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SMALLHOLDER COFFEE PRODUCTION IN PAPUA NEW GUINEA – FARMER TRAINING GUIDE

UNIT 1: BECOMING A COFFEE FARMER

MODULE 3:
ESTABLISHING A NEW COFFEE GARDEN

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The Smallholder Coffee Production in Papua New Guinea Training Program

The training program contains modules prepared in partnership with Australian Centre for International Agricultural Research (ACIAR) and by CARE-International.

The structures of the Extension Officer Training Program and the Farmer Training Program are shown in the table below.

Some modules also contain references to additional training that learners are encouraged to complete as part of their training.

ACIAR Resource

Monograph MN220 Smallholder Coffee Production in Papua New Guinea: a training package for extension officers and farmers. This package contains the modules for both the extension officer training guide and the farmer training guide. The ACIAR monograph is available online from **www.aciar.gov.au**

Hard copies of the ACIAR training package may be available by contacting ACIAR or the Coffee Industry Corporation (CIC)

CARE Resources

Organisational Strengthening Training
CARE Family Money Management Training

The CARE modules are available online from **https://pngcdwstandard.com/resources-for-use-by-cdws-working-with-wards-communities-groups-and-smes**

Hard copies of the CARE modules may be available by contacting the CIC or CARE-International.

Extension Officer Training Program

Title	Module reference
Introduction to smallholder coffee production in Papua New Guinea	ACIAR Smallholder Coffee Production in Papua New Guinea Training Package
Extension Principles	
Introduction to the Coffee Extension Officer and Farmer Training Guides	ACIAR Extension Officer Training Guide Unit 1 Module 1
The extension officer - roles and effectiveness	ACIAR Extension Officer Training Guide Unit 1 Module 2
Knowing Your Farmers	
Getting to know our coffee smallholders	ACIAR Extension Officer Training Guide Unit 2 Module 1
What factors affect smallholder coffee production?	ACIAR Extension Officer Training Guide Unit 2 Module 2
Strongim grup: course facilitator guide	CARE Organisational Strengthening Training

Farmer Training Program

Title	Module reference
Becoming a Coffee Farmer	
Knowing your coffee tree	ACIAR Farmer Training Guide Unit 1 Module 1
Coffee nursery development	ACIAR Farmer Training Guide Unit 1 Module 2
Establishing a new coffee garden	ACIAR Farmer Training Guide Unit 1 Module 3
Managing Your Coffee Garden	
Weed control	ACIAR Farmer Training Guide Unit 2 Module 1
Maintenance pruning and rehabilitation	ACIAR Farmer Training Guide Unit 2 Module 2
Shade management	ACIAR Farmer Training Guide Unit 2 Module 3
Drainage	ACIAR Farmer Training Guide Unit 2 Module 4
Pest and disease management	ACIAR Farmer Training Guide Unit 2 Module 5
Coffee berry borer management	ACIAR Farmer Training Guide Unit 2 Module 6
Soil fertility and nutrient maintenance	ACIAR Farmer Training Guide Unit 2 Module 7
Intercropping in your coffee garden	ACIAR Farmer Training Guide Unit 2 Module 8
Harvesting and Processing Coffee	
Coffee harvesting and processing	ACIAR Farmer Training Guide Unit 3 Module 1
Coffee grading systems and pricing	ACIAR Farmer Training Guide Unit 3 Module 2
Establishing a mini wet factory	ACIAR Farmer Training Guide Unit 3 Module 3
Coffee Marketing	
Understanding the domestic coffee market	ACIAR Farmer Training Guide Unit 4 Module 1
Kamapim ol praioriti	CARE Organisational Strengthening Training
Kamapim ol eksen plen	CARE Organisational Strengthening Training
Setim gutpela kastom bilong ronim grup	CARE Organisational Strengthening Training
Wok bilong meneja na memba na lida	CARE Organisational Strengthening Training
Coffee certification	ACIAR Farmer Training Guide Unit 4 Module 2
Fairtrade certification	ACIAR Farmer Training Guide Unit 4 Module 3
Family money management	CARE Family Money Management Training

CONTENTS

MODULE TOPICS

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INTRODUCTION

Aim of Module:

The aim of this module is to provide smallholder farmers with information about how to establish a productive and healthy coffee garden.

To establish a highly productive coffee garden it is important for farmers to select an appropriate site with well-prepared land, particularly with good drainage and shade. Farmers must also use the appropriate techniques for planting and maintaining their new seedlings.

LEARNING OUTCOMES:

By the end of this module you will be able to:

- Choose the best location for a new coffee garden
- Clear the site for the coffee garden
- Prepare the land prior to planting the coffee seedlings (fencing, plant spacing, drainage and shade trees)
- Transplant coffee seedlings from the nursery to the coffee garden; prepare planting holes; prepare seedlings for planting; and plant the seedlings
- Maintain the new coffee garden
- Understand the advantages and disadvantages of intercropping coffee with food crops

While this module outlines the basic steps in establishing a new coffee garden there are some links throughout to other modules which provide more detail on specific topics. These include modules on nursery development, weed control, pruning, shade management, drainage and intercropping.

LESSON PLAN:

The module has three parts

Sections 3.1 to 3.4	Choosing and clearing a site, preparing the land and shade trees
Sections 3.5 to 3.7	Planting and maintaining the coffee seedlings
Section 3.8	Intercropping

TIME REQUIRED TO COMPLETE THIS MODULE: 5 DAYS

LIST OF SYMBOLS:

Additional information for the extension officer

Information relating to CBB

Farmer notes, brochures & factsheets

Information for farmers that must be taken very seriously

For the Extension Officer

TEACHING AIDS:

- Farmer notes (one copy for each farmer plus spare copies)
- The coffee calendar and stickers
- Red, green, blue and black whiteboard markers and whiteboard eraser
- Posters of plant spacing, drainage, fencing and shade
- Measuring stick, string lines, pegs and hammer/rock to mark out an area for planting
- Laminated coffee garden template with the location of the coffee seedlings permanently marked on it
- Red and green coffee berries (to represent permanent and temporary shade trees)
- Well composted coffee pulp
- Fresh coffee pulp
- A bare root seedling and a polybag seedling
- Shovel
- Harvesting bucket full of water
- A coffee garden in which is growing a tall coffee variety recommended for smallholders, that is, either Typica, Arusha or Mundo Novo. It would be preferable if the coffee trees were planted at the recommended spacing for smallholders and were shaded appropriately, that is, with shade trees providing 30% shade cover
- Aids for exercises and quiz – butchers' paper and marker pens

PRE-TRAINING ACTIVITIES:

- Confirm number of training participants
- Near the location where the module will be presented, find a suitable site where a planting hole can be prepared
- Collect well composted coffee pulp and fresh coffee pulp
- Source red and green coffee berries
- Collect a healthy polybag seedling
- Identify a source for a bare root seedling that can be dug up either the day before or on the day of the presentation of the module
- Organise access to a coffee garden growing a tall coffee variety (preferably with shade trees providing an appropriate level of shade)

EQUIPMENT REQUIRED BY FARMER GROUP DURING TRAINING

Farmers will require the following equipment:

- Tools for clearing the land – axe, bush knife, spade
- Saw or secateurs to prune shade trees and trim seedlings
- Fencing equipment – posts, tomahawk, wires, nails, hammer, existing plants as a boundary (e.g. sisal)
- Shade trees
- Measuring stick, string, pegs and rope
- Shovel
- Harvesting bucket
- Water supply nearby
- Fresh coffee pulp
- Well composted coffee pulp

PRELIMINARY ACTIVITIES

The farmers will complete two exercises prior to undertaking the module topics. These include the coffee calendar and the quiz. The purpose of these exercises is for the extension officer to assess the level of knowledge of farmers in the group prior to completing the module.

The Coffee Calendar

Complete this exercise if the group has not had training within the past 12 months

The coffee calendar lists the main events and activities undertaken during an annual cycle of coffee production. The first item on the calendar is coffee berry development. All other activities are linked to the stage of development of coffee berries from flowering through to overripe cherry.

The annual coffee production cycle

1. Flowering and berry development
2. Harvesting coffee
3. Pulping and drying coffee
4. Maintenance – weeding, pruning, mulching, shade management, digging and maintaining drains, and maintaining fencing
5. CBB control measures

- Working with the farmer group, attach stickers to complete each row of the coffee calendar
- Begin by attaching the progressive stages of coffee berry development from flowering through to bright red cherry ready for harvest and to overripe cherry
- Attach a CBB sticker on the berry development row to indicate where berries can begin to become susceptible to CBB infestation
- Complete the remaining sections linking each activity with the different stages of berry development

New coffee garden activities

Attach the stickers relating to the establishment of a new coffee garden

1. Select a site for the coffee garden
2. Clear the site
3. Mark out locations of drains and dig them
4. Plant permanent and temporary shade trees
5. Prepare planting holes
6. Plant coffee seedlings
7. Replace dead or sick seedlings
8. Maintain the new coffee seedlings – weeding, mulching, managing shade, removing flowers, etc.
9. Plant intercrops

Quiz

Refer to the quiz located at the end of this module and have farmers complete the questions

Repeat the quiz on completion of the module topics

3.1 SITE SELECTION

When choosing a site for your coffee garden there are a number of important factors to consider. To maximise production, your coffee trees need to be growing in a suitable climate, in well-drained fertile soil, and, most importantly, you want to ensure that the garden is easily accessible for maintenance.

Drainage

- Drainage is one of the most important factors in selecting a site for a coffee garden
- Coffee will not grow well in waterlogged soils
- Avoid low-lying areas near creeks and waterways which may often be waterlogged

Air temperature and altitude

- Arabica coffee grows well in high altitudes but does not grow well in very high or very low temperatures. It cannot tolerate frost
- Avoid very high areas or hollows where cold air may settle at night making the coffee trees susceptible to frost

Soil erosion

- Choose a site where the soil will not wash away
- The risk of erosion is related to the type of soil, steepness of the slope, type and amount of vegetation cover and rainfall intensity
- Soils with good structure and lots of nutrients will absorb more water than compacted soils and soils with few nutrients
- Check to see if there is any evidence of erosion at the site
- Avoid steep slopes

Important components of a soil for plant growth include the

- Nitrogen content
- Exchangeable potassium and magnesium
- pH (acidity level)

Avoid sites close to coffee gardens infested with CBB

Good soil

- The soil should be deep, well drained, have moderate to strong structure and contain a lot of nutrients
- Choose a soil that has been looked after and in which other crops have grown well

Present land use

- Coffee will usually grow well after a crop of peanuts (*Arachis hypogaea*), pinto peanuts (*Arachis pintoi*), pigeon peas or soybeans
- Cover crops such as pumpkin and cucumber attract ladybirds which control green scale; these crops can also be sold at the market
- Avoid planting in old kaukau gardens because these are susceptible to pests, such as coffee ring borer, and there is also a risk of weevil attack. Leave the soil from an old kaukau garden for a year before planting coffee. Shade trees can be planted in that year giving the coffee garden a head start

Accessibility

- The coffee garden is easier to manage if it is easy to visit, that is, it is close to the house
- The location of the coffee garden is a household decision as food garden locations must also be considered

Food gardens and the coffee garden:

- The whole household should decide on where the coffee garden and food gardens will be located
- It is important to consider women's location preferences for food gardening
- It is also important to have easy access to the coffee garden for women harvesting

While the environment is important for location there will be other factors that farmers will need to consider, such as:

- Land tenure (potential for land disputes in the future)
- Displacement of vegetable gardens to more distant locations (will impact negatively on women)

Land tenure

- The lifespan of a coffee garden is many decades so choose a site where you have secure tenure of land over a long period of time

Objective:

To identify and discuss the characteristics of a suitable site for a coffee garden.

You will need:

Butchers' paper and a marker pen

EXERCISE 1

Choosing a suitable site for your coffee garden

List

- The key characteristics of a good site for a coffee garden that will maximise production from your coffee trees

Discuss

- Why each of these characteristics is important
- How the level of priority of each of these characteristics may differ depending on the individual site and household circumstances
- The importance of including the whole household in making the decision on where the new coffee garden should be located. Include the role of women in coffee production and the location of food gardens

3.2 CLEARING THE SITE

Once you have chosen a suitable site to establish your new coffee garden the land has to be cleared and prepared for planting. The best time to do this is during the dry season so that as soon as the wet season arrives new seedlings can be planted without delay.

SHADE TREES

Previously cleared sites

- Keep any existing trees that can be used as shade trees for your coffee, e.g. Yar (*Casuarina*) and Marmar (*Albizia*)
- If the existing shade trees are very old and too tall they should be ring-barked, then preferably cut down and replaced

Secondary forest sites

- These are sites that have been previously logged or gardened
- Assess if there are any trees present that can be used as shade trees for your coffee
- Yar (*Casuarina*) and Marmar (*Albizia*) are very useful shade trees. In particular, Yar is suitable in wetter areas and Marmar in seasonally dry areas
- Clear or ringbark the remaining trees that cannot be used for shade

What to do with fallen timber

- Timber can be used for fencing, firewood or construction. Any remaining timber should be left to decompose because in the process it will act as a slow release fertiliser. Burning is not recommended
- Stack any remaining fallen timber in rows

Shade trees in existing coffee gardens

- Retain all usable shade trees. Any that are too old may have to be ring-barked or cut down, if possible (see 'What to do with fallen timber' above). If the remaining trees that are to be used for shade are too tall, lop the branches to a height of 7 m above the ground.

Remember safety first: use a harness when climbing trees

Old coffee trees

- The old coffee trees should be cut off close to the ground and removed from the coffee garden. These can be used for firewood
- If the old trees were badly infected with disease, such as coffee leaf rust or pink disease, it is better not to move them so as to prevent spread of the disease spores and infection of new coffee trees. If you must move them it is best to bag them up, take them away and burn them. The preference is to burn diseased trees in place, if they are not too close to neighbouring trees

Other vegetation

- Clear grasses and shrubs as if you were clearing a food garden
- Dig deeply to remove any problem weeds like kunai or couch grass

What to do with all remaining debris

- Stack all debris in rows and not in one or two sites in the garden. The coffee will be planted in between the rows of debris
- It is **better <u>not</u> to burn** the debris as coffee is sensitive to ash (ash is susceptible to erosion). If left to decompose, the debris will slowly release nutrients into the soil that can be used by the coffee trees
- If removed weeds have the potential to re-establish then they should be composted in a pit
- A large amount of weed debris is required for composting to produce enough heat to kill the weeds, including the seeds. If composting, rake the weeds into a pile or place them in a compost pit (sufficient in size to plant a banana plant into it) and leave for several months. Composting in a pit will take longer than if in a pile. After composting is complete the compost can be used on the coffee garden

Coffee trees are sensitive to high pH or alkaline soils. The ash from burnt debris increases the pH of the soil and is likely to have a negative impact on the growth of the coffee trees.

Note: Many farmers may not compost their weeds because they think it is too much extra work

Compost pit *(Source: Rauke Buimeng)*

Kaukau and your new coffee garden

Do not plant kaukau in your new coffee garden nor plant your new coffee seedlings in an area where kaukau has been cultivated within the last 12 months, otherwise coffee ring borer or weevils may become a problem.

- Providing that there is no possibility of the weeds re-establishing it is not necessary to compost or burn them as they can be used as mulch in the coffee garden (or in food gardens)

Weeds and kitchen waste

Weeds and kitchen waste are not rubbish. They are a resource containing nutrients that can help your coffee grow.

Once the site is cleared

- Once the site has been cleared it may be used for planting food crops until the coffee is planted. Aibika, asbin, banana, cabbage, broccoli, tomato, onion, pumpkin, cucumber, corn, legumes and other vegetables are suitable crops. Kaukau should be avoided as it harbours pests
- **Trees suitable for shading coffee** can also be planted once the site for the new coffee garden has been cleared, although, it will be important to decide on plant spacing for the coffee trees before planting shade trees
- Any household food waste or debris remaining from weeding or harvesting of food crops can be placed in the coffee garden to help improve the fertility of the soil

Objective:

To discuss site clearance for a new coffee garden and the importance of making use of existing resources at the site

EXERCISE 2

Clearing the site for a new coffee garden

Discuss:

1. Assessing the new site. What was the site previously used for? Can any existing trees be retained as shade trees for the new coffee garden?
2. The best way to clear unwanted vegetation – ringbarking and felling trees, digging out problem weeds and clearing any remaining grasses and weeds
3. How fallen timber can be used
4. How removing any vegetation from the site is removing valuable nutrients. What is the best way to deal with the debris so as not to lose valuable nutrients? Why is it better not to burn debris?
5. Planting of shade trees and food crops on the cleared site before the coffee is planted. Which food crops can be grown? Which food crops should not be grown?

3.3 LAND PREPARATION

Once the land has been cleared, it is time to prepare the site for planting. This will involve **fencing**, deciding on **plant spacing** and then establishing a **drainage** system.

Fencing

It is recommended that coffee gardens be fenced if the area has **free-roaming** animals, particularly domestic or wild pigs and goats, that could enter your coffee garden and damage the young coffee trees. Fencing also provides some **protection against theft of young coffee seedlings.**

Types of fencing

- Wired fencing such as barbed wire or pig wire
- Timber fencing
- Plants such as lepa or sisal *(Agave sisalana)*
- Large and deep drains

A timber fence under construction

Sisal or lepa planted to form a fence

Rivers, cliffs, hills and forests form natural barriers against some unwanted intruders.

Pigs and goats can be very destructive in a coffee garden reducing the production potential and income from the coffee trees as well as creating a lot more work for the coffee farmer. They can:

- Damage **drains** by filling them with soil, mud and sticks
- Spread **pests and diseases** of coffee (people entering a coffee garden can also spread pests and diseases)
- **Uproot** coffee seedlings and shade trees
- Dig around coffee trees and **destroy the roots** of the trees
- Rub against coffee trees and **destroy suckers and buds**
- **Eat** the leaves
- **Disturb** coffee branches, flowers and cherries
- **Compact** the soil

Pigs damaging a coffee garden (*Source: Bob Kora*)

Benefits of rigid fencing include:

- Reduce **soil erosion** caused by water
- Provide a windbreak for the coffee trees
- Divert water away from coffee gardens into drains and water storage areas to prevent **waterlogging**

Fencing your coffee garden may not be necessary, if:

- Village pigs and goats are kept in pens or tethered and are not roaming freely
- Theft of cherry is unlikely
- The coffee garden is located in an isolated place that is free of roaming animals and where theft is unlikely
- There are sufficient natural boundaries which prevent animals from entering the garden

Plant spacing

What to consider when deciding on coffee tree spacing

To achieve good yields from your coffee, it is important to use the recommended spacing. Factors that will determine the best spacing include: the **climate** and **soil** quality; the **variety** of coffee you are planting; the susceptibility of your area to coffee **pests and diseases**, like CBB; future **management** practices; **shade** trees; whether or not you will be **intercropping** with food crops over the long-term; and **drainage**.

- **Climate and soil**. Temperature, altitude, rainfall and soil quality will determine the coffee variety you choose to grow
- **Coffee variety**. Tall varieties of coffee (e.g. Typica, Arusha and Mundo Novo), which are the preferred option for low-input farming, require more space than the shorter, more compact varieties. Density per hectare for the tall varieties ranges from 2,500 to 3,000 trees per hectare. Taller varieties are easier for farmers to manage because:
  - Wider spacing makes them easier to harvest and carry out pest and disease control, such as sanitation control of CBB
  - Being taller means there is less bending over to harvest
  - If farmers are willing to put more time in, the dwarf variety, Catimor, is an option. However It is recommended that it be planted at a lower density than that usually recommended for dwarf varieties so farmers have easier access for sanitation control of CBB

- **Pests and diseases**. In areas susceptible to coffee pests and diseases (e.g. CBB and green scale) it is recommended that all tall coffee varieties be planted at a density of 2,667 trees per hectare. This is achieved by planting trees in rows 2.5 m apart and within the row 1.5 m apart
- **Future management practices**. The lower planting density (less trees per hectare) used for tall varieties makes for **easy access to your coffee trees** to carry out harvesting, weeding, and pest and disease control
- **Intercropping.** The extra space in the inter-rows under low planting densities can be planted with food crops for household consumption or marketing. Growing intercrops will increase labour efficiency and can provide additional nutrients for the coffee trees
- **Shade trees** are a very important part of a coffee garden and are particularly beneficial to smallholders as they **reduce the amount of labour** required to manage coffee trees *(see Section 3.4 'Shade')*
- **Drains**. *See 'Drainage' in this section*

Note: For more information on food gardening in coffee gardens, see the module on intercropping

Activity: Plant spacing

1. Display the plant spacing poster pointing out the recommended spacing for smallholders of 2.5 m x 1.5 m
2. Explain how other spacings are used in specific situations

Spacing

Plant spacing recommended for a low-input farming system is less dense than that used in a high-input system. If trees are planted too closely together there is greater risk of the spread of pests and diseases such as CBB, green scale, pink disease and CLR, particularly if the trees are touching each other. Pruning, harvesting and general sanitation are more difficult too with higher planting densities.

In a low-input system, it is recommended to use a rectangular spacing of 2.5 m x 1.5 m. Some of the benefits of this spacing are:

- Easier access for maintenance and harvesting
- Less competition between coffee trees for moisture, nutrients and light
- Food crops can be intercropped with the coffee while it is young

If intercropping is to be a permanent activity in the coffee garden during the coffee off-season it is recommended to use spacing of 2.5 m x 2.0 m.

See Section 3.8 on intercropping for more information

Plant spacing

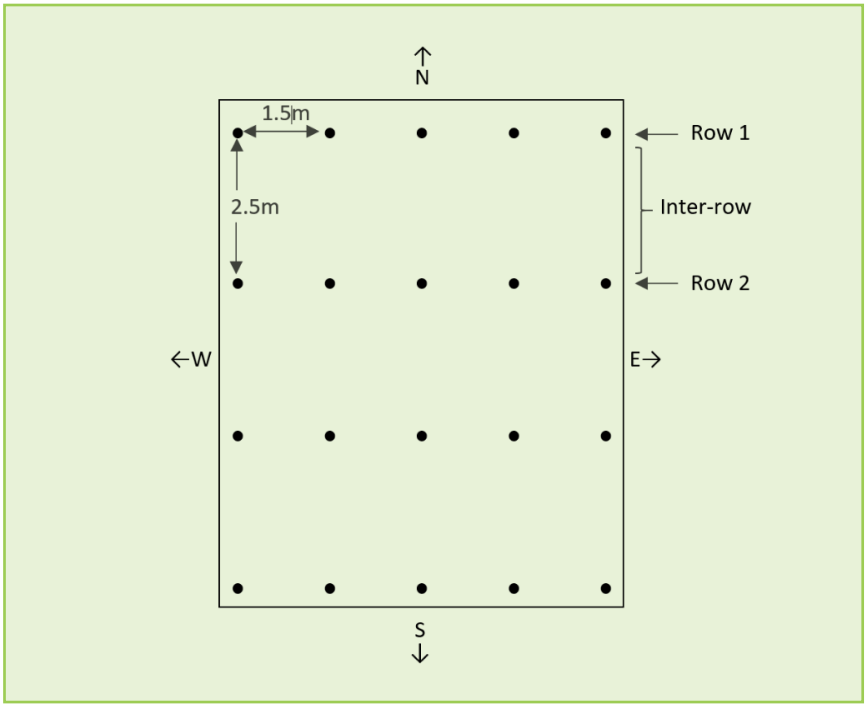
Spacing	Density per hectare	Remarks	Varieties
Rectangle 2.5 m x 1.5 m (3.75 m² per tree)	2,667 trees	Standard practice for tall arabica coffee varieties grown in a low-input farming system. Enables easy access for maintenance and harvesting.	Typica Arusha Mundo Novo
Rectangle 2.5 m x 2.0 m (5 m² per tree)	2,000 trees	Planting arrangement for tall arabica coffee varieties that will be intercropped long-term with food crops in the coffee off-season. Provides sufficient space for air movement and for the intercrops to access light. Minimises competition between the intercrops and coffee trees.	Typica Arusha Mundo Novo
Rectangle 2.5 m x 1.0 m (2.5 m² per tree)	4,000 trees	Planting arrangement for dwarf varieties in a CBB environment. Enables access for sanitation. Only recommended for business-minded farmers who apply best management practices and who have sufficient labour.	Catimor
Triangle 2.0 m x 2.0 m x 2.0 m (3.5 m² per tree)	2,873 trees	Planting arrangement for tall arabica coffee varieties grown on slopes where erosion might be a risk. This planting arrangement slows runoff and reduces soil erosion.	Typica Arusha Mundo Novo

Planting arrangements

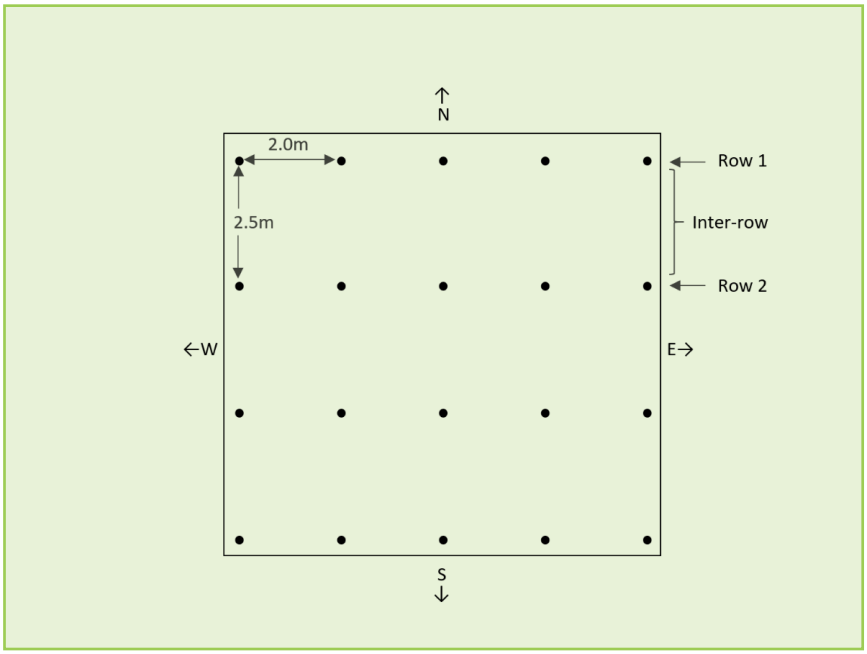
Rectangular planting arrangement

Trees in a rectangular planting arrangement are closer together within the rows and further apart between rows (inter-row distance).

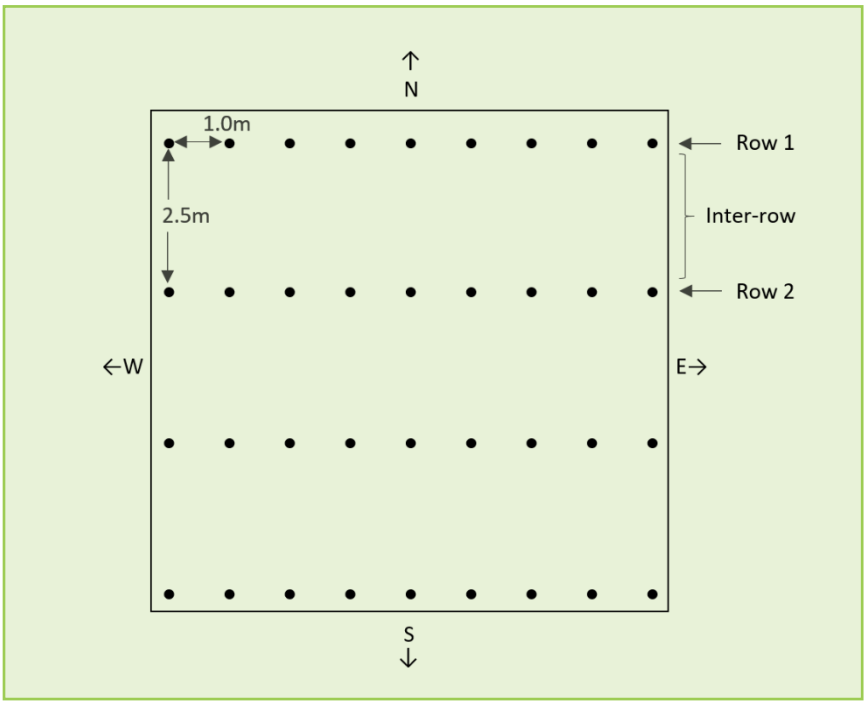
- This planting format provides good access for pest and disease control, pruning and harvesting
- Rows are planted so that they are facing the north to maximise tree exposure to sunlight



Standard spacing: 2.5 m x 1.5 m



Low density spacing for long-term intercropping: 2.5 m x 2.0 m

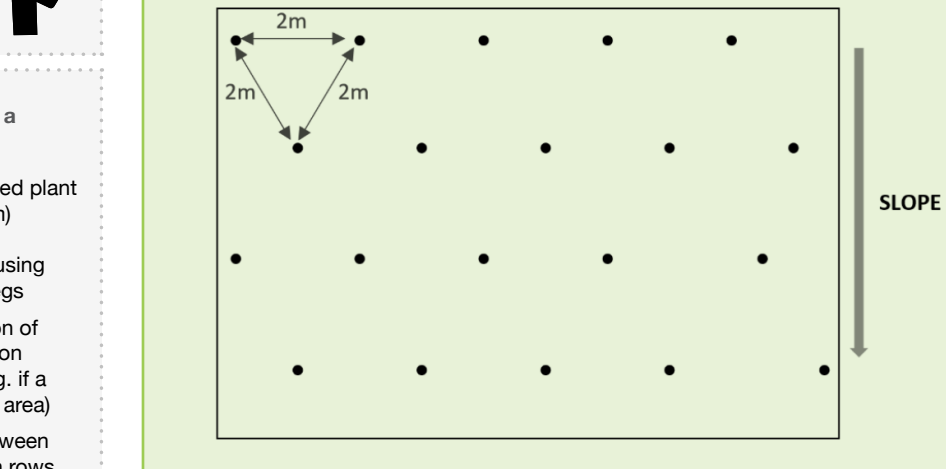


High density spacing for dwarf varieties in a CBB environment: 2.5 m x 1.0 m

Triangular planting arrangement

Trees planted in a triangular arrangement are all the same distance apart.

- This planting arrangement is used on steep slopes
- Trees planted in this format slow water runoff and reduce erosion



Activity: Marking out a coffee garden

Using the recommended plant spacing (2.5 m x 1.5 m)

- Mark out an area using string lines and pegs
- Identify the location of drains depending on circumstances (e.g. if a low-lying swampy area)
- Show spacing between trees and between rows
- Depending on terrain, rows should run East-West

Triangular spacing for slopes where potential risk of erosion: 2.0 m x 2.0 m x 2.0 m

Activity: Drainage

Using the drainage poster show the position of drains:

- In different soil types
- When using the recommended tree spacing

Drainage

Coffee trees need moist and healthy soil. Too much water can be a problem for the health and growth of the tree. Therefore, drainage systems must be used in the coffee garden so that excess water can run away. **This should be done before the coffee is planted.**

- Drainage systems are simple networks of valleys that carry away excess water
- Drains are common in PNG food gardens, although traditionally, drains were constructed that ran directly downslope to ensure quick water runoff
- A downhill drainage system at 90 degrees to the contour is **not permitted** in a coffee garden. Steep downhill drainage systems are not suitable because they increase soil erosion and wash away topsoil which is rich in nutrients
- Drainage systems for coffee gardens should:
  - Drain away excess water in a controlled manner that does not cause erosion
  - Avoid overflowing of water onto low-lying areas
  - Control runoff (flow) from steep sites
  - Be free of large obstacles that may prevent the smooth flow of water
  - Have local plant species growing at the main outlet of the drain to stabilise the ground and prevent gully erosion and land slips
  - Have sediment traps placed at suitable points along the drains for collection of eroded sediment. These sediments should be returned to the coffee garden after the rain storm event or during a dry period

Note: For more information see the Drainage module

The steps for setting up a drainage network are as follows:

1. Mark out and dig the main drain
2. Mark out the coffee tree locations using sticks or other markers
3. Mark out the locations of field drains (in relation to tree markers) and dig the drains

Objective:

To understand why it may be important to have a new coffee garden secured from animals and intruders

EXERCISE 3

Fencing a new coffee garden

Discuss:

1. The situations in which it may be important to have a new coffee garden fenced? Why is it important not to allow pigs in a new coffee garden?
2. The types of fencing that can be constructed around a new coffee garden. What materials can be used? What are the benefits of rigid fencing?

Objective:

To identify the factors that need to be considered when deciding on spacing of coffee trees in a new coffee garden.

You will need:

Butchers' paper and a marker pen

EXERCISE 4

Coffee tree spacing

List:

1. The factors to consider when deciding on plant spacing for the coffee trees when establishing a new coffee garden

Discuss:

1. Pests and diseases
   a. What are some of the pests and diseases that affect coffee?
   b. Will the climate influence the prevalence of certain pests and diseases?
   c. Consider the spacing requirements for management and control of CBB.
   d. Is it true that densely planted coffee can encourage pests (e.g. CBB) and diseases? Why?

Objective:

To become familiar with the recommended plant spacing for different coffee varieties and the alternative spacing arrangements that may be used in specific situations.

EXERCISE 5

Types of plant spacings

Discuss:

1. Why the standard plant spacing of 2.5 m x 1.5 m is recommended for smallholders
2. Other plant spacings that may be used
   - In what situations do these alternative plant spacings apply?
   - What is the optimum planting pattern and spacing if the coffee garden is to be established on a steep slope? Why?
   - What is the optimum plant spacing if intercropping is to be practised permanently?

Objective:

To understand why it is important to have a good drainage system in a new coffee garden.

EXERCISE 6

Drainage

Discuss:

1. The purpose of a drainage system in a coffee garden. Why is it important to have a drainage system that drains water away in a controlled manner? Why are downhill drainage systems not suitable?
2. The three steps involved in setting up a drainage network
   - Mark out and dig the main drain
   - Mark out the locations for the coffee trees
   - Mark out and dig field drains

3.4 SHADE

Now that coffee tree locations have been marked out, the location of shade trees can be marked out too. At some sites shade trees may already be present.

To achieve good yields, smallholders should plant their coffee under shade. An appropriate shade level is where approximately **30%** of sunlight is blocked out.

Shade trees should be planted 3-4 months before planting the coffee seedlings.

Note: See the Shade management module for more detailed information on shade establishment and management

Benefits of shade trees

There are many benefits of shade trees when they are providing the appropriate level of shade (30% shade):

- Optimise vegetative growth (growth of leaves, stems and roots) on the coffee trees which will in turn optimise reproductive growth (flowering and fruit formation)
- Control the timing of flowering and fruiting
- Slow the bean ripening process, therefore, improving bean size and density (weight), and cup quality (Note: heavier weight = more money)
- Protect the coffee trees, and in particular the flowers, from low night **temperatures**, strong **sunlight**, **wind** and heavy **rain**
- The coffee trees are healthier and more resilient to pests and diseases. Many pest predators, such as birds, are attracted to shaded environments
- Reduced light intensity in the coffee garden and leaf litter from shade trees suppresses **weeds** meaning less time is spent on weeding
- The canopy cover and leaf litter protect against **moisture** loss, soil **erosion** and loss of **nutrients**
- The roots of shade trees improve **drainage**. Those with deep roots bring **nutrients** up from the lower soil layers. These nutrients are then made available to the coffee via leaf litter from the shade trees
- Some shade trees **fix nitrogen** (e.g. Yar and Marmar) meaning they take nitrogen from the air and convert it into a form that can be used by plants. These trees will add nitrogen to the soil
- Shade trees require regular maintenance and pruning, but their advantages (e.g. weed suppression) mean **reduced labour inputs** overall
- Provide a source of **timber** and **firewood** which can also be sold

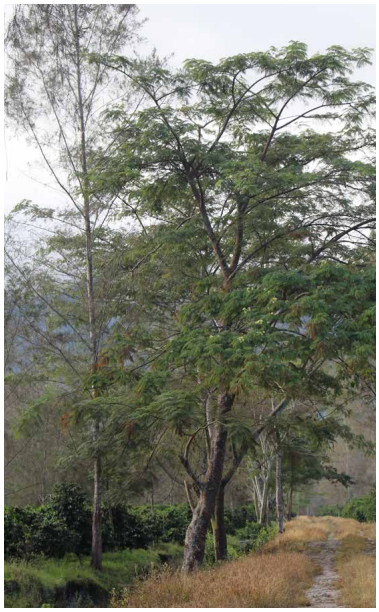
Types of shade trees

There are two types of shade trees - **Permanent** and **Temporary**.

Permanent shade trees should be planted 3-4 months prior to planting the coffee seedlings. They will take some time to establish but will be present for the life of the coffee garden. Yar and Marmar are good examples of permanent shade trees.

Temporary shade trees should also be planted 3-4 months prior to planting the coffee seedlings. They will grow more quickly than the permanent shade trees and may provide shade for up to 3 years or until the permanent shade trees are established. Temporary shade trees are particularly important in a new coffee garden as young trees are a little weak and must be protected. Banana, is a good example of temporary shade.

Yar *(Casuarina)*



Marmar *(Albizia)*
(*Source: Cora Moabi*)

Activity: Shade trees

Using the shade poster, show photos of the shade trees recommended for coffee gardens in the area where the training is taking place.

Activity: Planting layout

Demonstrate planting layout for coffee and shade trees

- Use a laminated board with locations of coffee trees permanently marked on it (plant spacing 2.5 m x 1.5 m)
- Mark in drains
- Use green and red berries to position shade trees (green for temporary shade and red for permanent shade). Permanent shade trees are planted within the rows of coffee, temporary shade is planted between the rows
- Show how the shade trees are thinned each year from Year 1 to Year 5, by removing the berries from the board (shade tree spacing will depend on location and the type of shade tree)

Important messages:

- Plant temporary and permanent shade trees 3-4 months prior to planting the coffee seedlings
- Ensure temporary shade is tall enough before seedlings are transplanted
- Thinning and pruning of established shade trees may be required before planting coffee seedlings
- Do not grow shade trees that will compete with the coffee trees for water, nutrients and space

Objective:

To identify the benefits of shade trees, the types of shade trees and when they should be planted.

You will need:

Butchers' paper and a marker pen

EXERCISE 7

Shade Trees

List:

1. The benefits of shade trees

Discuss:

1. The different types of shade trees
2. Any previous experiences farmers have had with temporary shade trees. What worked and what didn't?
3. The two best permanent shade trees to plant in the highlands
4. Which shade trees to avoid and why
5. When shade trees should be planted

3.5 PREPARING PLANTING HOLES

After the land has been prepared, fences erected, drains dug, shade trees planted and coffee tree locations marked out, the next step is to plant out the coffee seedlings. The best time to plant seedlings is at the beginning of the wet season. Before the coffee seedlings can be planted out, however, time needs to be taken to prepare good planting holes for the seedlings. Preparing good planting holes will enable better establishment of the coffee seedlings and is important for their future productive capacity.

The **size of the planting hole** and **the way the soil is prepared** are both very important for good growth of the coffee trees. Good preparation of planting holes is particularly important on **slopes** and in **clay** or **compacted soils**.

Note: It is best to plant out the coffee seedlings at the beginning of the wet season, particularly in areas that have a marked dry season.

Important things to carefully consider before preparing the planting holes are:

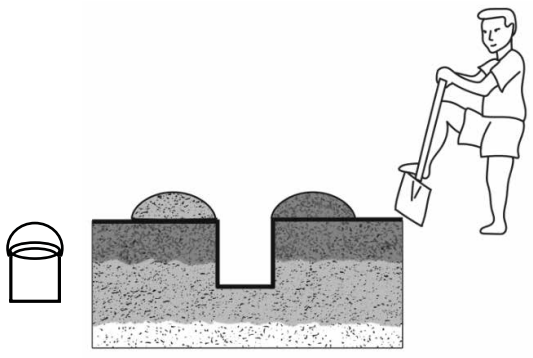
- When you plan to plant the coffee seedlings
- The quality of the soil and slope of the coffee garden
- The field planting arrangement for the coffee trees *(see 'Plant spacing' in Section 3.3)*

When to prepare the planting holes

- It is best to prepare the planting holes about 4 weeks before transplanting the coffee seedlings. This means that all of the holes need to be ready **4 weeks** prior to the onset of the wet season
- If in a part of the coffee garden the soil contains a lot of clay or is compacted, it may be necessary to prepare the holes in this area at least **6 weeks** prior to planting the seedlings

The size of the planting hole

The planting hole should be roughly **the size of a large bucket** (45 cm wide and 45 cm deep) to allow for the development of a good root system.



A planting hole the size of a bucket.

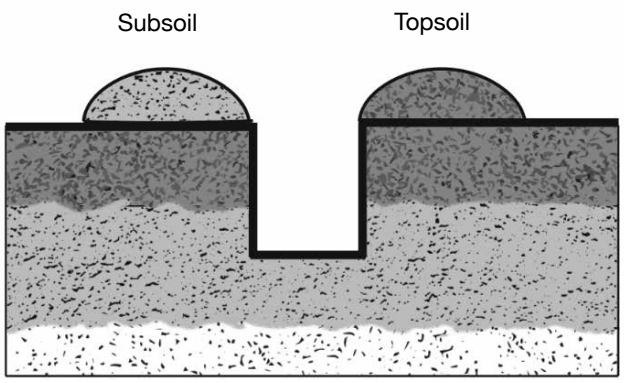
Digging the planting holes and preparing the soil mix for backfilling the planting holes

The method of preparing planting holes will depend on the type of soil. Some soils are very fertile with at least a bucket depth of black topsoil, while some soils have a shallower level of topsoil or are dense clays which affect drainage and the capacity of roots to penetrate the soil.

Preparing planting holes in well drained soils with a deep layer of topsoil

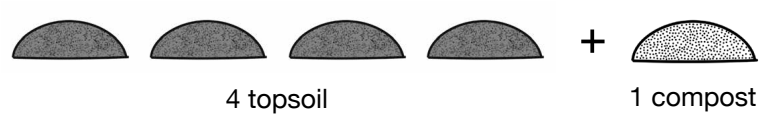
Preparing planting holes in well-drained soils with a deep layer of topsoil

- Dig the planting holes at least **4 weeks** prior to transplanting the coffee seedlings to allow weathering and cracking which improves root penetration and drainage
- As each hole is dug, place the topsoil and the deeper soil, or subsoil, in separate piles next to the hole

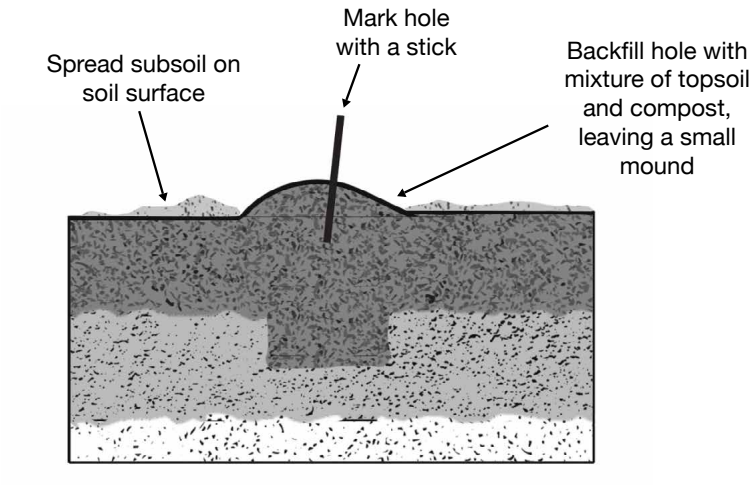


Separate piles of topsoil and subsoil.

- When the sides of the planting holes have begun to weather (after about 2 weeks), mix the topsoil with some organic matter, such as well composted coffee pulp, in the ratio of 4 parts topsoil to 1 part compost



- When well combined, backfill the hole with the soil mixture forming a small mound above the ground
- Spread the subsoil around on the surface of the coffee garden
- Mark the planting hole with a stick



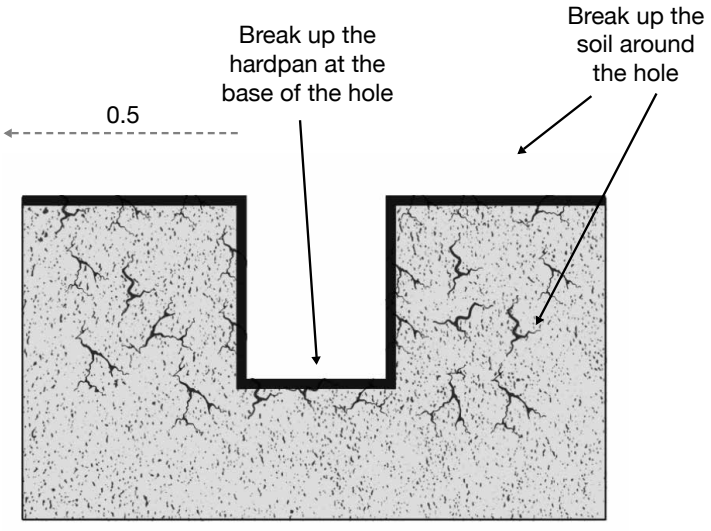
Planting hole backfilled 2 weeks prior to planting seedlings

Preparing planting holes in soils with shallow topsoils, clay soils, compacted soils or on steep slopes

Note: This is very labour intensive work and these types of holes are not recommended for more than a few trees.

Preparing planting holes in soils with shallow topsoils, clay soils, compacted soils or on steep slopes

- If a small area of your prepared coffee garden has hard, clayey or compacted soil, you could use the following treatment to help ensure the coffee tree is productive.
- If planting into poorer soils, the holes will need to be prepared well in advance of transplanting the seedlings. Dig the holes **6-8 weeks** prior to planting the seedlings
- As the hole is dug, place the topsoil and subsoil in separate piles, as described above
- In **poor, dense or compacted soils** there may not be any dark topsoil. Dig out the hole, then break the hardpan in the bottom of the hole, and mix in a little manure or compost. Then smash up the ground surrounding the hole to a distance of half-a-metre from the hole



Breaking up poor compacted soils

- Leave the hole open for at least 4 weeks to allow for weathering and cracking (6-8 weeks if the soil is very dense or compacted)
- Coffee roots will not grow in **waterlogged soils**. If the planting holes fill with water then drainage needs to be improved by deepening existing drains and/or digging more drains

Note: Avoid digging planting holes where old stumps have been left to decay as they may contain root diseases that affect the roots of your coffee trees.

Activity: Preparing planting holes

Show the videos or demonstrate how to prepare planting holes:

- Preparing a hole in a well-drained soil with a deep layer of topsoil
- Preparing a hole in soil with a shallow layer of topsoil, clay soil or compacted soil

Indicators of waterlogging:

- Water puddling on the soil surface
- The soil surface staying wet and glistening, and not drying out
- Dark, wet or slimy topsoil
- Boggy soils
- Water sitting in planting holes or holes dug for fencing or drains
- The presence of plants that grow on boggy and swampy land such as *Typha* (candlestick, *hagaku*) and mosses
- Other deep rooted plants will turn yellow

- At least 2 weeks before planting the coffee seedlings mix any **topsoil** with **well composted** organic matter (manure or coffee pulp) using 4 parts topsoil to 1 part compost

4 topsoil 1 compost

- When the topsoil is shallow, some **subsoil** will have to be used to fill the hole. Mix the subsoil with an **<u>equal</u>** part of compost, then add to the soil mixture

1 subsoil 1 compost

- Mix the soil and compost thoroughly and backfill the planting hole so that a slight mound is formed
- Spread any remaining subsoil around on the surface of the garden
- Mark the planting hole with a stick

Activity: Compost

Show examples of good quality compost suitable for the planting hole (e.g. well composted coffee pulp and/or manure).

Explain that after planting the coffee seedlings:

- A thin layer of fresh coffee pulp, rich in potassium, can be spread over the soil surface but **must not** touch the stems of the seedlings
- A thin layer of fresh pulp can be reapplied regularly

Composting:

Composting of grasses, manure and coffee pulp takes several months. If it is **not** fully composted it may:

- burn the roots of the coffee seedlings
- contain viable weed seeds
- contain diseases such as coffee leaf rust

Compost is ready for use when it is dark and crumbly and has a pleasant, earthy smell. Other indicators are the growth of weeds and the presence of worms.

Objective:

To understand the planning involved in preparing the planting holes, including, most importantly, the timing of this activity.

EXERCISE 8

Planning for planting of the coffee seedlings

Discuss:

1. When the seedlings should be planted
2. How long it is before planting, that the planting holes should be prepared. How does the quality of the soil determine when the holes should be prepared?

Objective:

To understand how to prepare a planting hole in different soil types.

You will need:

Butchers' paper and a marker pen

EXERCISE 9

Preparing the planting holes

Discuss and illustrate:

1. The size of the hole
2. How to prepare a hole in a well-drained soil with a deep topsoil layer. What is done with the soil as it is removed from the hole? How long should the hole be left open to allow for weathering to occur? What type of soil is used for backfilling the hole? To improve soil quality, what is the soil used for backfilling the hole mixed with and in what ratio?
3. How to prepare a hole in a small area of the coffee garden that may have clayey, dense soil. What is involved in digging the hole? How long should the hole be left open to allow for weathering to occur? How is the quality of the backfill soil improved?

3.6 PLANTING THE COFFEE SEEDLINGS

Field planting involves transplanting the coffee seedlings from the nursery into the new coffee garden. This can occur once the coffee garden is well prepared. Before the coffee seedlings can be transplanted, however, it is important to ensure they are of good quality, that is, they should be **tough** and at the **right stage of development**.

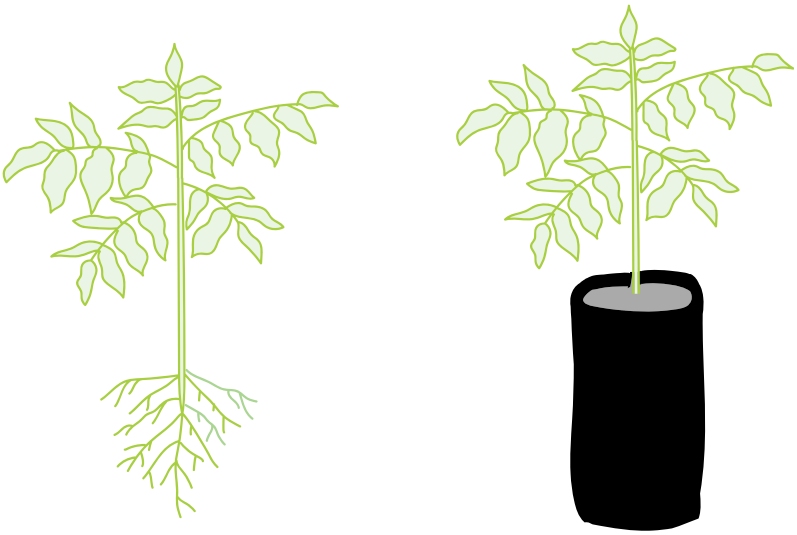
When are seedlings ready for transplanting?

Note: See the Coffee Nursery Development module for more detailed information.

When are seedlings ready for planting?

To be ready for planting, seedlings should:

- Have been in the nursery for 6-9 months
- Have 8-9 leaf pairs or 2-3 primary branches
- Be free of pests and diseases
- Not have bent taproots
- Be healthy and hardened off



(a) Bare root seedling (b) Polybag seedling

Healthy seedlings ready for transplanting

Transplant bare root seedlings as soon as they are ready because survival rates will be poor if they are overgrown.

Note: Plant seedlings at the right time

It is far better to plant seedlings on time rather than correct overgrown seedlings. Seedlings planted at 6-9 months old will establish well and become productive much more quickly than overgrown seedlings.

Overgrown seedlings

- The best way to facilitate good establishment and growth of seedlings in the field is by transplanting them when they are **6-9 months old**
- Sometimes seedlings may become overgrown if they have been left in the nursery for too long (more than 9 months)
- If you are faced with a shortage of seedlings, overgrown polybag seedlings can be used if they are given careful attention. **It is best to discard overgrown bare root seedlings**
- Overgrown seedlings have a lot of stem growth and possibly bent taproots, if grown in polybags. If left in this state it is unlikely they will establish well in the coffee garden as too many nutrients and a lot of energy is used in supporting the excess growth

If it is necessary to plant out seedlings that have become overgrown there are three techniques that may be used to give the seedlings a better chance in the field:

1. **Capping** in the nursery
2. **Taproot pruning** at the planting hole (if grown in polybags)
3. **Bending** in the coffee garden after the seedlings are established and appear not to be growing well

- While still in the nursery it is important that overgrown seedlings are capped prior to transplanting
- If seedlings grown in polybags have bent taproots it is important to prune these prior to planting
- These measures can enable successful field establishment of overgrown seedlings. However, if overgrown seedlings are **NOT** attended to prior to transplanting they can be monitored in the field and if they do not establish well, the process of bending can be applied *(refer to Section 3.7 'What to do with tall, thin and weak coffee trees that are not developing well')*

Capping in the nursery

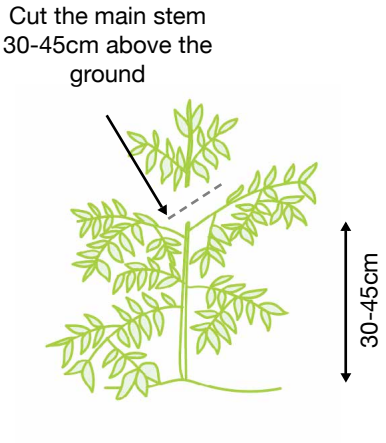
Capping is the removal of the growing tips of seedlings so that they put more energy into growing branches. This technique can be used if the seedlings are tall and thin.

- Find the seedlings in the nursery that are overgrown but healthy
- On each seedling find the pair of branches that is about 30–45 cm above the soil in the polybag
- Cut the **main stem** a small distance (3 cm) above the pair of branches making sure the spot to be cut has developed brown bark. If brown bark is not present, cut lower down the stem where brown bark has developed

Capping overgrown seedlings

Capping overgrown seedlings

Step 1:
Find seedlings in the nursery that are overgrown but healthy.



Step 2:
Cap the stem (which has brown bark) above the branches.

Step 3:
Transplant the seedling in the normal way.

Taproot pruning

Taproot pruning

Taproots can become bent when the seedlings have been in polybags for too long

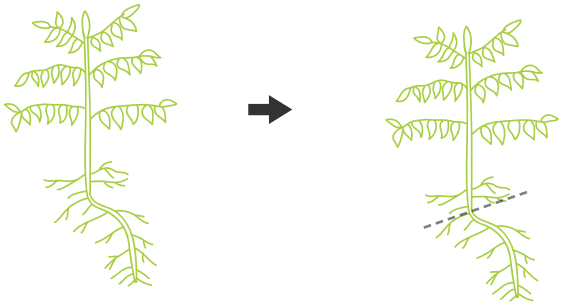
- You will not see bent taproots until the polybag is removed
- Bent taproots will limit nutrient and water availability for young, bearing trees and may cause them to die back or fall over
- While the taproot will not regrow it should be cut above the bend to encourage other roots to grow which will help support the plant and supply water and nutrients to the stem

To prune taproots:

When removing the polybag just before planting the seedling, check to see if the taproot is bent

- If bent, cut the taproot just above the bend ensuring other roots are still attached to the remaining taproot. This is important as it is the smaller roots and root hairs that enable the seedling to take up water and nutrients from the soil
- So that the plant can recover from taproot pruning, remove at least the top third of the stem and leaves (fewer leaves mean less water and nutrients are required by the plant)

Pruning bent taproots



Step 1:
Separate all seedlings with bent taproots.

Step 2:
Cut off the bent taproot ensuring some roots are still attached to the remaining taproot.

Step 3:
Pruned taproot with some roots still attached.

Step 4:
Remove the top third of the stem and leaves.

Step 5:
Plant the seedling in the usual way.

Bending

- Bending is a method used to encourage growth of new branches on seedlings that were overgrown when planted
- Bending is usually carried out after the seedlings have become established (about 3 months after planting)
- *See Section 3.7 'Looking after your new coffee seedlings'* for directions on *bending*

Planting the seedlings in the new coffee garden

Field planting involves transplanting the coffee seedlings from the nursery into the new coffee garden. This can occur once the coffee garden is well prepared.

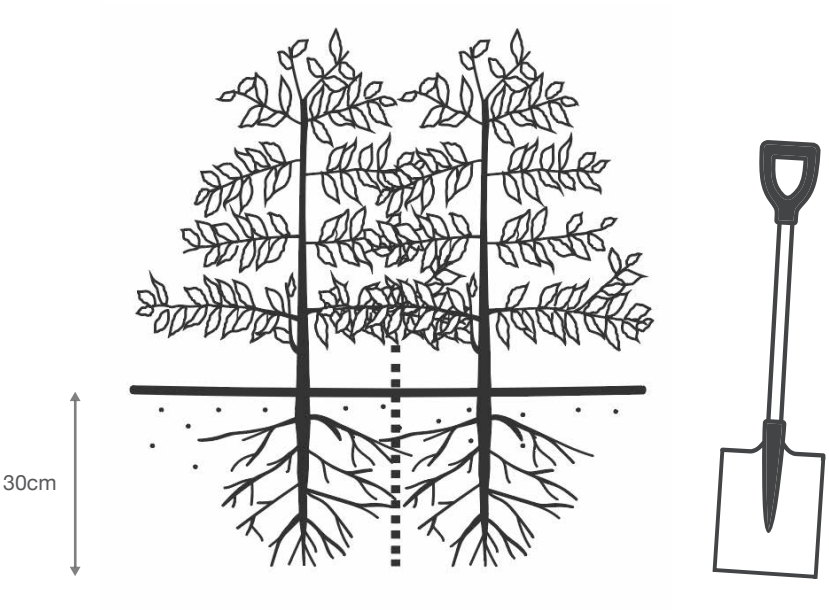
Transplanting bare root seedlings

It is important to take a lot of care when transplanting bare root seedlings. Because the roots are exposed they can be easily damaged. The aim is to maximise the survival rate of seedlings in the field.

Removing bare root seedlings from the nursery bed

Removing bare root seedlings from the nursery bed

- The planting holes should be prepared about 4 weeks **before** the seedlings are removed from the nursery bed (*see Section 3.5 'Preparing planting holes' for more details*)
- 1-2 weeks before transplanting, using a spade, cut around the seedlings in the nursery bed in blocks to separate interlocking roots between seedlings. This will toughen the seedlings and minimise transplanting shock
- Ensure the seedlings are kept moist



Interlocking roots of seedlings cut using a spade

- When transplanting bare root seedlings, it is best to remove them from the nursery beds early in the morning and plant them in the coffee garden on the same day so that they do not lose too much moisture.
  If the roots dry out the seedlings will die
- Water the seedlings well prior to removal
- Take care when removing the seedlings from the nursery bed as it is important not to damage the roots
- Place the shovel half way between each seedling and dig to a depth of about 30 cm. Dig the soil to this depth all around the seedling, then gently lift it, shaking off any excess soil. It is alright for some soil to remain attached to the roots
- Only use seedlings with a straight taproot
- To keep the seedlings moist wrap them in wet newspaper or cloth and ensure the newspaper or cloth does not dry out. Place seedlings in something rigid (e.g. a large split bamboo pipe) to minimise movement as they may be damaged if they rub against each other or are bent
- Carry the seedlings to the coffee garden and place in a shaded spot ready for planting

Planting bare root seedlings

- Open the pre-prepared planting hole with a shovel
- Place the seedling in the hole. Ensure the taproot is straight. The crown of the seedling, which is where the stem meets the taproot, should be level with the soil surface
- While holding the seedling upright backfill the hole with the soil mix and press firmly. The soil can be slightly mounded to allow free run-off of water and also to allow for some sinkage of the soil
- Place mulch such as fresh coffee pulp (which is high in nutrients) or grass around the seedling. **The mulch should not touch the seedling** as it will burn the stem
- Gently pour a bucket of water around the seedling

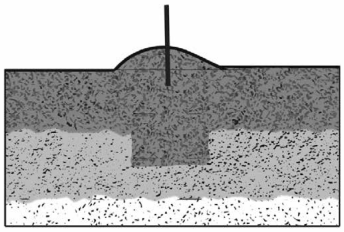
Planting bare root seedlings

Activity: Planting a bare root seedling

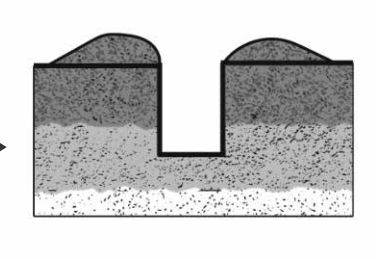
Demonstrate how to plant a **bare root** seedling

1. Position the seedling in the hole
2. Backfill the hole with soil mix
3. Make a small mound around the base of the seedling stem
4. Place mulch (e.g. fresh coffee pulp) around the base but away from the stem
5. Gently pour a bucket of water around the seedling

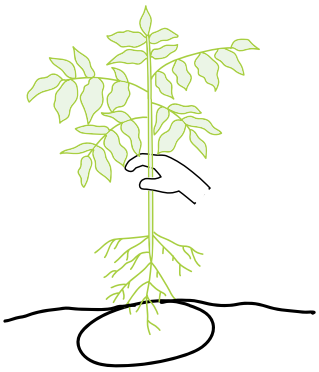
Planting a bare root seedling



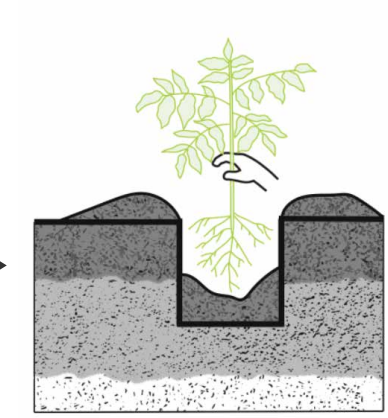
Step 1:
Locate backfilled planting hole.



Step 2:
Clean out planting hole.



Step 3:
Hold the seedling firmly in an upright position.



Step 4:
Place the seedling in the hole with the base of the stem level with the soil surface. Backfill the hole with the soil mix.

Step 5:
Firmly press the soil around the hole.

Step 6:
Place some mulch around the seedling ensuring it does **not** touch the stem. Gently pour a bucket of water around the seedling.

Planting polybag seedlings

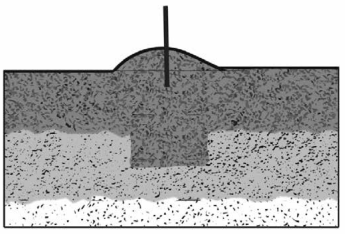
- Water the seedlings well prior to removing them from the polybag
- Split the polybag open using a sharp knife and pull the plastic down and away from the soil mix
- Loosen the soil mix if it is hard so that the roots can grow out into the surrounding soil in the hole
- Check that the taproot is straight. If the taproot is bent follow the instructions for Taproot pruning, earlier in this section.
- Place the seedling in the centre of the hole with the base of the stem level with the soil surface

Planting a polybag seedling *(Source: Leo Aroga)*

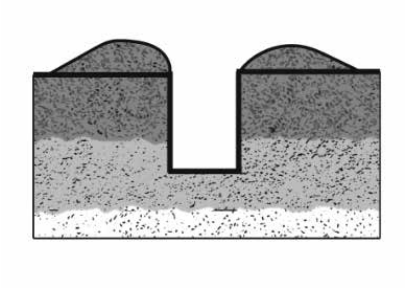
- While holding the seedling upright backfill the hole with the soil mix and press firmly. The soil can be slightly mounded to allow free run-off of water and also to allow for some sinkage
- Place mulch, such as fresh coffee pulp, around the seedling keeping it away from the stem to prevent stem burn
- Gently pour a bucket of water around the seedling

Planting polybag seedlings

Planting a polybag seedling

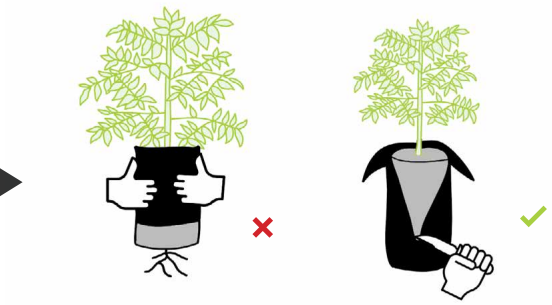


Step 1:
Locate backfilled planting hole.

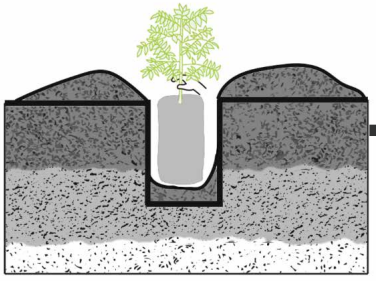


Step 2:
Clean out the preprepared planting hole.

Step 3:
Take a healthy polybag seedling.



Step 4:
Carefully cut down the side of the polybag with a sharp blade and remove the seedling with the soil attached.



Step 5:
Place the seedling into the hole, holding the base of the stem level with the soil surface. Backfill the hole with the soil mix.

Step 6:
Firmly press the soil around the hole.

Step 7:
Place some mulch around the seedling and gently water.

Planting self-sown seedlings:

A lot of farmers plant self-sown seedlings but this is **bad practice** and is discouraged by CIC for a number of reasons:

Disadvantages of planting self-sown seedlings:

1. Seedlings are often weak and unhealthy
2. Roots can be damaged when transplanting
3. Seedlings take a long time to establish in the field
4. Development of coffee trees, including cherry production, is delayed
5. Trees are highly stressed due to poor development
6. Performance of the trees is compromised
7. High mortality rates
8. Income potential over the long-term is reduced

Objective:

To understand the best time to plant a coffee seedling.

You will need:

Butchers' paper and a marker pen

EXERCISE 10

Planting seedlings at the correct time

List:

1. The attributes of a good quality coffee seedling that is ready for planting

Discuss:

1. The importance of planting seedlings when they are of peak quality
2. The methods that can be used to correct overgrown seedlings if there is a shortage of seedlings

Objective:

To understand best practice when planting bare root and polybag seedlings.

You will need:

Butchers' paper and a marker pen

EXERCISE 11

Planting coffee seedlings

List and discuss:

1. The steps involved in transplanting a bare root seedling. How is it removed from the nursery? How should it be protected when being carried from the nursery to the coffee garden? How is it planted in the hole? Once the hole has been backfilled, what is applied to the soil surface to provide nutrients to the coffee seedlings, suppress weeds and maintain moisture?
2. The steps involved in planting a polybag seedling. How is it removed from the polybag? How is it planted in the hole? Once the hole has been backfilled, what is applied to the soil surface to provide nutrients to the coffee seedlings, suppress weeds and maintain moisture?

3.7 LOOKING AFTER YOUR NEWLY PLANTED COFFEE SEEDLINGS

After you have planted your coffee seedlings, you need to take good care of them as they are weak until they become established. Some of the causes of damage and death of seedlings planted out include:

1. Pest and disease attack
2. Animal and human damage
3. Water stress due to infrequent watering (wilting can happen quickly if seedlings are not kept moist)
4. Competition from weeds
5. Poor planting methods
6. Poor quality seedlings (e.g. self-sown seedlings)
7. No temporary shade
8. No mulch

During the first year after the coffee seedlings are planted your trees will not produce cherries but it is very important that you spend time in your coffee garden looking after your young coffee trees. While it is important to continually maintain your coffee trees at all ages, maintenance is **critical in the first year** as they require more attention while they are becoming established.

Looking after the new coffee garden

Tasks to maintain healthy seedlings

Some of the main tasks that must be carried out during the first year after planting the seedlings are:

- Mulching
- Weeding
- Watering in dry periods
- Removing flowers and pruning
- Monitoring pests and diseases
- Managing shade
- Replacing dead coffee seedlings with new healthy seedlings (infilling)

WARNING

- Dry grasses and leaves are a fire hazard in fire prone areas
- It is not necessary to cover all of the ground in the coffee garden with mulch. Mulching only to the drip line of each tree is sufficient. This will reduce the fire hazard if grasses and leaves are used
- In fire prone areas it is best to use coffee pulp as mulch around the coffee trees, as long as it does not touch the stems of the trees

Mulching

Mulching is covering the soil with anything that can stop weeds growing and help to retain soil moisture. It can also provide nutrients for the coffee trees. Mulching should be done immediately after transplanting the seedlings and throughout the first year of establishment of the young coffee trees. When shade trees like Yar become established, the leaf litter provides mulch.

Sources of mulch

- Mulch used when the coffee trees are planted is most commonly derived from weeds and grasses and other debris remaining when the coffee garden area was cleared
- As the coffee trees become established sources of mulch may include debris from intercrops and maintenance weeding
- Fresh coffee pulp is a very good source of mulch as it is high in nutrients

Fresh coffee pulp
Fresh coffee pulp should be distributed as soon as possible to avoid leaching losses
But it should be **applied thinly** (just one layer) and **not next to stems**
If this is done regularly it will, over time, build up the soil fertility
If applied thickly and next to a coffee stem it can burn the stem or the roots of the coffee tree

How to mulch your coffee trees

- Place the mulch around the base of the tree as in the following diagram
- The mulch should **never** be placed against the seedling stem. Leave some space between the seedling stem and the mulch

Mulching a coffee tree out to the dripline, while keeping a space between the mulch and the stem of the coffee tree.

Note: See the Weed control module for more information.

Weeding

- Seedlings should be kept weed-free
- Weeds will compete with the coffee seedling for soil moisture, nutrients and sunlight
- Minimal weeding should be required if a cover crop or intercrops are grown in the coffee garden (in the first year only) and mulch is applied to the coffee trees

Watering in dry periods

- It is important to regularly check soil moisture while the coffee seedlings are becoming established so that they do not become stressed
- If the seedlings become stressed their roots will not establish well and they become more susceptible to pests and diseases and to the effects of temperature extremes
- Permanent damage or death may result if the stress is excessive
- Mulch and shade both contribute to maintaining soil moisture
- If there has been a prolonged dry period it may be necessary to water the seedlings

Note: Removing flowers in the first year after transplanting is very important for establishment and growth of the tree and for future income.

Removing flowers and pruning

- To enable the coffee trees to establish well, flowers should be removed when the trees are young
- No crop should be allowed on the trees in the first year and very little in the second year
- Not allowing trees to crop will ensure that they produce a lot of healthy cherries once they reach full maturity
- At first flowering after transplanting, pick off any flowers to encourage strong root and stem growth
- If the flowers are not removed the tree will put energy into the flowers instead of the roots and shoots

Note: See the Pruning module for information on how to complete these pruning tasks.

Pruning is an essential task in the first two years after planting to establish a well-structured healthy tree.

Two types of pruning are recommended for recently established coffee trees:

1. **Structural pruning**
   This is pruning the tree, or training it, so it grows into the correct shape and has the right number of stems.
2. **De-suckering**
   It is important to remove suckers as they will compete with the main stem of the tree for nutrients and light.

Removing suckers keeps the tree open to allow airflow and reduce humidity, and makes the tree less vulnerable to pests and diseases, including CBB.

Monitoring pests and diseases

- Pests and diseases may become a problem in the new coffee garden so it is important to keep the seedlings strong and healthy so that they can better withstand an attack
- A weed-free coffee garden with good airflow will reduce the potential threat from pests and diseases
- It is also beneficial to plant intercrops or cover crops that harbour predators of coffee pests. For example, pumpkin and cucumber attract ladybirds which control green scale

Shade management

Note: See the Shade management module for information on how to manage shade trees.

- **The ideal shade tree should block out about 30% of sunlight**
- Do not allow too much shade to cover the coffee seedlings
- Prune and thin the shade trees to prevent them from overshading the young coffee trees
- Banana plants provide a good form of temporary shade but may also need to be managed so they provide an appropriate shade level

Infilling

Note: Always infill as soon as possible with a new seedling if the old one dies.

Infilling is replacing dead or diseased seedlings in the coffee garden with new healthy seedlings.

- Even under very good management some transplanted seedlings will die
- Some seedlings should be left in the nursery to use for infilling. If planted seedlings die within the first few months then they can be replaced with spare bare root or polybag seedlings from the nursery. If the spare seedlings are overgrown seedlings, they will have to be treated using the techniques for managing overgrown seedlings in Section 3.6
- Seedlings for infilling should be planted in the same way as for all new seedlings as described in Section 3.6.
- Dead or sick seedlings to be replaced should be removed and burnt to prevent infection of the replacement seedling

A farmer replacing a wilting young coffee tree with a new bare root seedling.

What to do with tall, thin and weak coffee trees that are not developing well

This problem is often caused by planting overgrown seedlings. There are two strategies for correcting tall and thin coffee trees after they have become established in the coffee garden:

1. **Capping**
2. **Bending**

These methods will encourage growth of new side branches.

Capping

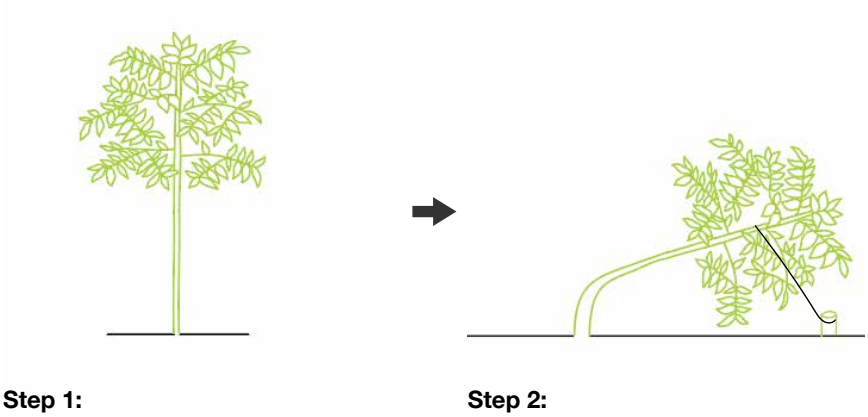
- This is the simplest and the easiest of the two options
- *Refer to Section 3.6, 'Capping in the nursery' in this module for directions on capping seedlings*

Bending

1. This method can be done after the seedlings have developed a good root system (about 3 months after transplanting)
2. The seedling is bent over and pegged to the ground to allow suckers to grow
3. Carefully bend the stem over and peg it to the ground, preferably near the growing tip
4. Allow for new suckers to develop along the stem, preferably about 30 cm above the soil surface
5. When the suckers are 8-12 months old, cut off the end of the old stem

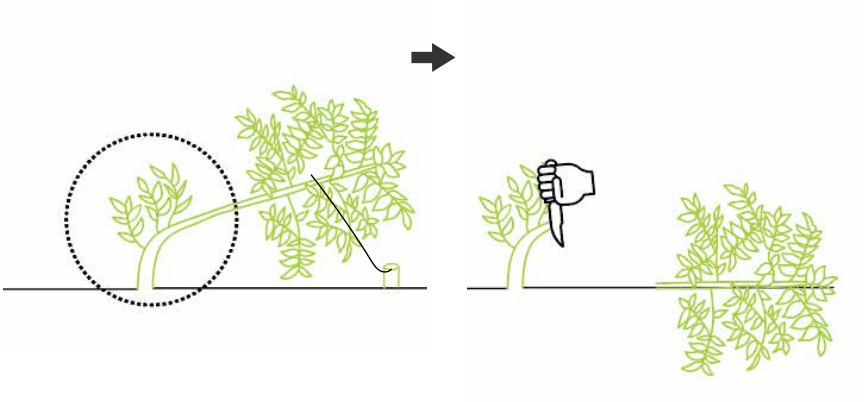
Bending overgrown seedlings

Bending overgrown seedlings



Step 1:
Find a tall, thin & weak seedling with well established roots.

Step 2:
Bend down the stem & tie it to a stake.



Step 3:
Let 3-5 suckers develop.

Step 4:
Cut off the bent stem.

Step 5:
Allow the new suckers to grow.

Objective:

To identify and discuss the maintenance required in a new coffee garden.

You will need:

Butchers' paper and a marker pen

EXERCISE 12

Coffee garden maintenance

Discuss:

1. The importance of keeping a new coffee garden well maintained from the beginning

List:

1. The activities involved in maintaining a newly planted coffee garden

Discuss:

1. The importance of each activity and how it is applied or undertaken

3.8 INTERCROPPING

Once you have established your new coffee garden, you may wish to intercrop food crops with the coffee trees *(see Farmer Training Guide Unit 2 Module 8: Intercropping in your coffee garden for more detailed information).*

Intercropping coffee with food crops has many benefits, particularly in the first year or two when the coffee garden is becoming established. These benefits relate to the health of the coffee garden, household food supply, labour and income.

Conditions suitable for intercropping

Intercrops can only be grown in the coffee garden under certain conditions:

1. When the coffee garden is newly planted
2. After the main pruning or change of production cycle pruning
3. After rehabilitation of coffee plots

Now that your new coffee garden has been planted there is ample space and light to grow food crops in the inter-rows between the rows of coffee trees. This practice can continue until the coffee trees are about two years old or until they are providing too much shade to allow for growth of intercrops.

Why intercrop?

- More land for gardening
- Another source of income
- Efficient use of labour
- Better maintenance of the coffee garden
- Mulch is provided by crop residues
- Erosion and weeding is reduced
- Increased production from healthier trees due to greater attention given to the coffee garden

Types of food crops recommended for intercropping with coffee

The following are the best types of food crops to grow when intercropping:

1. Annual crops
2. Legume crops
3. Shallow rooted vegetables
4. Food crops that provide soil cover
5. Crops that provide temporary shade for young seedlings, like banana

Not all food crops are suitable for intercropping with coffee. You should use only those that are recommended and avoid using those that are not.

Advantages and disadvantages of intercropping

Advantages and disadvantages of intercropping

Intercropping

Advantages:	Disadvantages:
1. The **coffee seedlings are maintained** as you take care of the food crops (improved mulching, weeding, pruning, shade regulation and erosion control).	1. You may plant crops that attract **pests and diseases** that can damage the coffee seedlings.
2. Make use of unused land and provide a **source of income** while waiting for the coffee seedlings to mature.	2. If you plant food crops that will be harvested after more than a year they may **compete** with the coffee trees for nutrients, space, sunlight, moisture and air.
3. **Women** will be more involved with the coffee while looking after the food garden; gives them better access to land for food gardening.	3. Some food crops, including legumes, may **compete** for soil nutrients and the farmer will have to add extra nutrients to compensate for these nutrient losses.
4. Crop residues after harvesting intercrops may provide **mulch** for the coffee trees. Remaining roots will add to soil organic matter and increase fertility.	4. The coffee tree **roots may be damaged** when harvesting the intercrops resulting in reduced coffee yields. This can be a problem when the roots of intercrops grow deep into the soil in response to the application of fertiliser.
5. Legume plants used for intercropping **add nutrients** (nitrogen) to the soil. Peanuts are a good example	5. You should not intercrop root crops such as kaukau, tapiok, taro and yam, because during harvesting the coffee **root systems may be disturbed.** Kaukau also attracts coffee ring borer and weevils, which can attack coffee.
6. If fertiliser is added to the food crops then the coffee will also benefit.	6. Leafy food crops may **over shade** the coffee seedlings.
7. Dead and sickly coffee seedlings can be detected more quickly because you are in the coffee garden more often.	7. Gardens with valuable crops will attract thieves
8. Increasing the biodiversity in the coffee garden adds to the richness in soil organisms and beneficial insects, and the establishment of stronger symbiotic relationships	

Crops that are recommended for intercropping and those that should not be intercropped with coffee

Food crops recommended and those to avoid for intercropping with coffee

Type of food crop	Recommended for intercropping	NOT recommended for intercropping	Why NOT recommended?
Legumes:	Soya beans, peanuts, Pinto peanuts	*Asbin* (Winged bean)	Winged bean climbs up coffee trees and chokes them (may be used if staked).
Vegetables:	Cabbage, pak choi, broccoli, carrot, tomato, onion, zucchini, pumpkin, chilli, ginger & cucumber	Choko and corn	Choko climbs up coffee trees. Corn competes for light
Root crops:	Potatoes	Kaukau, taro, tapiok & yam	Coffee roots are damaged when harvesting. Some attract pests (e.g. kaukau hosts a weevil that eats the tips of the coffee trees and it also attracts the coffee ring borer).
Fruits & nuts:	Banana & Tamarillo during the first 3 years of coffee establishment (they can be boundary plants in mature coffee gardens)	Guava, kapiok (bread fruit), avocado, karuka (Pandanus), marita (Pandanus), muli (citrus) and pineapple	Too large and will overshade the coffee trees. Citrus hosts coffee green scale and pink disease. Guava hosts green scale.
Grasses:		Sugar cane & rice	Compete with the coffee trees for moisture and light (sugar cane)
Other:		Shrubs	Compete with the coffee trees for nutrients, moisture and light

Objective:

To understand the advantages and disadvantages of intercropping in a coffee garden, and identify which food crops are suitable for intercropping and those that should not be intercropped.

You will need:

Butchers' paper and a marker pen

EXERCISE 13

Intercropping in a coffee garden

List:

1. The advantages of intercropping food crops in a coffee garden
2. The disadvantages of intercropping food crops in a coffee garden
3. Intercropping in the short-term until the coffee trees are established versus long-term intercropping. Should intercropping be considered when deciding on coffee tree spacing?
4. Food crops that farmers may have intercropped with coffee in the past and their experiences with them. Were they suitable?

Discuss:

1. The food crops that can be intercropped in a new coffee garden
2. Those crops that should **NOT** be intercropped

3.9 KEY MESSAGES

What are the important messages for the farmer?

1. The factors to consider when selecting a site for a new coffee garden include drainage, climate, erosion, soil type, current land use, accessibility, land tenure, location of food gardens and the presence or absence of CBB nearby
2. When clearing the site, retain any trees that may be suitable shade trees for the coffee
3. Decide on plant spacing, build fences and drains and plant shade trees prior to transplanting the coffee seedlings
4. When planting the coffee, take care to prepare the holes well and use good quality seedlings to maximise future production and income
5. After planting, follow-up with a good maintenance program including mulching, weeding, infilling, removing flowers, pruning coffee and shade trees and monitoring pests and diseases
6. Intercropping the coffee seedlings with food crops has many benefits including: better maintenance of the coffee; an additional source of income; and improved soil fertility

3.10 QUIZ

Place an '✓' in the correct box.

1. Which of the following is an important factor to consider when establishing a new coffee garden?

- A Land tenure
- B Erosion control
- C Drainage
- D All of the above

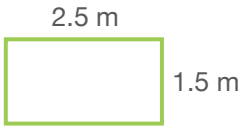
2. When clearing a site for a new coffee garden, fallen timber can be used for fencing, firewood or construction. What is the best way to dispose of any remaining timber?

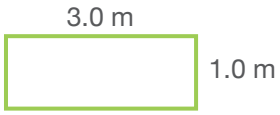
- A Remove it from the coffee garden
- B Burn it on site and rapidly release nutrients
- C Leave it to decompose in the coffee garden and slowly release nutrients
- D Heap it all at the boundary of the coffee garden and let it decompose

3. When clearing a site for a new coffee garden, what should be done with any old coffee trees that are badly infected with disease?

- A Move them to the boundary of the garden and burn them
- B Move them to the boundary of the garden and leave them to decompose
- C Burn them in place if they are not too close to neighbouring trees retained for shade
- D Leave them in place to decompose

4. Which of the following is the standard plant spacing recommended for the smallholder farmer growing tall coffee varieties?

A 

B 

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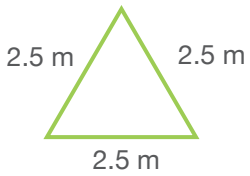
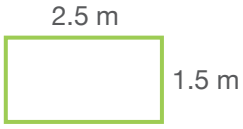
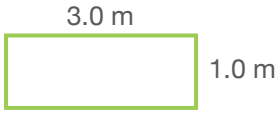
D 

5. Which plant spacing is most suitable for smallholders who intend to practice long-term intercropping of tall coffee varieties?

A 

B 

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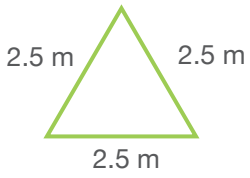
D 

6. What is the ideal shade level in a coffee garden?

A 70% shade
B 50% shade
C 30% shade
D 0% shade

7. Nitrogen fixation is a process that occurs in some plants whereby nitrogen from the air is converted into a form that can be used by the plant. The process increases the amount of nitrogen in the soil. Nitrogen is an important nutrient that helps plants like coffee grow strong and healthy.

   Which of the following are nitrogen-fixing trees, and could be used as permanent shade trees?

   A Kumerere (Gum tree, *Eucalyptus*) and Yar (*Casuarina*)
   B Yar (*Casuarina*) and Marmar (*Albizia*)
   C Marmar (*Albizia*) and Banana
   D Banana and Pigeon Pea

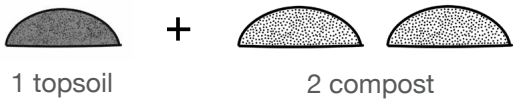
8. When digging a planting hole for a coffee seedling you separate the topsoil and the subsoil. Which is the better soil to use when backfilling the hole when planting the coffee seedling, and why?

   A Topsoil, because it contains a lot of clay
   B Subsoil, because it brings nutrients to the surface
   C Topsoil, because it has good texture and is rich in nutrients enabling good root penetration and growth
   D Subsoil, because it has good texture and is rich in nutrients enabling good root penetration and growth

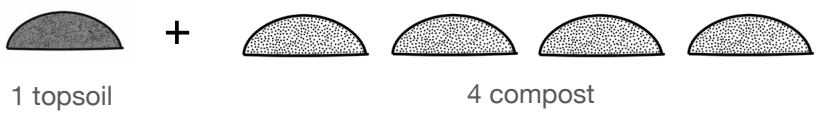
9. When preparing a planting hole to plant a coffee seedling what is the recommended ratio of **topsoil** to compost when preparing the soil mix for backfilling the hole?

   A 4:1

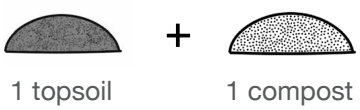
   B 1:2



   C 1:4

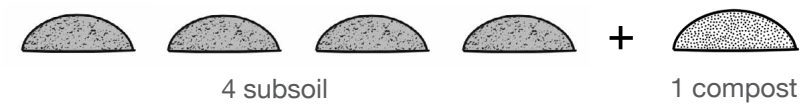


   D 1:1



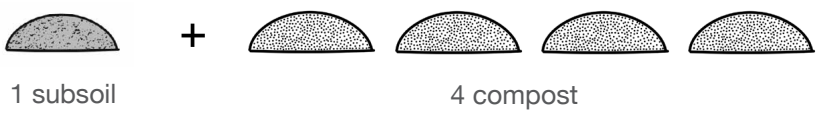
10. When preparing a planting hole to plant a coffee seedling, subsoil may be required for backfilling the planting hole if the topsoil layer is very shallow. What is the recommended ratio of **subsoil** to compost when preparing the soil mix for backfilling the hole?

A 4:1



B 1:2

C 1:4



D 1:1

11. In a new coffee garden, why is it better to prepare the planting holes well in advance of planting the coffee seedlings?

A To save time when planting the seedlings

B So they will fill with water

C To allow for weathering and cracking of the soil which will enable better root penetration and establishment of the coffee seedling

D To allow the hole to dry out

12 Young coffee seedlings are ready for transplanting from the nursery into the new coffee garden when they:

A Are pest and disease free

B Have been in the nursery for 6-9 months

C Have 8-9 leaf pairs or 2-3 primary branches

D All of the above

13. After a new coffee garden has been planted it is very important to take good care of the coffee seedlings so that they establish well and become highly productive coffee trees. Mulching and shade management are important maintenance tasks as they assist in:

- A Maintaining soil moisture
- B Suppressing weed growth
- C Reducing susceptibility of the coffee seedlings to pests and diseases
- D Reducing labour requirements for maintenance
- E All of the above

14. Kaukau should not be planted on the site for a new coffee garden because it harbours:

- A Coffee berry borer
- B Coffee ring borer
- C Green scale
- D Pink disease

15. Crops that are suitable for intercropping with coffee include:

- A Citrus and karuka
- B Corn and choko
- C Cabbage, carrot and asbin
- D Cabbage, carrot and potato

16. True or false.

	True	False
a. Shade trees should be planted at the same time as the coffee seedlings.	☐	☐
b. Coffee roots will not grow well in waterlogged soil.	☐	☐
c. Transplant the coffee seedlings from the nursery to the new coffee garden when they are at least 12 months old.	☐	☐
d. Structural pruning and de-suckering are not required for the first 3 years after planting the coffee seedlings in a new coffee garden.	☐	☐
e. The planting hole for a new coffee seedling should be about the size of a harvesting bucket.	☐	☐

3.11 SOURCES OF FURTHER INFORMATION

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