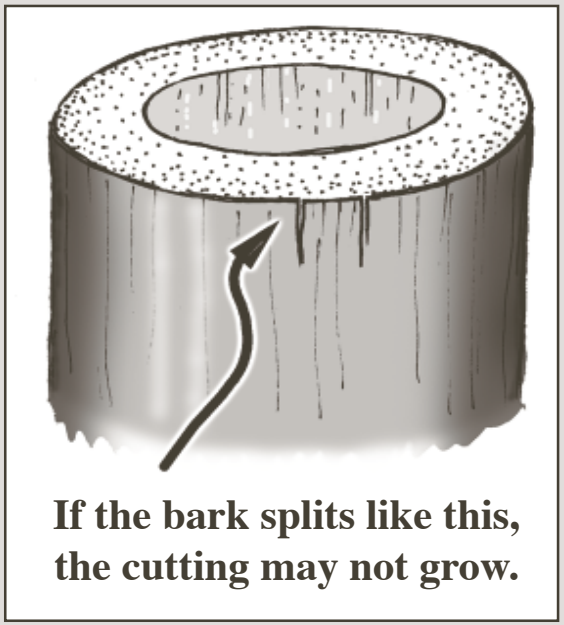

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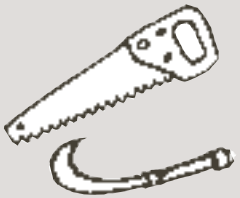

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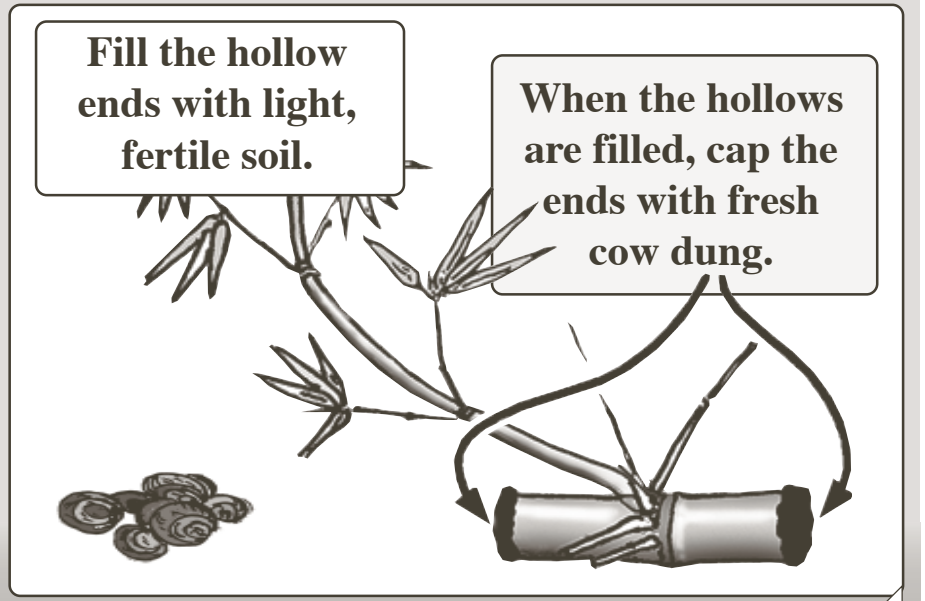

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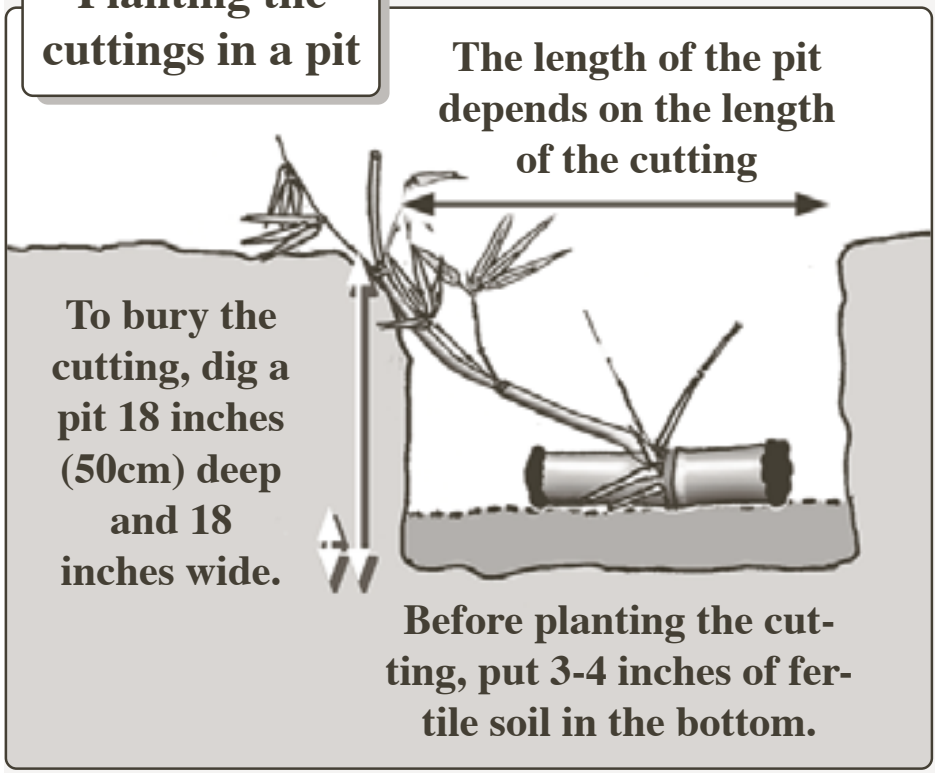

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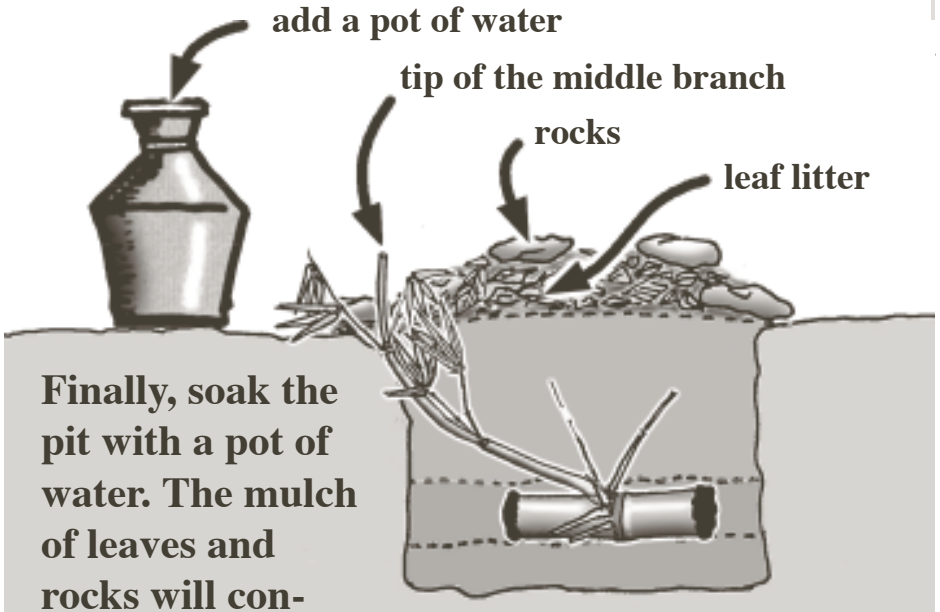

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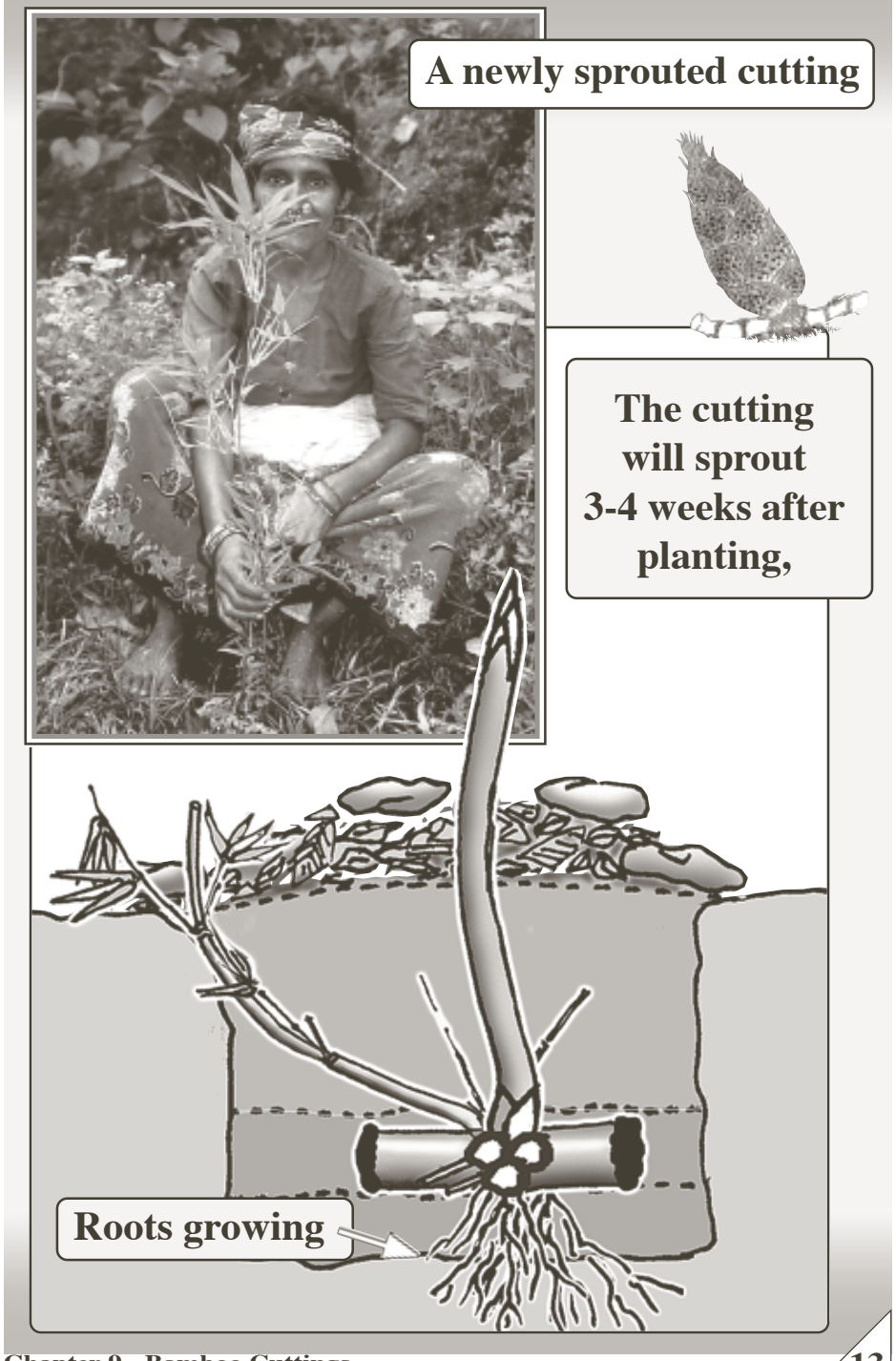

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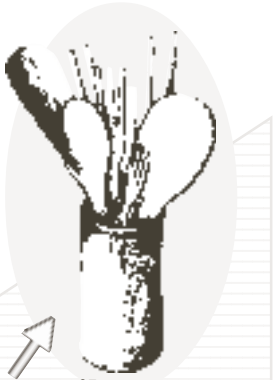

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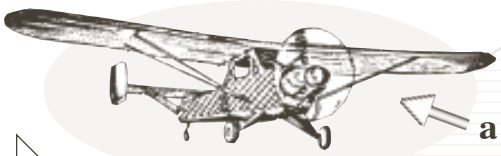

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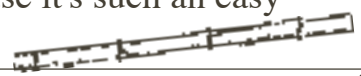

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What is a Living Fence ?

A living fence along a path, Nepal

A ***Living Fence*** is a fence made of living trees and shrubs. Made from thorny or non-thorny plants, it can also be called a green fence, or hedge.

There are many ways of using a barrier to prevent harmful pests from coming onto the land. Everyone knows that stone and mud, bricks, barbed wire, bamboo, or even cut branches can be used to make a fence. But the most productive form of barrier is the living fence, because as well as being a barrier, it can also produce many other benefits for the home.

In this chapter, information is given about making and managing a living fence.

Why make a Living Fence ?

Benefits of the Living Fence

- Crops are protected against harmful pests.
- The living fence can act as a windbreak.
- As well as protecting the land, various products such as fodder, firewood, medicines, timber, nectar, etc. can be taken from the living fence.
- Beneficial animals such as predator insects can also find a place to live in the living fence.
- The living fence saves money.
- It prevents soil erosion.
- It can prevent terraces from collapsing
- It can be used where materials for fencing are not found, e.g. plentiful rocks, barbed wire, large branches or trees, etc.

So, as well as using the live fence for protection, it can also be used to increase farm production. If a fence has tree cotton in it, for example, this is even a cash crop. Citrus varieties such as orange, lime, lemon, etc. can make very good fences. They also produce valuable fruit, and are good for bees.

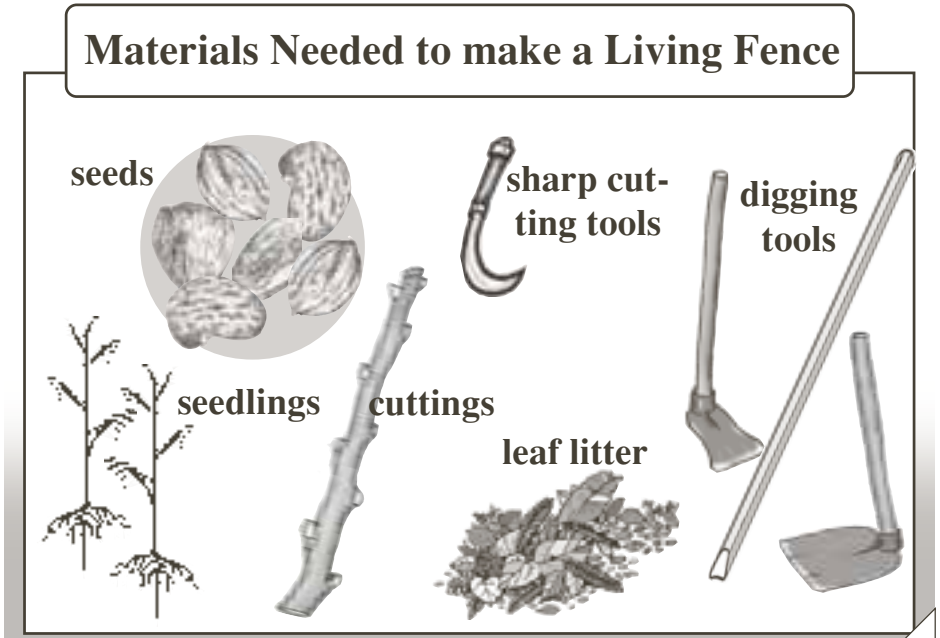
This Chapter's Author:

Mr Bhuvan Khadka
Himalayan Permaculture Group,
Surkhet, Nepal

How to make a Living Fence ?

Where to make a living fence ?

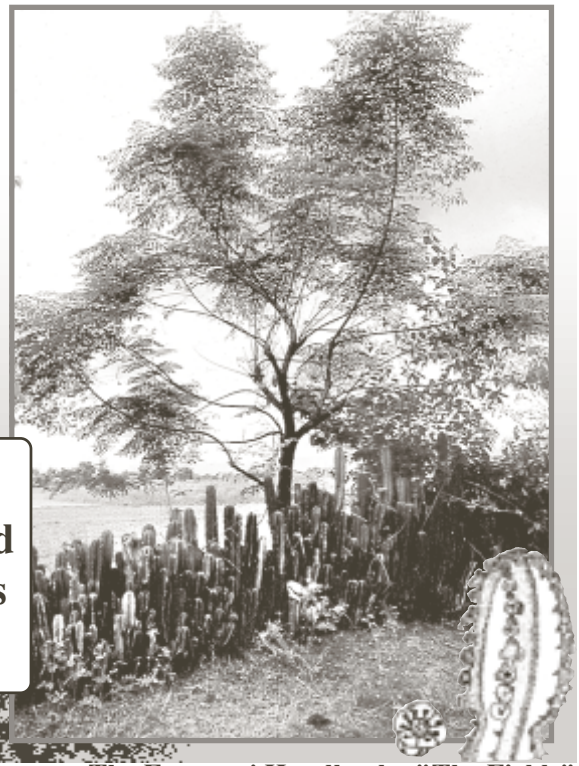
According to your location and its climate, landscape, soil, etc. there are many plants that can be used for a living fence. Planted on the edges of the land, the living fence protects against harm from the outside, including the wind. Within the farm, living fences are useful along **edges** such as pathways and edges of fields or terraces. They can give shade and shelter, as well as other useful farm produce. The kitchen garden can be protected by a living fence, and even separate vegetable or nursery beds can have their own small living fences.



Choosing what to plant in the living fence

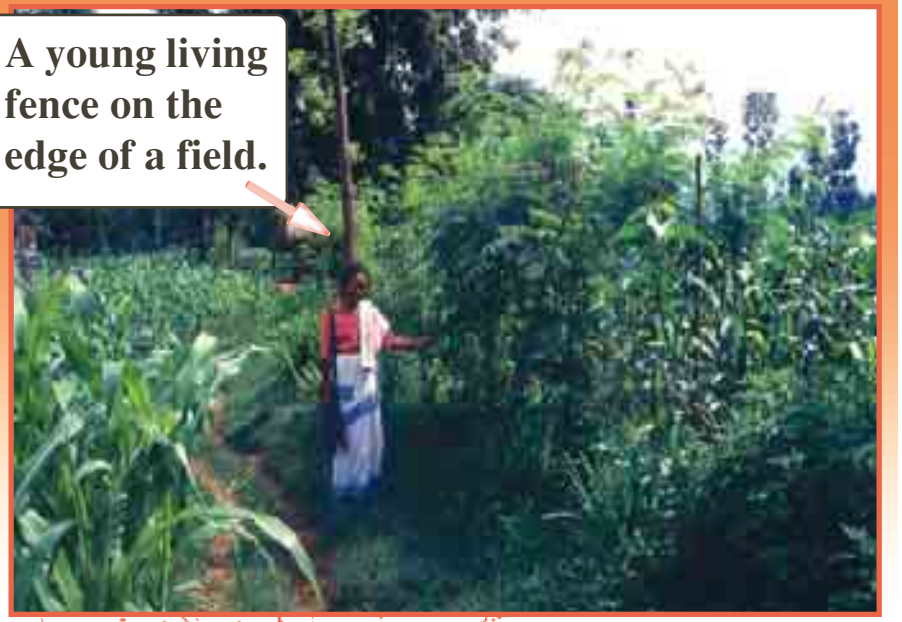
Many types of plant can be grown in home-made nurseries and planted in the fence when they are large. Many species grow from burying branches in the soil like cuttings. The fence can also be planted with suitable seedlings collected from the forest. Different methods for growing seedlings are descibed in the ***Home Nursery*** chapter.

By collecting seed and cuttings from around the community and local forest, and making home nurseries, we can grow small, large, climbing vine, or any type of seedling. In the living fence it is good to have as many thorny plants as possible, such as blackberry, *Berberris,* babool *(Acacia nilotica),* baer *(Aeglis),* blackthorn, hawthorn, honey locust, mesquite *(Prosopis),* khayer *(Acacia catechu)*, etc. Thorny plants are mainly useful around the boundary of the farm.



Living plants make a fence and also give various other products

Let's See how to make a living fence



A young living fence on the edge of a field.

At high altitude, castor in the fence produces lots of biomass.

A fence can also be planted within the farm. Here, various useful trees are planted along the edge of a path.

The fence shades the path as well as giving other products.

Within the farm and on the edge of paths, useful plants like worm-wood, *Lucaena,* lemon grass and marigold have been planted.

Ipomea (morning glory) is grown easily from direct cuttings, and woven into a thick, strong fence.

Lemon grass helps to stop weeds from growing into the kitchen garden, and can be cut for mulch

In Britain, willow branches are densely planted. They sprout and are woven together to make a strong fence

Maintenance

How to maintain a Living Fence

Things to consider when making a living fence

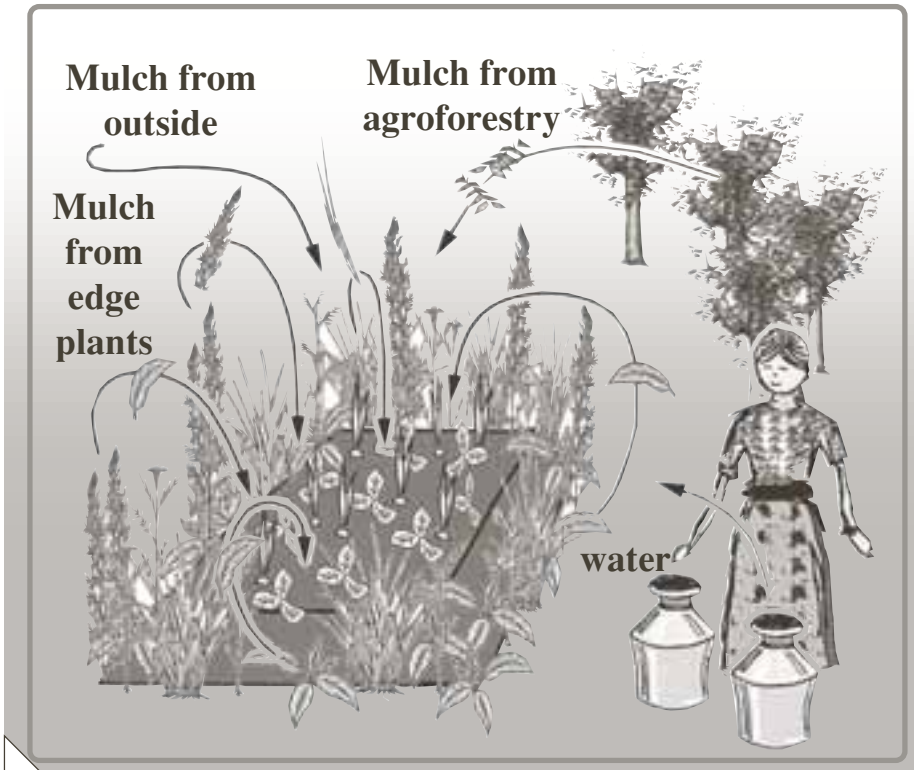
After planting seed, seedlings or cuttings in the living fence, mulch thickly with straw, leaf litter, etc. This controls the weeds, and allow the plants to grow well. Weeds need removing, and the plants should be watered if possible. Replace any plants that die.

Once the plants have grown, there is not much maintenance. Well planned harvesting of products from the fence is the only maintenance that is needed. Cutting or pruning branches will give yields of fodder, firewood, mulch material, etc. If there is too much shade, branches can be cut to let in more sun.

Firewood collected only from the living fence

The kitchen garden needs a good fence around it to protect against strong sun and wind, livestock, weeds and other harmful things. Inside the kitchen garden, each vegetable bed can be surrounded by small fences of comfrey, lemon grass, basil, marigold, wormwood, and *Adhatora* which protect against invasive weeds and even flying insect pests. There are other beneficial yields of mulch material, fodder, flowers, etc. This can also be called **edge farming** or **companion planting.**

Biomass cut from the living fence helps to increase yields from the land



Farmers' Experience

Mrs Khagisara Gharti

From Nepal, Surkhet district, Gumi - 3, Ratadada village, and a member of "Hariyali" women's group, Mrs Khagisara Gharti has planted her own living fence. Now let's hear what she says.

Mrs Khagisara Gharti

"It's been 5-6 years since I planted our living fence. I learned it from the Homestead programme (JPP). There are many benefits from the fence. I'm always cutting fodder and bedding, firewood and so on from the fence. Leaves can be cut and mulched directly on the soil, or carried to the livestock and used as bedding or fodder. Because it's in your own fence, it's close and only takes a moment to cut and gather. It takes a few years to start producing well, but now this method has saved me a lot of time. I've planted mulberry, *Lucaena,* tree cotton, *Ipomea, Melia,* and the like in the fence. If any gaps appear, I plant something else to fill it straight away. "

Read On !

Subjects Related to Living Fence

This chapter provides enough information for you to be able to make your own Living Fence. However, this information is also linked to other methods. For extra benefits let's read, learn and practice from other related chapters.

Agroforestry chapter

Planting trees on farmland can bring farmers many benefits. But you can't plant just any tree, anywhere. This chapter gives information on how to plant trees without affecting farm yield.

Chapters on how to make various nurseries

Different types of nursery are needed to grow a variety of different plants. Information on how to build and manage the home nursery, fruit nursery, air nursery, hot bed and leaf pots is given in these chapters.

Mulching chapter

Mulch keeps the soil covered, keeps weeds down and conserves water. Information on how to mulch the soil is given in this chapter.

Livestock Management chapter

In this chapter information is given about producing fodder near the house and other easy methods to improve management and health of livestock.

What is S.R.I. ?

It has become difficult to increase production from traditional rice farming. It needs extra labour and a lot of compost. Farming with modern methods is also expensive in outside inputs. With conventional methods, only by using expensive chemical fertilisers, pesticides and hybrid seed can farmers increase their production.

It is increasingly difficult for ordinary farmers to afford all these things. It is also known that using chemicals is harmful to the environment

A clump of rice grown with the SRI method. This has grown from a single seed.

So here we are demonstrating a new method of growing rice which can use local seed and organic compost, while still increasing rice production. This method is called ***"System of Rice Intensification" (S.R.I.)***, and in this chapter we describe the principles and methods of SRI.

Why do SRI ?

Benefits of practicing SRI

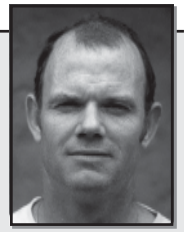
- rice production increased
- less water needed
- less seed needed
- no extra external inputs needed
- can use local/traditional seed
- due to better soil and water management:
  - less pests & disease
  - better quality grain
  - more fertile soil

How to do SRI ?

SRI involves four major changes from conventional rice production:

1. The seedlings grown in the nursery beds are transplanted after just 8-10 days, or at the 2-leaf stage.
2. Seedlings are transplanted singly, not in a bunch.
3. Seedlings are transplanted at a wide spacing, from 20 to 50 cm apart.
4. Much less water is kept on the paddies.

This booklet's author
Chris Evans, advisor,
Himalayan Permaculture Group, Nepal
www.designedvisions.com

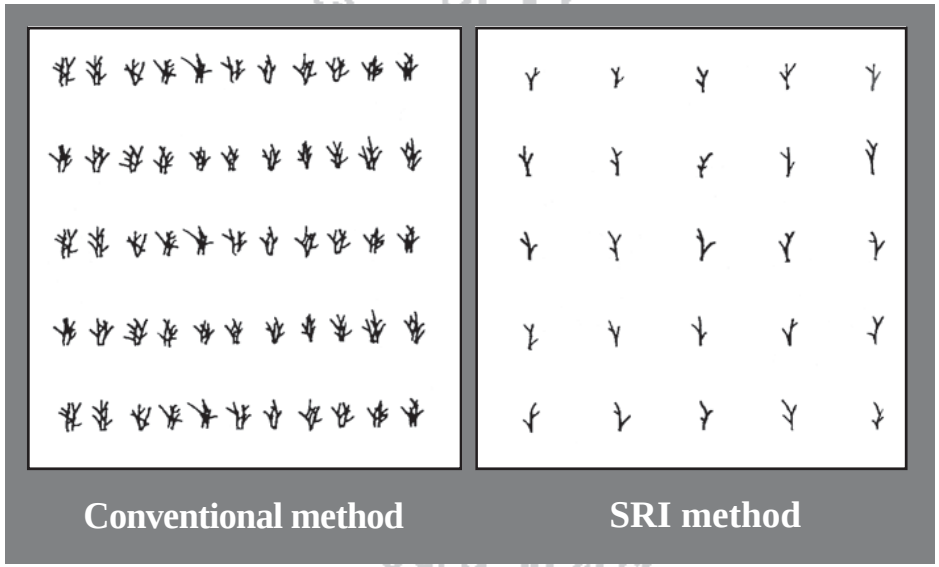


1. The seedlings grown in the nursery beds are transplanted after just 8-10 days, or at the 2-leaf stage. It is the ***biological*** age of the seedling which is important rather than the number of days. In warmer areas the 2 leaf stage is reached in just 8-10 days. This may take 3 or even 4 weeks in colder areas. The old seed case is still attached to the plant at this stage. Such a small seedling should be transplanted with much care not to disturb the roots, and when planting, the roots should be pointing down, not bent upwards as often happens when planting quickly. When are left pointing upwards, the ability of the plant to grow and seed well is reduced. When the seedling is planted small, it can grow without being disturbed, its roots grow bigger and so it can produce better grain.

2-leaf seedlings

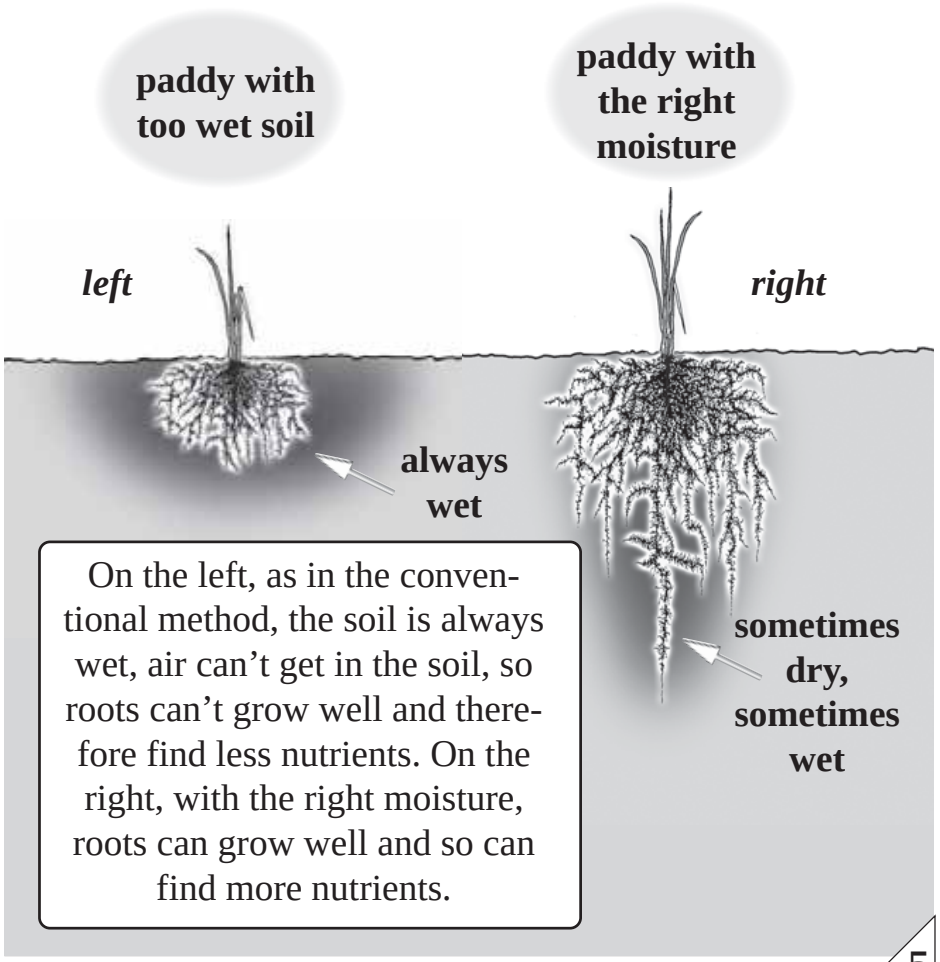
At Sunrise Farm in Kathmandu, Nepal, rice seed is sown in old egg boxes filled with soil. This means less root disturbance when planting the seedlings.

2. Single seedlings are transplanted. In the conventional or traditional method, a bunch of 3-6 seedlings are planted together in a clump. This leads to competition between the roots, and later the leaves. Single seedlings do not compete and they can get more access to nutrients and water.



3. Seedlings are planted at wide spacing. There can be between 20 to 50 cm between single seedlings. Seedlings that are in clumps and planted close together suffer from competition (as in 2. above). They will compete for water, nutrients and light. Planting far apart means that each seedling has lots of light and plenty of space to obtain nutrients and water. Also, when single seedlings are spaced wide apart much less seed is needed. If the conventional method needs 100 kg per hectare of seed, with SRI only 7 kg of seed is needed to plant a hectare.

4. After transplanting, much less water should be allowed onto the paddy. In the conventional method, paddies are kept flooded only to control weeds in the rice. But this means that less air is allowed in the soil. When the soil is waterlogged, scientists have found that up to 75% of roots can die. When there is too much water, the roots do not grow well. In SRI, out once the seedlings are established, water is managed to keep the soil moist and sometimes even dry. This promotes good root growth, so the plant can find plenty of nutrients from a bigger area.

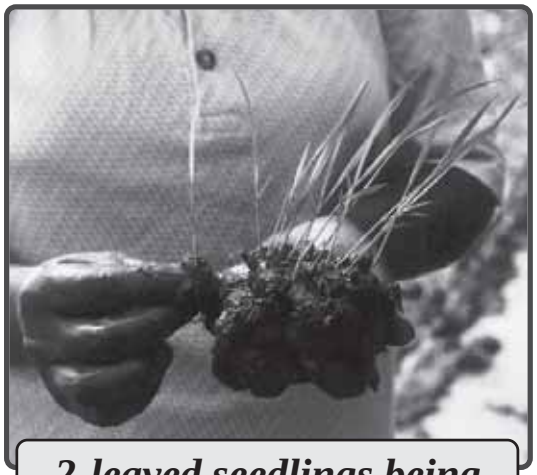


Taking the above 4 differences into account, the SRI method is described below

1 As in the traditional paddy rice cultivation, first sow the seeds in a nursery, but sowing more thinly makes it easier to transplant the small seedlings later on.

2 Seedlings are planted when they are 8-10 days old (in warm areas) or whenever the 2-leaf stage is reached. At this time the rice seed husk is usually still attached to the seedling.

3 When transplanting the 2-leaf seedlings great care must be taken not to damage the roots, or expose them to the sun. The seedlings should be planted as soon as possible - if possible within 15-20 minutes of uprooting.



2-leaved seedlings being lifted from the nursery.

A rake is used to mark out planting distances. The distance between teeth of the rake becomes the planting distance of the seedlings

Shyam's rake has holes on the horizontal bar at different distances. This means he can set different widths to mark out his planting distances.

4 When planting the seedlings, the roots should point downwards, not be bent upwards.

The seedlings are then planted according to the marks of the rake, anywhere between 20-50cm.

5 Plant the seedlings singly, one-by-one. The distance between seedlings can be 20 to 50cm. Farmers can research this themselves to find which distance is best for management and yield. Some farmers prefer 40cm, some 30, etc.

The roots of the seedling should point downwards

6 For up to 2 weeks, as the seedlings are establishing , the paddy should be kept wet. After this, water should be managed to allow just the right amount of moisture. Once every 1-2 weeks the soil can be allowed to completely dry out, even crack. In the monsoon season, rain should be enough to satisfy water needs. If irrigation is needed, flood the field once in the evening, allow it to soak in overnight, then drain off any excess water. When the rice flowers, more water can be allowed to flood the field. From 3-4 weeks before harvest, no irrigation should be done & the field drained.

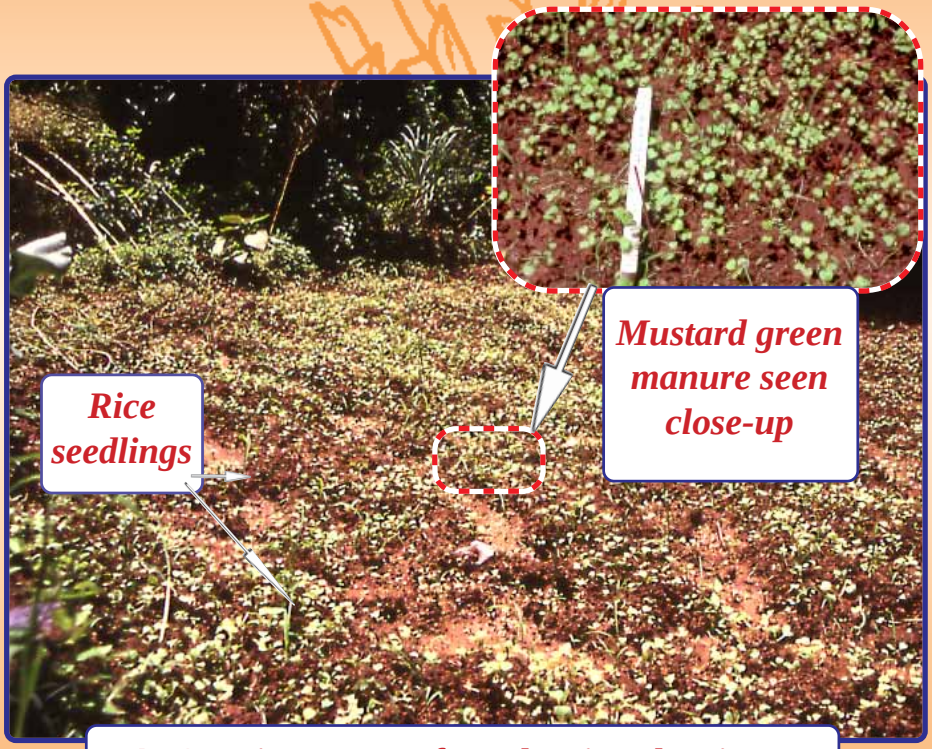
Fields under SRI, one month after planting

Compost

Good organic fertilizer for the soil is crucial for the success of SRI, to give good root growth. Because plants are far apart, mulch can also be added. Mulching will also help control the weeds. Green manures can also be used. For example, before planting rice, sesbania can be grown and ploughed into the soil. Mustard can also be sown with the transplanting to control weeds, and be dug in at time of first weeding.

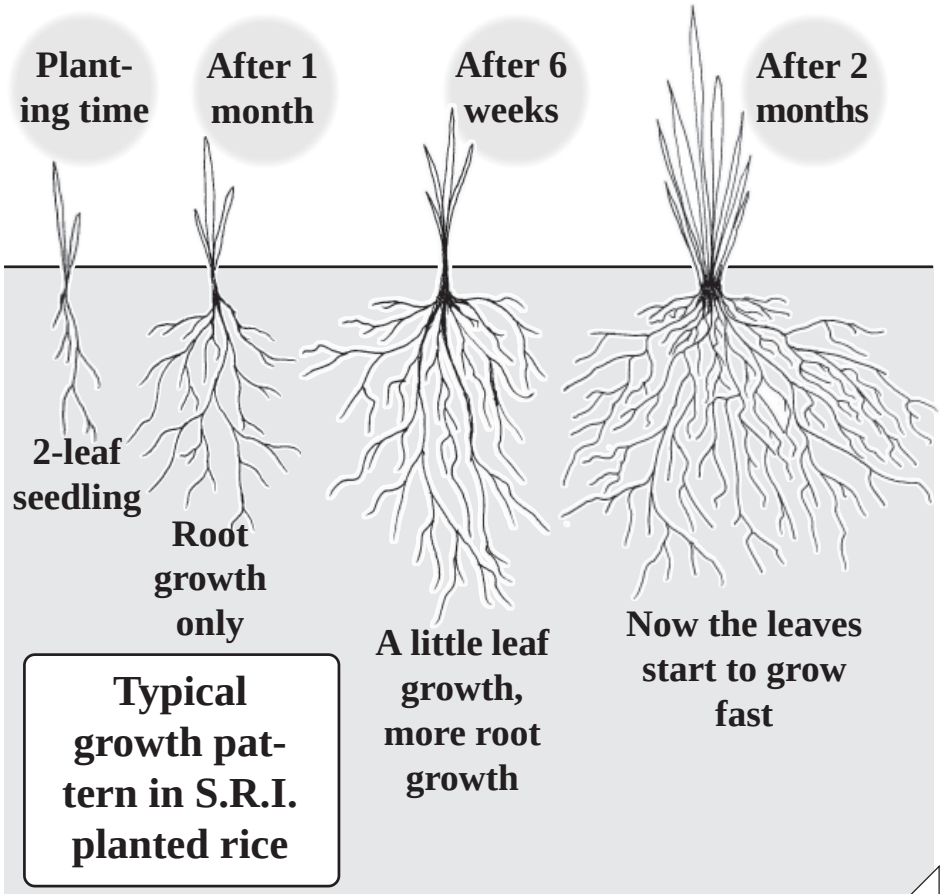
Weeding

In SRI because the soil is not saturated with water, and seedlings are further apart, more work is required in weeding. The first weeding should be done about 10 days to 2 weeks after transplanting. The next weeding may be 2 weeks later. At least 3-4 weedings will be needed, but in SRI the more weeding is done, the better the rice production will be. Uprooted weeds should be left to rot on the soil.



At Sunrise Farm, after planting the rice a green manure of mustard is sown. This helps to control weeds, and after 2-3 weeks is dug in, which helps to aerate the soil as well as providing a source of nutrients.

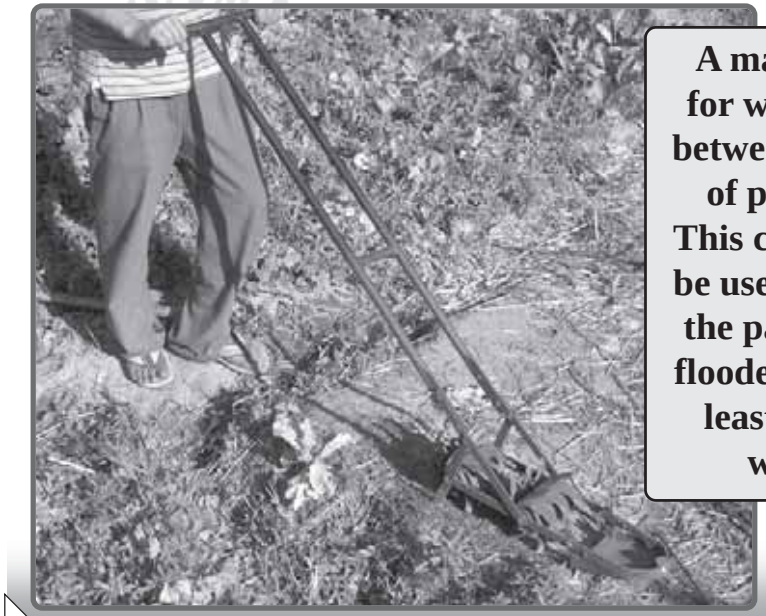
Because seedlings are small and planted far apart, for up to 1 month the crop may look very poor. But at this time, most development is going on in the roots. In the second month, tillering starts and in the third month the above-soil plant grows very fast and becomes a thick clump. Most work is needed at planting because the seedlings are small and need great care. But as experience grows, this work can be done faster. Weeding takes more work than traditional paddy cultivation, but production increases as a result. Mulching and green manures can reduce the amount of weeding needed.



Typical growth pattern in S.R.I. planted rice

On the left is a rice plant grown with the SRI principles. On the right is a plant grown with the conventional method.

After the SRI rice has been planted, green manures like *Sesbania*, mustard or buckwheat can be sown and then be dug into the soil. Any form of mulch can be also be laid down. Either of these will help to control weeds as well as add fertility to the soil.



A machine for weeding between rows of paddy. This can only be used when the paddy is flooded, or at least very wet.

Rice plants in SRI method

Rice, planted as single seedlings at 40cm distance, is starting to ripen.

A large, multi-tillered clump of rice from a single seedling

Paddy managed under SRI has shown good increases in yield. Double yields are not difficult to achieve, and some farmers have achieved up to 4 times their normal yield. To try out SRI, start experimenting with the above ideas on a small area of your land. If you find good results, increase the area. Form a network with other farmers and research/development organisations, so more people can try and share experiences. Keep good records of inputs and outputs, and any new approaches which work well for you, in your area.

Comparison between conventional and SRI methods

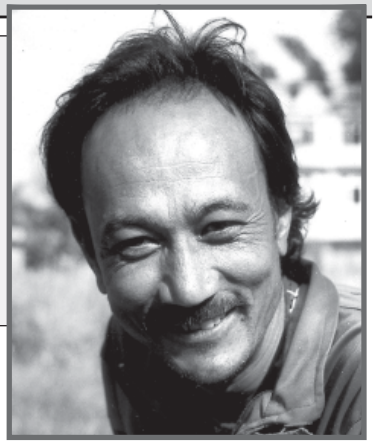
	Conventional method	SRI method
No: seedlings per clump	4	1
No: tillers per seedling	8.3	55
No: seeds per tiller	114	189
No: seeds per plant	824	5858
Yield (tonne/Ha)	2.0	7.3

Joelibarison 1998

Farmers' Experience

Mr Shyam Shrestha

Mr Shyam Shrestha, owner and manager of Sunrise Farm, Sita Paila on the outski-rts of Kathmandu in Nepal, has been growing rice using the SRI principles since 2001. Now let's hear about his experience.



Shyam Shrestha

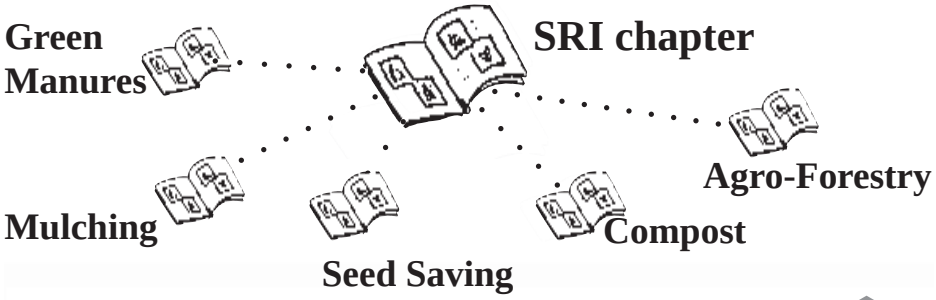
My experience since 2001 has shown me that although SRI requires more thought and work in some areas, the benefits more than compensate for this. But I also think that once we get more practice and develope a habit of planting this way, jobs like planting seedlings and weeding, which take more time at the moment, will become quicker as we get more experienced. You should take care not to put too much water on the fields. I use more mulch to control weeds. You shouldn't weed late - this makes it more difficult later. Before if we weeded twice, with SRI we weed 3 or 4 times. I've used green manures of mustard and *Sesbania*. This keeps the soil more loose and makes weeding easier. With mustard I got a benefit of some greens to eat as well as the weed control and soil improvement. So overall I've seen that with extra work, the fruits are more abundant!

This booklet was produced with the participation of the SRI Group-Nepal, an alliance of (I)NGOs and individuals interested to research, evaluate and network SRI practice in Nepal.
http://groups.yahoo.com/group/sri-nepal
sri-nepal@yahoogroups.com
SRI homepage (International) - http://ciifad.cornell.edu/sri/

Read On !

Subjects Related to SRI

Good benefits can be had from the information in this book about SRI. However, this information is also linked to other methods. For extra benefits let's read, learn and practice from other related chapters.



Green Manures chapter - use green manures to add fertility to the soil and produce more crops

Mulching chapter - how to grow more crops with less work while keeping the soil covered

Seed Saving chapter - information on methods to produce and store various quality seeds at home

Compost chapter - information on how to make good compost quickly is given in this chapter

Agro-Forestry chapter - how to plant and manage trees on farmland to increase and diversify farm yield