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SMALLHOLDER COFFEE PRODUCTION IN PAPUA NEW GUINEA – FARMER TRAINING GUIDE

UNIT 2: MANAGING YOUR COFFEE GARDEN

MODULE 1:
WEED CONTROL

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WEED CONTROL

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 inform farmers of the impacts of weeds on coffee productivity and describe methods of weed control that are cost effective and place low labour demands on farmers both in the short and long-term.

Weeds can have a negative effect on coffee tree establishment and growth thereby impacting coffee tree productivity. Weeds can choke young coffee seedlings and trees, provide refuge for pests and they compete with coffee for space, light, nutrients and water. Weeds should not, however, be considered a waste product; they are a resource containing valuable nutrients and they add organic matter to the soil. Good weed management practices can minimise the negative impact of weeds and in the long-term minimise the amount of labour required to control them.

LEARNING OUTCOMES:

By the end of this module you will understand:

- The impacts of weeds on coffee trees and coffee tree productivity
- The types of weeds growing in the coffee garden
- Labour demands of weed control
- The Integrated Weed Management (IWM) approach to controlling weeds
- That weeds are not a waste product but instead a valuable resource containing nutrients and are a source of mulch
- Control and recycling measures for specific weeds

LESSON PLAN:

The module has two parts

Sections 1.1 to 1.3	Types of weeds and their impacts
Sections 1.4 to 1.7	Measures for controlling weeds and recycling nutrients in weeds

TIME REQUIRED TO COMPLETE THIS MODULE: 2 DAYS

LIST OF SYMBOLS:

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 participant plus extra copies)
- Specimens of annual and perennial weeds
- Tools for removing weeds (e.g. spade and fork)
- Weed poster
- Intercropping poster
- Shade poster
- Butchers' paper and marker pens

PRE-TRAINING ACTIVITIES:

- Confirm number of training participants
- For presentation of this module arrange to use a coffee garden with appropriate (30%) shade cover and good weed management
- If possible, find a coffee garden located nearby with poor weed management so that it can be used as a comparison. Before training, identify the weeds present so that they can be pointed out to farmers during training
- One day before training, or the morning before, collect samples of annual and perennial weeds. The following are some examples:
  - **a.** Annual weeds – black nightshade, cobbler's pegs
  - **b.** Perennial weeds – kunai, couch grass
    (For more examples see table in Section 1.7)
- Obtain a bucket of suitable mulch (e.g. 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.

Annual coffee production events and activities (stickers)

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 with the first row by attaching the progressive stages of coffee berry development from flowering through to bright red cherry ready for harvest and to overripe cherry.
- Complete the remaining rows, linking each activity with the different stages of berry development
- For this module, place emphasis on activities relating to weed management

Weed management activities (stickers)

- A new coffee garden
  1. Clear the site for the new coffee garden
  2. Completely remove and bury perennial weeds that are difficult to control, such as broomstick, nutgrass, kunai, couch grass and Wandering Trad (also known as Wandering Jew)
  3. Plant temporary and permanent shade trees
  4. Slash grasses just prior to planting the coffee seedlings
  5. After the coffee seedlings have been planted, remove any weeds from around the seedlings before the weeds flower and set seed. Replenish the mulch
  6. Slash the grass cover outside the circle of mulch, or plant intercrops or cover crops between the rows of coffee
- An established coffee garden
  1. Prune the shade trees to maintain the shade level in the coffee garden at 30%
  2. Occasionally remove weeds where necessary

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

1.1 THE IMPACT OF WEEDS ON COFFEE PRODUCTION

What are weeds and how do they become a problem in the coffee garden?

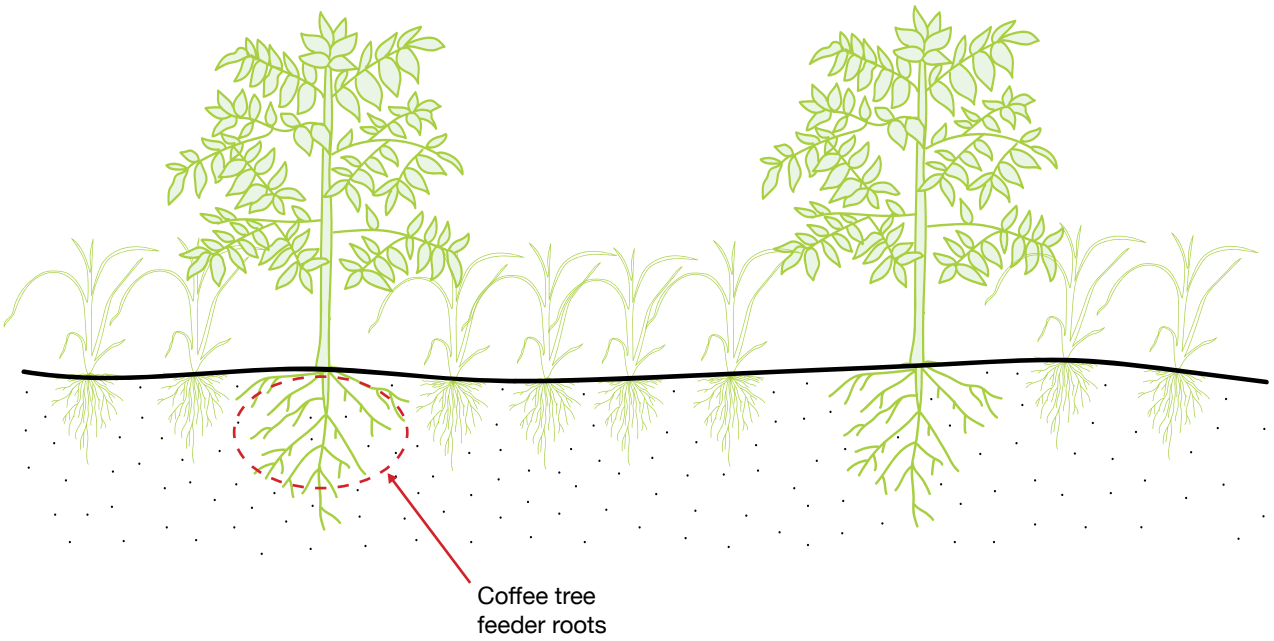
- A weed is a plant growing where it is not wanted and is competing with cultivated plants
- During the first 2-3 years after transplanting coffee seedlings into a new coffee garden, the canopy of the developing coffee trees covers only a small proportion of the soil surface. The remaining soil surface is exposed to sunlight and moisture and is ideally suited to invasion by weeds
- As coffee trees mature, weeds can remain a problem if certain management practices are not applied
- Weeds can have many negative impacts, not only on the coffee garden but also on the household

Competition

Weeds can compete with coffee both directly and indirectly:

Direct competition

- Weeds compete with coffee trees and shade trees for water, nutrients, space, and sunlight
- Competition from weeds is particularly challenging because coffee tree feeder roots and weed roots both grow in the surface soil
- If coffee trees cannot take up sufficient nutrients from the nutrient-rich surface soil they will expend extra energy growing deeper roots in search of nutrients, thereby reducing their productive efficiency
- Weeds often weave a net of rhizomes, or underground stems, around the roots of the coffee trees constricting their growth and slowing down their development
- When the coffee trees are young, tall weeds may physically obstruct their growth by leaning on or winding around the stem and branches
- Weeds can also compete with shade trees



Roots of weeds occupying the same soil zone as coffee tree feeder roots

Indirect competition

- Weeds can impact management practices (mulching, pest control and harvesting)
- Weeds create hiding places for pests and diseases
- Some weeds may have a toxic effect on the coffee trees. That is, chemicals are released by the weed that restrict the growth and development of the coffee tree
- Weeds can delay the age of bearing of coffee trees and reduce the long-term overall productive capacity of the coffee trees

Cost

The cost of weeds to coffee productivity

- When the coffee trees are young, weeds delay establishment of the coffee trees, increase the time to maturity and reduce their bearing capacity
- When there are a lot of weeds, coffee trees produce smaller beans thus affecting coffee quality and prices
- Stumped coffee trees are also vulnerable to competition from weeds suppressing sucker development and reducing productive capacity

The main factors that determine the cost of weed control

- The type of weed species present
- The timing of weed control
- The carry over effects of control measures
- The physical characteristics of the coffee garden
- The presence or absence of shade trees

Chemical control

- Using chemical control is costly, while using mulch and shade to control weeds is cheaper
- Mulch and shade are much more beneficial to the coffee garden in the long-term in terms of production and costs
- Chemical control of weeds may not comply with certification criteria, especially organic certification schemes, and may be harmful to the farmer if not applied safely

Labour

- Using mechanical control, and to a lesser degree mulching, requires a lot of labour
- Weeds make it more difficult to harvest cherry, prune trees and undertake CBB sanitation control
- High labour demands in the coffee garden may impact the household if labour is diverted away from other important household tasks, such as maintaining food gardens

Pests and diseases

- Weeds create ideal environments for pests and diseases to thrive
- If the weeds are dense, airflow around the coffee trees may be restricted enabling pests and diseases to flourish
- Weeds provide a habitat for pests to feed in and to reproduce
- The presence of weeds can prevent farmers from noticing trees in the coffee garden that are affected by pests or diseases

- Weeds make it more difficult to find berries dropped during harvesting. These may contain CBB

Level of impact of weeds

The level of impact of weeds is determined by the:

- Types of weeds, their population densities and distribution
- Environment - climate and the fertility of the soil
- Management practices

Objective:

To understand the impact of weeds on the establishment and growth of the coffee garden as well as the impact on the coffee farmer's household

EXERCISE 1

The impact of weeds

Discuss:

1. The experiences farmers have had with weeds. How have weeds impacted coffee and/or food garden production? How has this impacted the household?
2. How weeds compete with coffee trees and shade trees
3. Why it is important to manage weed growth right from when the coffee garden is first established
4. The short and long-terms costs of poor weed management
   - Financial cost in terms of coffee production
   - Household labour costs
5. Why it is important to incorporate good weed management strategies in a CBB environment

1.2 TYPES OF WEEDS

Characteristics of weeds

Plants that become weeds tend to have all or some of the following characteristics:

- Produce abundant quantities of seed
- Germinate and rapidly establish a population
- Have a seed dormancy or resting stage which allows the seed to survive during unfavourable conditions
- Long-term seed viability
- Effective seed dispersal mechanisms
- Vegetative structures (roots and stems) with food reserves that allow them to survive and spread
- Have an ability to colonise disturbed soil

Classification of weeds

There are many varieties of weeds that can grow and become a problem in the coffee garden.

Annual weeds

- These include grasses and broad-leaved weeds that usually produce **abundant seed**, have a **simple root system** and complete their **life cycle in one season**, meaning they emerge and die off within a year
- These weeds are the least competitive and damaging to the coffee trees
- Annual weeds are the **easiest to control**

Cobbler's Pegs *(Bidens pilosa)* is an annual weed.

Cobbler's pegs *(Bidens pilosa)*

Why is it a weed?

- Produces abundant quantities of seed (one plant can produce up to 30,000 seeds)
- Seeds are robust and can germinate in a variety of situations including on the soil surface or in shallow soil
- Seeds can remain viable for many years
- Seeds readily attach to clothing and animals and can be easily dispersed by vehicles and water
- Grows in a wide variety of habitats
- Is very invasive and can outcompete many other plant species

Perennial weeds

- These include grasses, sedges and broad-leaved weeds that persist or continue to **regrow each year**
- They typically regrow from a **network of stems and root systems**
- Stems include stolons and rhizomes. **Stolons** are stems that trail above the ground and **rhizomes** are stems that spread under-ground. Rhizomes often contain swellings or storage organs, such as tubers, which enable the plant to store food and survive through to the next season
- Even after the aerial parts of many weeds have been removed the underground **rhizomes and/or tubers persist**
- The structures that enable these weeds to persist make them much more **difficult to control** than annual weeds

Kunai grass *(Imperata cylindrica)* is a perennial weed.

Activity:

1. Show some examples of annual and perennial weeds.
2. Identify the differences in growth habits in the stem and root systems.

Annual and perennial weeds

Kunai grass *(Imperata cylindrica)*

Why is it a weed?

- Reproduces by both seeds and rhizomes
- Produces abundant quantities of seed
- Seeds are dispersed by wind
- Seeds can remain viable for up to one year
- Rhizomes are aggressive and can lay dormant for long periods
- Grows in a wide range of soils and climatic conditions
- Regenerates rapidly if burnt or slashed
- Is highly competitive and invasive

Objective:

To understand why plants become weeds and the different types of weeds that may grow in the coffee garden.

You will need:

Specimens of annual and perennial weeds

EXERCISE 2

The types of weeds that grow in coffee gardens

Discuss:

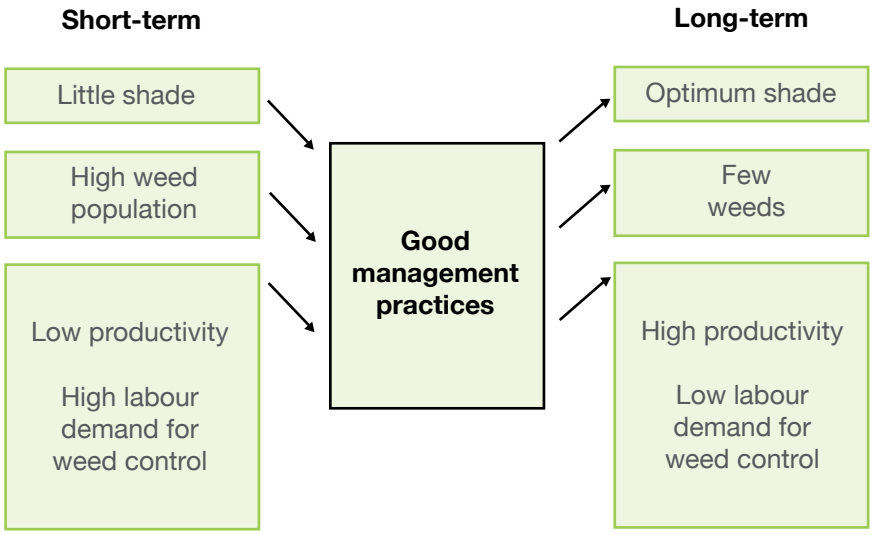
1. Some of the characteristics of plants that can make them successful weeds (Show some examples of annual and perennial weeds)
2. How weeds are classified as either annual or perennial. What is the difference between the two types of weeds? Which has the most impact on the coffee trees? Which is the most difficult to control and why?

1.3 LABOUR INPUT AND WEED CONTROL

Labour input in weed control

When a new coffee garden is first established, labour demands for weed control are high but with good management these demands decline over time.

- In a new coffee garden it is important that weeds are removed to prevent competition with young coffee trees and allow growth and establishment of the coffee and shade trees
- Over time, along with the use of good management practices, the coffee and shade trees will become well established and shade the surrounding exposed ground, thereby suppressing weed growth
- Increasing amounts of leaf litter through time will also suppress weeds
- There will be a declining requirement for labour to control weeds as the productivity of the coffee trees increases

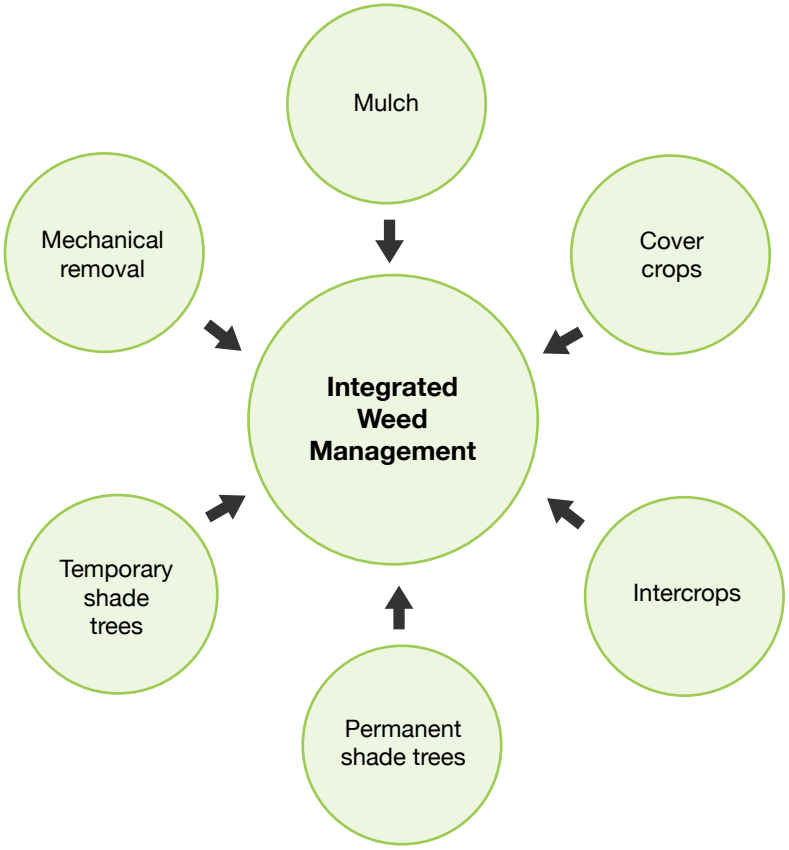


The **ultimate goal** is good weed control with optimum shade and minimal labour input. The best way to achieve good weed control is by using a system known as **Integrated Weed Management**. This system combines the use of a number of different types of control measures in order to minimise weeds and maximise production.

1.4 INTEGRATED WEED MANAGEMENT

Integrated Weed Management

The best way to control weeds is by using a system of Integrated Weed Management (IWM). This form of weed control uses a variety of methods to manage weeds in the coffee garden for the whole productive life of the coffee trees. The control measures incorporate both mechanical (e.g. using a spade) and cultural techniques (e.g. using shade management).



Mechanical control is the physical removal of weeds by pulling them out by hand or removing them using a fork or spade. **Cultural control uses techniques** to encourage the competitiveness of the desired species and suppress the growth of weeds. These techniques include the use of mulch, cover crops, intercrops, and shade trees.

It is important to always keep in mind that your objectives are to:

1. **Minimise weed growth** in your coffee garden
2. Use the **least amount of labour** necessary

Chemical control

- A last resort in any weed management strategy is the use of chemicals as they are **expensive** and can be **unsafe** for your health and the environment
- If farmers wish to apply for certification, the use of herbicides is not recommended. Most certification bodies do not allow the use of chemicals, or if allowed, their use is limited

Short and long-term measures for weed control

Short and long-term measures for weed control

There is a range of methods of weed control that can be implemented in the coffee garden from the short-term to the long-term. Short-term methods require high labour inputs and are the least preferred, while long-term control methods require minimal labour.

1. Short-term - Mechanical control and mulch
2. Medium term - Temporary shade, cover crops or intercrops
3. Long-term - Permanent shade

Mechanical control

- When the coffee garden is first planted, the shade trees are still young and provide little shade. If little shade is present, sunlight reaching the ground enables weeds to grow
- Weeds can be removed using tools and manual labour
- This method of control may be required while the permanent shade trees, which will be used in controlling weeds in the long-term, are establishing
- Care must be taken, during manual removal of weeds, not to damage the roots of the coffee trees
- Using tools and manual labour can be very labour intensive and can take up a lot of the farmer's time allowing less time for other important tasks

Cost:

If tools are already available, mechanical control is inexpensive unless paid labour is used.

Labour demand:

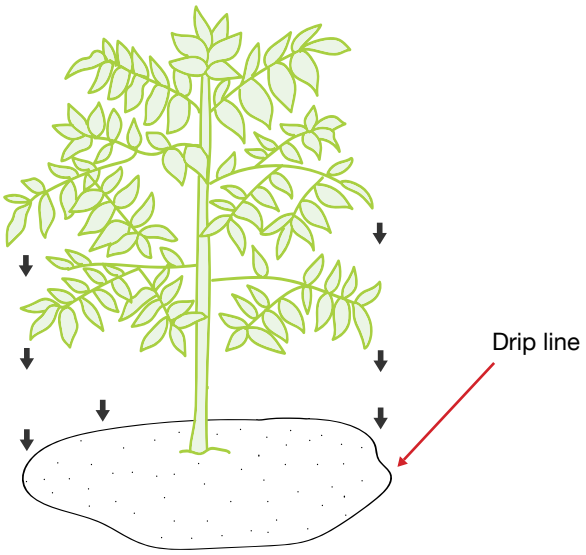
High

Effectiveness:

- Removing weeds completely by hand is an effective control method but not the most efficient in terms of labour
- Suitable in the short-term

Application:

- **Carefully** remove the weeds from around the coffee trees ensuring not to damage the coffee tree roots
- To prevent damage to the roots, remove weeds by hand-pulling inside the drip line and using tools, such as a spade or garden fork, outside the dripline

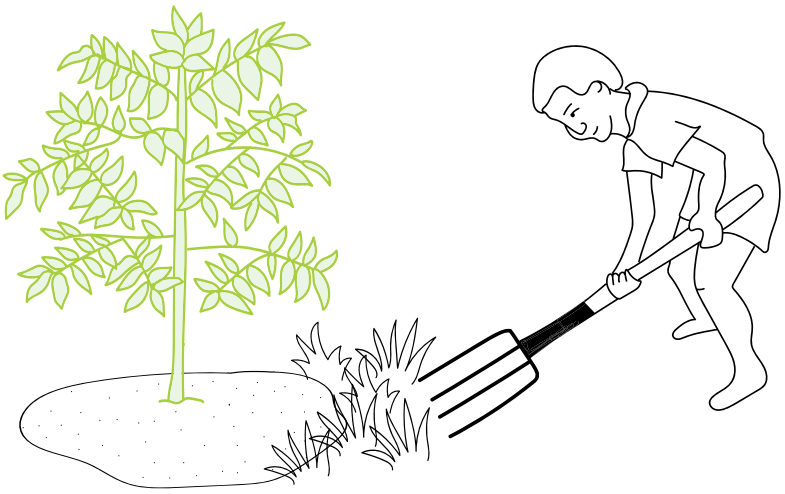


- The removed weeds contain valuable nutrients that should be retained in the coffee garden. For directions on how to effectively use these valuable nutrients, see Section 1.6 ‘Nutrient recycling strategies for weeds’

Activity:

Demonstrate how to remove weeds around a coffee tree without damaging the roots (hand-pulling inside the dripline, using tools outside the dripline).

Note: If there are no coffee trees present, demonstrate the technique around any shrub/bush growing at the training site.



Using a garden fork to manually remove weeds around a coffee tree, outside the drip line.

Burning weeds

- Do not control weeds by burning areas of the coffee garden
- The coffee trees may be damaged by fires
- Coffee trees do not like ash from fires
- Kunai grass will readily burn even when green. It will then rapidly regenerate from its underground rhizomes and cause a greater problem than was already present

Activity:

Show suitable forms of mulch (e.g. debris from shade trees, coffee pulp and weeds).

Note: Ensure that weeds contained in the mulch are not those that easily regenerate

Mulch

- Mulch is decaying plant matter and is placed around the base of the coffee trees in a new coffee garden
- Mulch has very important functions, one of which is to suppress the growth of weeds
- Other functions are to retain moisture, improve soil structure and provide nutrients to the coffee trees
- 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
- Coffee pulp makes ideal mulch. While preventing weed growth it also provides the coffee trees with additional nutrients
- Over time the mulch decomposes and has to be replenished
- As the shade trees grow they become a good source of mulch. Any debris that they drop can be used to replenish mulch around the coffee trees. Debris falling between coffee trees and between rows will help to minimise weed growth
- Applying mulch by hand to control weeds is much faster than removing weeds by hand-pulling or using tools such as a spade or garden fork

Cost:

Medium

Labour demand:

Medium. Mulching requires less labour than for mechanical weed control.

Precautions:

- In high rainfall areas, mulch can depress yield as the coffee tree roots may become waterlogged causing the roots to rot
- Mulch can burn young trees and should be kept away (10 cm) from the main stem of the coffee tree

Effectiveness:

Effective as a weed suppressant

Benefits of mulch:

- Suppresses weeds
- Conserves soil moisture, improves aeration and regulates soil temperature
- Controls soil erosion
- As the mulch decomposes it releases nutrients into the soil which can be used by the coffee trees
- Encourages soil microbes which help the trees take up nutrients from the soil
- Makes the coffee trees less vulnerable to pests and diseases. The trees are healthier and less susceptible to infestation by pests and diseases

Application:

How to mulch your coffee trees

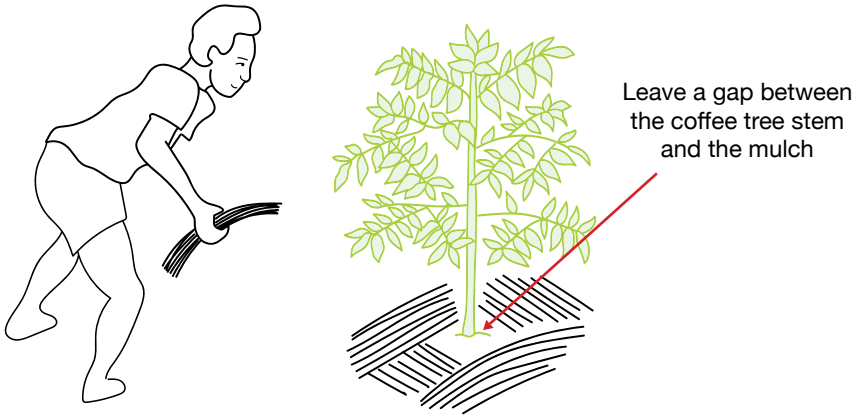
- Ideal mulch includes coffee pulp, banana leaves and stems, removed weeds, and debris from shade trees

Coffee pulp

- Place a layer of mulch 5-10 cm deep around the base of the coffee tree out to the dripline
- Leave a gap of 10 cm between the mulch and the stem of the coffee tree. The mulch should **never** touch the stem of the tree

Mulching

Always leave a space of about 10 cm between the coffee tree stem and the mulch so that it does not burn the stem.



Mulching a coffee tree out to the dripline

Temporary shade

Temporary and permanent shade trees are planted just prior to young coffee seedlings being planted in a new coffee garden.

- Temporary shade trees are fast growing and provide shade for young coffee seedlings until the permanent shade trees become established
- Temporary shade trees decrease weed growth by reducing the amount of sunlight reaching the ground
- They provide mulch through leaf litter
- As the temporary shade trees are thinned they can be left in the coffee garden to decompose and provide valuable nutrients for the coffee trees
- A very common and useful temporary shade tree is banana

Cost:

Low

Labour demand:

Medium. Temporary shade trees will have to be removed to allow more space for the coffee trees to grow.

Precautions:

- As temporary shade trees are planted at a high density, ensure they do not compete with the young coffee trees
- Too much shade by temporary shade trees can make the young coffee trees weak and thin

Application:

- Plant temporary shade trees when planting the permanent shade trees, about 4 months prior to planting the coffee seedlings. *See the 'Shade management' module for more detail on shade tree spacing*
- As they mature, gradually remove the temporary shade trees
- Some manual removal of weeds will still be required as the recommended shade cover will not yet have been established

Cover crops

- Cover crops, such as Pinto Peanut *(Arachis pintoi)*, are crops planted to cover the soil rather than be harvested
- The purpose for growing cover crops is typically to manage soil erosion, suppress weeds and improve soil fertility
- Cover crops are slashed at the end of the wet season and the debris is left on the ground to mulch the soil and provide nutrients for the coffee trees. Cover crops are often referred to as green manure

Cost:

Medium

Labour demand:

Medium. Cover crops have to be sown and then slashed at the end of the wet season.

Precautions:

- Ensure cover crops are slashed at the end of the wet season so that they do not compete with the young coffee trees

Effectiveness:

Effective as a short-term weed suppressant until the permanent shade trees become established.

- When growing, the cover crop will smother weeds and protect the soil from erosion
- A cover crop may compete with the coffee for nutrients, but if the cover crop is cut at the end of the wet season and left to decompose, the lost nutrients will be returned to the coffee trees via leaf and stem litter
- While the cover crop is decaying, weeds will continue to be suppressed
- Ideal cover crops are leguminous ground covers as they add nitrogen to the soil
- The growth of cover crops must be controlled so as not to hinder the growth of the coffee trees

Cover crops		
Local name	**Scientific name**	**Growth habit**
	Flemingia congesta	Woody legume, deep rooted
Gras komb or cow grass	*Desmodium* sp.	Creeping legume
Pinto peanut	*Arachis pintoi*	Groundcover legume, grows best in light shade but can tolerate both full sun and heavy shade
	Stylosanthes gracillis	Small shrub legume
Calopo	*Calopogonium mucunoides*	Vigorous creeping legume, suppresses weeds, improves soil fertility and coffee yields

Application:

- Plant a cover crop after the coffee seedlings have been planted
- Do not sow the cover crop too close to the coffee trees to minimise competition with the coffee for water, nutrients and sunlight
- Slash the cover crop at the end of the wet season taking care not to damage the young coffee trees
- Leave the cover crop debris where it is slashed

Activity:

Show the intercropping poster to demonstrate how weeds are suppressed by the presence of an intercrop.

Note: See the modules on establishing a new coffee garden and intercropping for more information on mulching and intercropping.

Intercrops

- Intercrops are grown between the rows of coffee trees
- Ideal intercrops include cabbage, broccoli, onion, banana, peanut, carrot, tomato, zucchini, pumpkin, chilli, ginger and cucumber
- Intercrops are consumed by the household or sold at markets

Cost:

Medium

Labour demand:

Medium. Intercrops should be sown or planted at the beginning of the wet season and harvested at the start of the dry season.

Precautions:

- Ensure intercrops are harvested at the end of the wet season so that they do not compete with the young coffee trees

Effectiveness:

Effective as a short-term weed suppressant until the permanent shade trees become established.

- Like cover crops, intercrops suppress weeds and protect the soil from erosion
- If the intercrops are fertilised the coffee will also benefit. Residues from intercrops also add valuable nutrients to the soil
- Intercrops provide temporary shade to young coffee seedlings
- In addition, intercrops provide food for the household and/or provide an additional source of income
- Farmers are encouraged to maintain their coffee as they take care of the intercrops

Permanent shade

- Permanent shade trees are planted in the coffee garden for the purpose of providing shade to the coffee trees for their entire productive life
- They are typically large, long living trees that provide filtered light to prevent overbearing dieback, suppress weeds, mulch the soil via leaf litter, and bring nutrients up from deep in the soil that can be used by the coffee trees

Cost:

Low

Labour demand:

Low, however, permanent shade trees require occasional pruning.

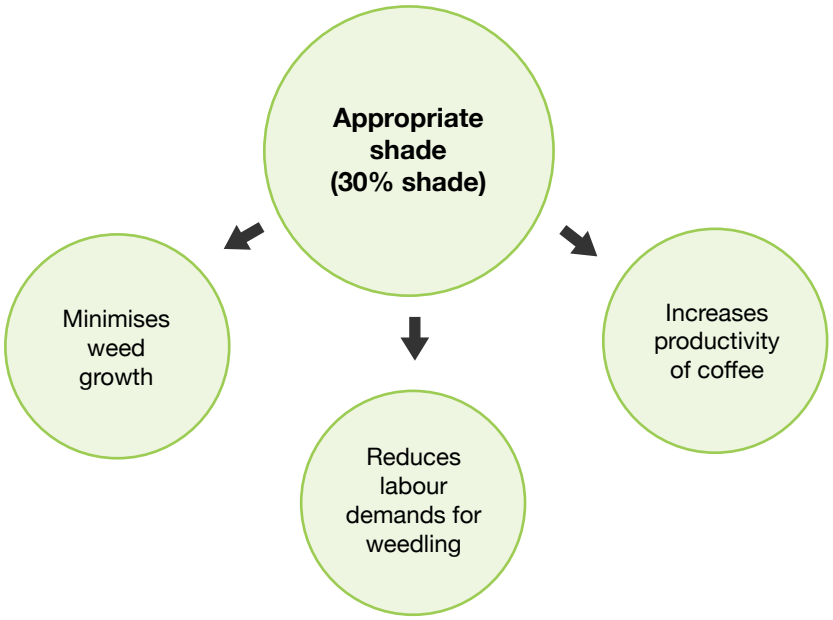
Precautions:

- Shade trees should provide an appropriate level of shade cover, that is, they should reduce full-sun by about 30%
- Too much shade can make the coffee trees weak and thin

Effectiveness:

- One of the ultimate objectives of coffee garden management is to establish an **appropriate level of shade cover**. The many benefits of shade are discussed in the module on shade management. One very important benefit of permanent shade is **long-term weed control**
- Permanent shade trees take time to become established and provide little benefit in reducing weed growth in the coffee garden when they are young. However, as the shade trees grow the amount of weeding required will decline
- When the recommended shade level is reached in the coffee garden many weeds are unable to access sufficient sunlight for growth
- In the long-term, weeds should only have to be removed by hand every now and then
- Shade **reduces the labour** required to control weeds allowing the farmer to spend more time on other important tasks
- This is the most effective method for controlling weeds
- Good weed control contributes to making your coffee trees **healthy** and **highly productive**
- An **appropriate** level of shade is about 30% and is recommended for the best results

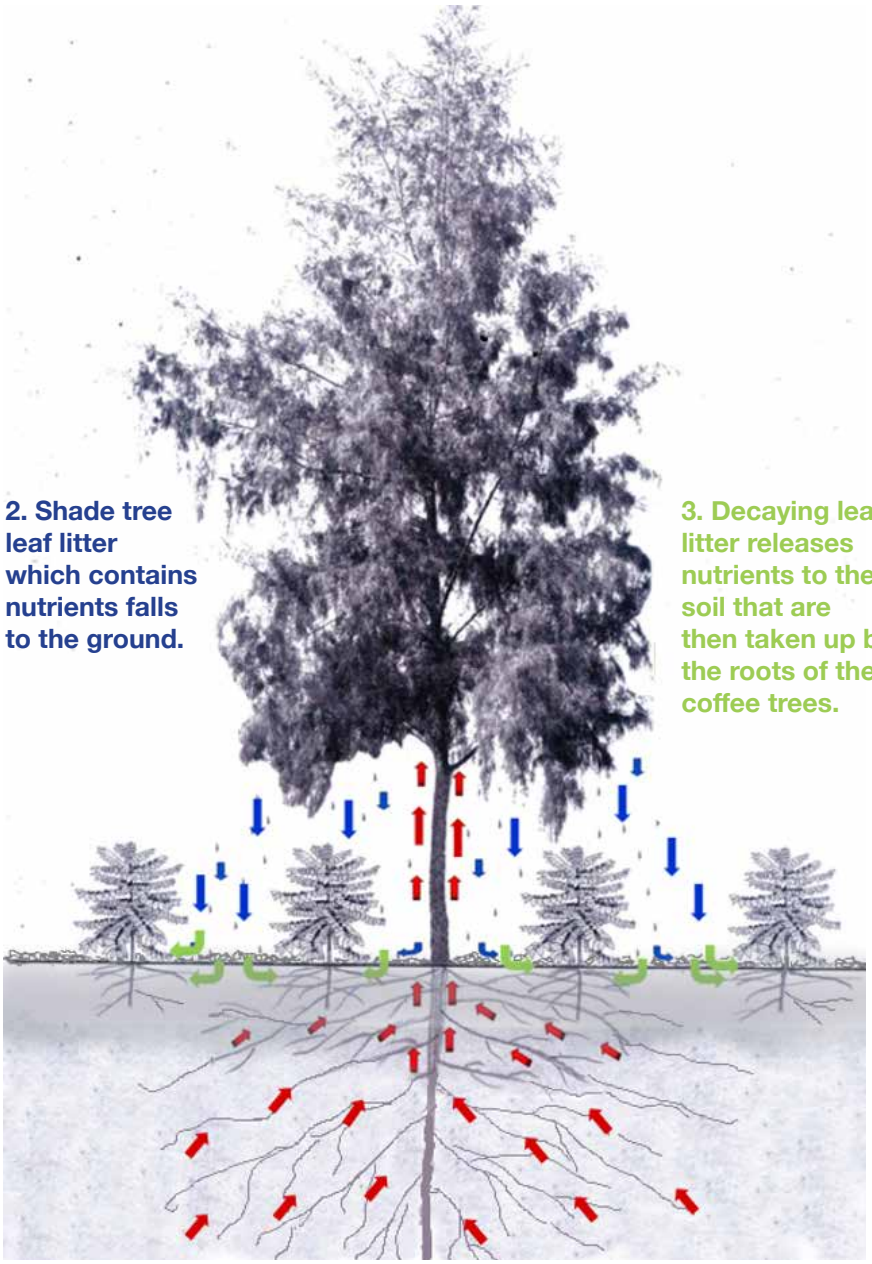
Appropriate shade and its benefits



- In the process of controlling weeds, shade trees provide other benefits for coffee trees
- The shade trees take up nutrients from deep in the soil which are transported to their leaves. As the leaves age, they drop, **mulching the ground and suppressing weed growth**. As the leaves decompose they release nutrients into the soil that can be taken up by the roots of the coffee trees, improving coffee tree health and productivity

Leaf litter from Yar trees suppressing weeds in a coffee garden

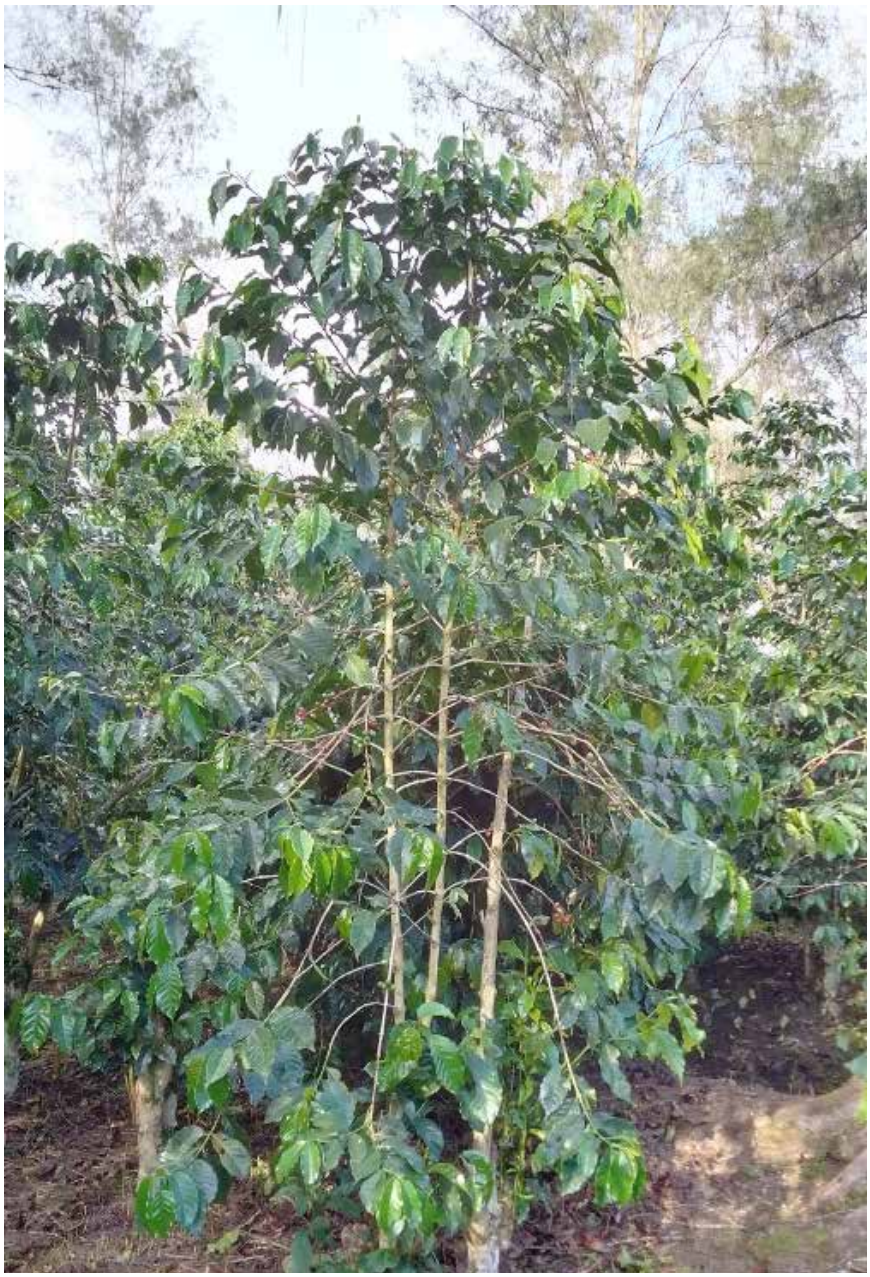
Nutrient cycling and permanent shade trees



Nutrient cycling in a coffee garden with shade trees

Application:

- Plant permanent shade trees along with the temporary shade trees when the coffee garden is being established
- When the permanent shade trees are completely established they will be very effective in suppressing weeds
- Occasional hand removal of weeds may be required but if the shade trees are of the appropriate variety and shape (pruned well) hand removal of weeds will be minimal



Coffee garden with few weeds due to an appropriate level of shade
(*Source: Leo Aroga*)

Activity:

Visit a coffee garden with good weed management, and show how a 30% level of shade suppresses weeds (less light reaching the soil).

If there is an unshaded area nearby, show how there are many more weeds present in the absence of shade.

Note: See the *Farmer Training Guide Unit 2 Module 3: Shade Management* for more detailed information on shade trees.

Coffee garden with a lot of weeds present due to insufficient shade (*Source: Leo Aroga*)

Methods of weed control

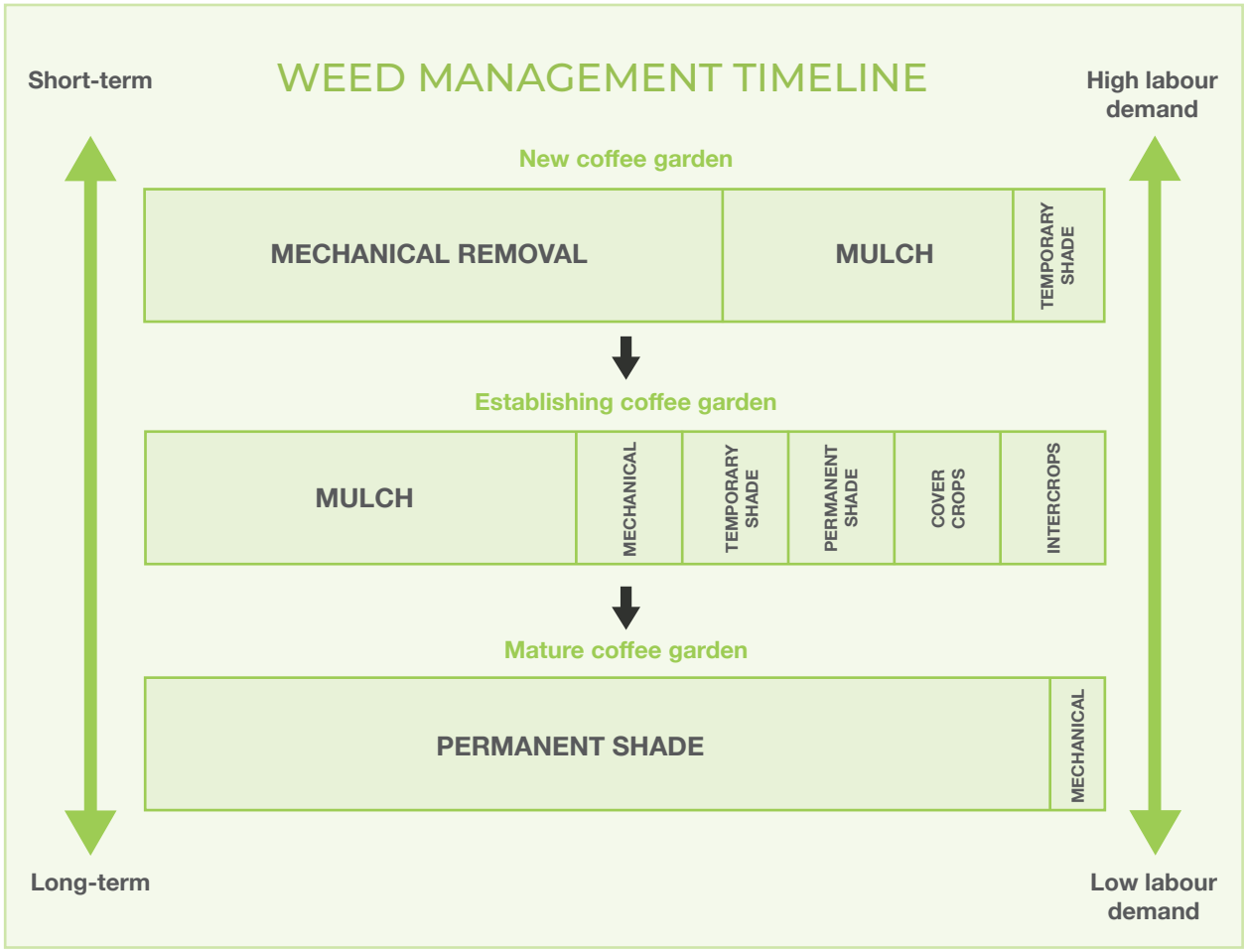
Short-term

Long-term

Methods of weed control

	Description	Cost	Labour demand	Precautions	Effectiveness
Mechanical	Using tools and manual labour to remove weeds.	Low cost (unless using paid labour)	High	There is a risk of damaging coffee tree roots if digging out weeds close to the coffee trees.	Removing weeds completely by hand is an effective method. However, it is not the most efficient method. Suitable in the short-term.
Mulch:	Adding nutrient rich, decaying plant matter, such as coffee pulp, to suppress weeds.	Medium cost	Medium (mulching still requires labour but less than mechanical)	In high rainfall areas can cause waterlogging thereby depressing coffee yields.	Effective as a weed suppressant and also provides nutrients.
Temporary shade, cover crops & intercrops:	Planting temporary shade or crops that suppress weeds.	Medium cost	Medium (harvesting & slashing)	Can compete with the coffee trees if unsuitable crops are planted.	Effective as weed suppressants and also provide nutrients, particularly if they fix nitrogen.
Permanent shade:	Planting permanent shade trees that suppress weeds.	Low cost	Low (shade trees require occasional pruning)	Shade trees should provide an appropriate level of coverage, that is, they decrease full sun by one-third.	Most effective for long-term control of weeds. Shade trees drop leaves that mulch the soil and decompose, releasing nutrients.Take time to become established.

Weed management timeline



In summary, for successful weed management throughout the lifecycle of the coffee garden:

- It is best to use a mixture of control measures
- These measures include mechanical removal, mulching, temporary shade, cover crops, intercrops and permanent shade
- Mechanical removal of weeds, mulching, growing cover crops and intercrops are methods used to control weeds while the coffee and permanent shade trees are becoming established
- Chemical control, though effective, is not recommended due to cost and safety, and because it is against the environmental criteria of many certification organisations
- Ultimately, in the long-term, a shade level of 30% provided by permanent shade trees is the best way to control weeds in the coffee garden

Objective:

To understand the concept of Integrated Weed Management.

EXERCISE 3

Integrated Weed Management (IWM)

Discuss:

1. The meaning of Integrated Weed Management
2. Why it is important to use an integrated approach to weed control

Objective:

To identify the different weed control measures used when implementing an IWM system and how and when they are applied.

You will need:

Butchers' paper and a marker pen

EXERCISE 4

IWM strategies

List:

1. The control measures used in an IWM system

Discuss:

1. Short and long-term goals in weed management
2. How and when each of the control measures is implemented in an effort to achieve these goals
3. The ultimate goal in weed management and how this influences labour demands and coffee tree productivity

1.5 IMPLEMENTING WEED MANAGEMENT MEASURES

It is important to closely monitor weeds in your coffee garden as neglect can result in abundant weed growth. Weed control will then be more difficult and will require larger inputs of labour. Abundant weed growth will negatively impact the productivity of the coffee trees and hence reduce your income from coffee.

When using an integrated approach to weed management, measures of weed control are first implemented when the coffee garden is being prepared for planting. From here it continues through to when the coffee trees are fully mature and then throughout their productive life.

The method of weed control will depend on the individual weed species. In general, annual weeds are the easiest to deal with, whereas more labour is required in the management of perennial weeds.

Annual weeds

- These tend to have shallow roots and can usually be controlled quite successfully with mulch and regular removal by physical uprooting
- It is preferable to remove the weeds before they flower and produce seed
- After removal, most annual weeds can be used as mulch around the coffee trees

Note: See Section 1.6 on nutrient recycling strategies for weeds

Perennial weeds

- Management of perennial weeds, particularly those with stolons and rhizomes, will require more labour than annual weeds
- It is preferable that the whole root system of perennial weeds be removed to prevent regeneration of the weed from roots remaining in the soil
- After uprooting the weed, the debris can be recycled

Weed management in a new coffee garden

Implementing weed control measures while preparing a new coffee garden

- Completely remove and bury perennial weeds, such as broomstick, nutgrass, kunai, couch grass and Wandering Trad, as they can be very difficult to control
- Perennial weeds compete with the coffee seedlings for water, space, sunlight and nutrients
- The roots of weeds can become entangled with the roots of the coffee seedlings, making them very difficult to remove without damaging the coffee plants
- Plant temporary and permanent shade trees prior to planting the coffee seedlings. Temporary shade trees will establish sufficiently to provide shade for the young seedlings. They will also suppress weed growth to some degree
- Slash grasses prior to planting the coffee seedlings

Further weed control measures should be implemented as soon as the coffee seedlings are planted

- Mulch around the seedlings with coffee pulp or weed and grass debris to a distance of **75-100 cm** from the stem if possible, or at least to the dripline. The mulch must be kept about **10 cm from the stem** in order to prevent stem burn

A mulched coffee seedling in a new coffee garden

- Replenish the mulch as it decomposes to ensure moisture is retained around the seedlings and to prevent weed growth
- Infill where coffee seedlings have died to not only produce a uniform stand of coffee but also to suppress weeds
- Regular weeding is recommended as the danger of injuring the young coffee trees (shoots and roots) is minimised if the weeds are removed while they are still small
- It is preferable to remove weeds prior to them flowering in order to prevent seed set and dispersal. If weeds are continually allowed to set seed, a large bank of seed will build up in the soil creating more work to control them in the future
- When routinely monitoring weed growth remove any weeds that appear in the mulch **by hand** as tools may damage the roots of the coffee trees

Removing weeds by hand that are growing in the mulch.

- Clean weeding during the rains is not necessary as the presence of weeds will help prevent erosion
- Although less labour is required in the dry season, it is important to continue weeding in the dry months as this will prevent the weeds going to seed
- Grass cover outside the circle of mulch can remain but should be kept slashed. Weeds in this region can be removed by a spade or bush knife
- Cover crops can be inter-planted in the young coffee to smother weeds, protect the soil from erosion and provide nutrients for the young coffee trees
- The coffee trees can also be intercropped with food crops with this having a similar effect on weed growth as a cover crop

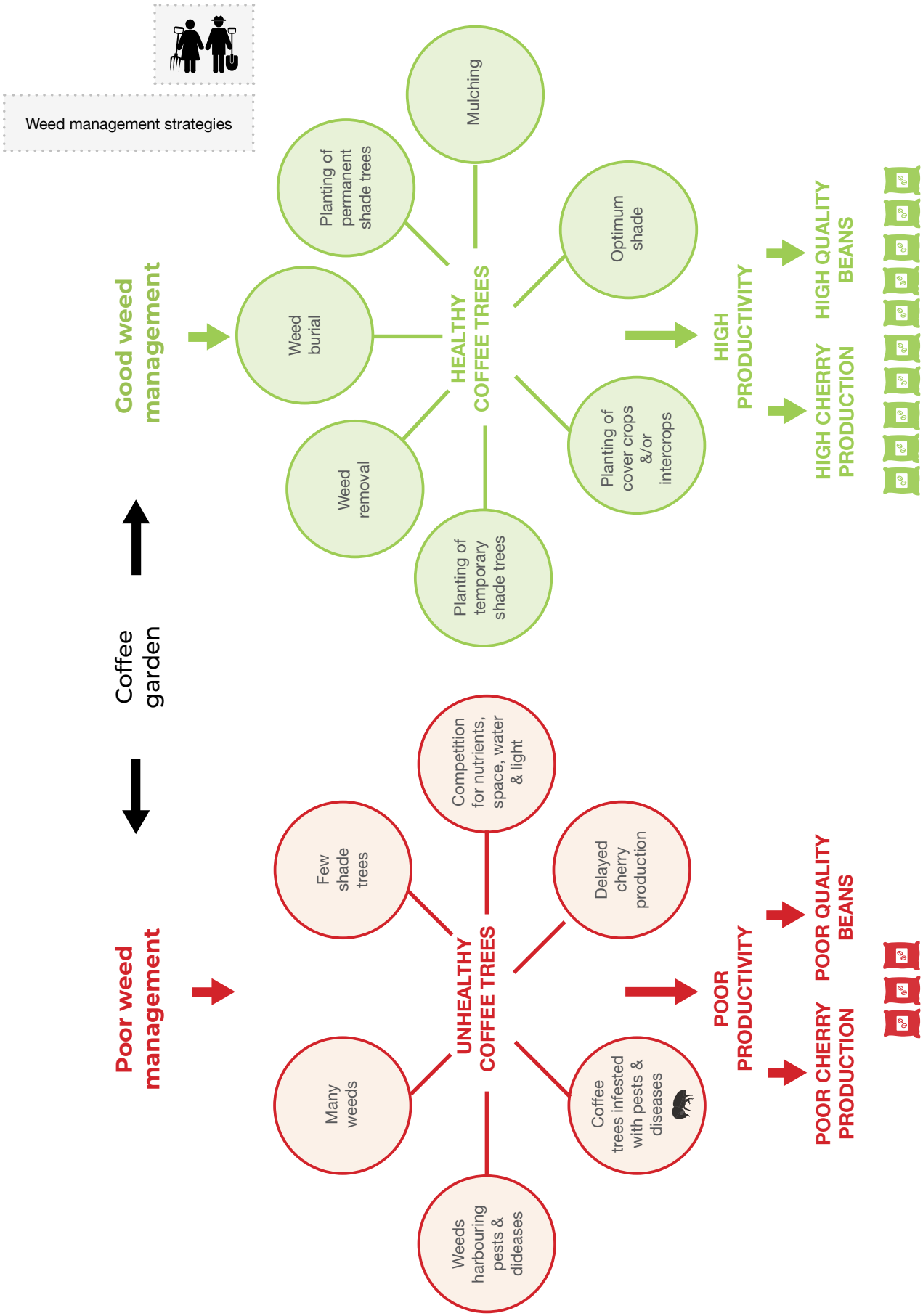
Weeds & CBB

To control CBB, it is important to clean harvest the coffee trees and pick up any berries dropped during harvesting.

If weeds are not removed from the coffee garden, dropped berries infested with CBB may be very difficult to find

Weed management in an established coffee garden

- As the coffee trees mature, their canopies will begin to provide shade, and falling leaves will provide leaf litter
- As the permanent shade trees establish, they will also provide shade and leaf litter
- The presence of shade and leaf litter will become effective long-term mechanisms for suppressing weeds
- From this stage on, weeds should be controlled through an integrated programme of slashing and shade tree management
- Removing weeds keeps the tree open to allow air flow and reduces humidity. This makes the tree less vulnerable to pests and diseases, including CBB
- Removing weeds makes it easier to find berries dropped during harvesting. If possible, it is important that dropped berries are picked up as they may be infested with CBB
- Weeds in the inter-rows should be slashed **prior to them seeding** and left in place as a form of mulch. Slashing along drains and the perimeter of the coffee garden is also recommended to reduce the dispersal of weed seeds
- Heavy shading will suppress weeds but negatively impact the coffee trees. For this reason, it is important to keep the shade trees pruned and at the right planting density so that they provide an **appropriate (30%) level of shade**
- If the coffee trees are planted at a wide spacing or are undergoing recycle pruning, they can be intercropped with food crops. This will help suppress weeds in the inter-rows


Weed management strategies
Good weed management
Weed burial
Planting of permanent shade trees
Mulching
Weed removal
HEALTHY COFFEE TREES
Optimum shade
Planting of cover crops &/or intercrops
Planting of temporary shade trees
HIGH PRODUCTIVITY
HIGH QUALITY BEANS
HIGH CHERRY PRODUCTION
Coffee garden
Poor weed management
Few shade trees
Competition for nutrients, space, water & light
Delayed cherry production
Many weeds
UNHEALTHY COFFEE TREES
Coffee trees infested with pests & diseases
Weeds harbouring pests & dideases
POOR PRODUCTIVITY
POOR QUALITY BEANS
POOR CHERRY PRODUCTION

Objective:

To understand what weed control measures are used in the initial stages of establishing a new coffee garden (up to when the coffee trees are about 3 years old).

EXERCISE 5

Implementing weed control measures in a new coffee garden

Discuss:

1. What the new coffee garden may look like before any clearing and weed removal occurs
2. The best way to approach weed control when establishing a new coffee garden taking into account your long-term objectives in terms of weed management
3. Labour demands in weed control during this period

Objective:

To understand what weed control measures are used once the coffee garden is established.

EXERCISE 6

Implementing weed control measures in an established coffee garden

Discuss:

1. What the established coffee garden may look like about 3 years after planting the coffee and shade trees
2. The best way to approach weed control when the coffee garden is established
3. Labour demands in weed control once the coffee garden is established

Objective:

To understand how all of the weed control measures can be integrated using a timeline.

EXERCISE 7

Timeline for implementing weed control measures

Using the information from Exercises 5 and 6 above:

Draw

1. A timeline of implementation of weed control measures starting when the coffee garden is initially cleared for planting the coffee seedlings to when the coffee trees and shade trees are fully mature. Include labour demands in the timeline

1.6 NUTRIENT RECYCLING STRATEGIES FOR WEEDS

Like coffee trees, weeds require water and nutrients for growth which they extract from the soil. Weeds that have been manually removed in the coffee garden contain **nutrients** and **organic matter** that can be used to improve the growth and productivity of the coffee trees. Hence, **weeds** should not be considered rubbish but instead a **valuable resource** that can **improve the fertility** of the soil in the coffee garden.

- Disposing of weeds outside the coffee garden is discarding valuable nutrients that can be used by the coffee trees
- When retained in the coffee garden, the weed debris will help enrich the soil
- It is **better not to burn** the debris as coffee is sensitive to ash (ash is also susceptible to erosion) and burning releases greenhouse gases
- Weeds uprooted or slashed can be used as mulch or buried in the coffee garden
- The long-term strategy should be to establish **30% shade** to minimise weed growth

Mulch

- Weeds that can be used as mulch include those that do not easily regenerate
- The weed debris can be spread around the coffee trees on the surface of the ground but should be kept clear of the main stem of the coffee tree
- The debris will gradually decompose and release nutrients into the soil which can be taken up by the coffee trees

Note: Composting may not be practical for many smallholders as the labour demand may be too high.

Buried weeds

- Weeds that can regenerate easily, like Nut Grass, Wandering Trad and Cobblers Pegs, should be buried to eliminate the threat of them regrowing
- Buried weeds can be left to decompose and release nutrients into the surrounding soil. They will become a nutrient sump that roots of the coffee and shade trees can tap into
- Alternatively, buried weed debris can be used to make compost. Compost can be used in the coffee garden to enrich the soil by improving soil structure and nutrient content, maintaining moisture, introducing beneficial microbes and helping suppress plant diseases
- If making compost, it is very important that there is enough **heat** generated in the compost **to kill the weeds**, including the seeds. To produce sufficient heat a large amount of weed debris is required
- To produce compost, dig a pit sufficient in size to plant a banana plant into it. Place the weed debris in the pit and leave for several months to decompose

Compost pit (*Source: Rauke Buimeng*)

- To speed up the rate of decomposition, add a small amount of topsoil and compost that contains a legume. Composting microbes will break down the weed debris faster if they have access to nitrogen
- Composting is complete when the decomposed material is dark and earthy and there is no recognisable plant material present. The compost can then be used in the coffee garden

Recycling of nutrients in weeds

Recycling of nutrients in weeds

Note: Weeds are a source of important nutrients. **Do not** remove weeds from the coffee garden as they contain a valuable source of nutrients that can be used by the coffee trees.

Objective:

To understand why weeds are considered a valuable resource in the coffee garden.

EXERCISE 8

Weed debris as a valuable resource

Discuss:

1. Why weeds are valuable in terms of nutrients and why weed debris should not be removed from the coffee garden
2. Why even problem weeds or those that regenerate easily should also be retained in the coffee garden

Objective:

To identify and discuss how weed nutrients are recycled in the coffee garden.

EXERCISE 9

Methods of recycling nutrients in weed debris

Discuss:

1. Nutrient recycling methods for:
   - Weeds that do not regenerate easily
   - Weeds that do regenerate easily
2. How these measures benefit the coffee and shade trees

1.7 COMMON COFFEE GARDEN WEEDS

Common weeds found in the coffee garden

English name *(Scientific)*	Pidgin name	Growth habit	Method of spread	Method of control and recycling of nutrients	Appearance
Amaranthus *Amaranthus* spp.	Aupa	Annual erect or spreading herb	Seeds	Control: Manual removal before seeding. Nutrient recycling: Leave on the ground to decompose or use as mulch around the coffee trees.	 *Source: B Kora*
Blackberry Nightshade *Solanum nigrum*	Karakap	Annual erect herb	Seeds	Control: Manual removal before seeding. Nutrient recycling: Leave on the ground to decompose or use as mulch around the coffee trees.	 *Source: G. Tilden*
Broomstick *Sida rhombifolia* ☆☆☆	Brum stik	Perennial shrub	Seeds	Control: Manual removal. Nutrient recycling: Leave on the ground to decompose or use as mulch around the coffee trees.	 *Source: G. Tilden*
Cobblers pegs *Bidens pilosa* ☆☆		Annual herb with upright stems	Seeds	Control: Manual removal before seeding. Nutrient recycling: Bury in a hole in the coffee garden.	 *Source: G. Tilden*

☆ Difficult weed to control

☆☆ Predominant weed in coffee gardens

☆☆☆ Predominant hard-to-kill weed

English name *(Scientific)*	Pidgin name	Growth habit	Method of spread	Method of control and recycling of nutrients	Appearance
Couch grass *Cynodon dactylon* ☆☆☆	Various	Perennial mat-forming grass with creeping stems	Seeds, stolons & rhizomes	Control: Manual removal. Nutrient recycling: Bury in a hole in the coffee garden.	 *Source: J. McKellar & M. Hamago*
Goat weed *Ageratum conyzoides* ☆☆	Various	Annual erect herb	Seeds	Control: Manual removal before seeding. Nutrient recycling: Leave on the ground to decompose or use as mulch around the coffee trees.	 *Source: J. McKellar & M. Hamago*
Kikuyu grass *Pennisetum clandestinum*	Kau gras	Perennial mat-forming grass with creeping stems	Seeds, stolons & rhizomes	Control: Manual removal. Nutrient recycling: Leave on the ground to decompose or use as mulch around the coffee trees.	 *Source: G. Tilden*
Kunai grass *Imperata cylindrica* ☆☆☆	Kunai gras	Perennial grass. Rhizomes are invasive and can lay dormant for long periods	Seeds & rhizomes	Control: Manual uprooting. Nutrient recycling: Bury in a hole in the coffee garden.	 *Source: G. Tilden; J. McKellar & M. Hamago*
Nut grass *Cyperus* spp. ☆☆	Nat gras	Perennial grass like plant. Produces creeping underground stems & rhizomes with small tubers.	Nuts & bulbs	Control: Manual removal Nutrient recycling: Bury in a hole in the coffee garden.	 *Source: J. McKellar & M. Hamago*

English name *(Scientific)*	Pidgin name	Growth habit	Method of spread	Method of control and recycling of nutrients	Appearance
Pig weed *Portulaca oleracea*	Pik wid	Annual succulent groundcover, broad leaves	Seeds	Control: Mulch & manual removal. Nutrient recycling: Leave on the ground to decompose or use as mulch around the coffee trees.	 *Source: Unknown*
Sensitive plant *Mimosa pudica*	Daiman gras	Prickly perennial groundcover Feeding host of CBB 	Seeds	Control: Manual removal prior to seeding. Nutrient recycling: Leave on the ground to decompose or use as mulch around the coffee trees.	 *Source: Pacific Pests, Pathogens, Weeds & Pesticides*
Sweet potato *Ipomoea batatas* ☆	Kaukau	Perennial vine	Vines & seeds	Control: Manual removal. Nutrient recycling: Leave on the ground to decompose or use as mulch around the coffee trees.	 *Source: ACIAR*
Wandering Trad *Tradescantia spp.* ☆☆☆	Various	Perennial creeping or semi-upright herb	Seeds, stolons & rhizomes	Control: Manual removal. Nutrient recycling: Bury in a hole in the coffee garden.	 *Source: G. Tilden*
Yellow weed *Galinsoga parviflora*	Various	Annual erect herb	Seeds	Control: Manual removal. Nutrient recycling: Leave on the ground to decompose or use as mulch around the coffee trees.	 *Source: B. Kora*

For a comprehensive list of weeds see the Papua New Guinea Coffee Handbook

Field exercises

Visit a newly established coffee garden and a mature coffee garden.

EXERCISE 1

Newly established coffee garden

Observe and discuss:

1. The current weed status
2. Current weed management strategies, short and long-term
3. How weed management could be improved

Identify weeds that are present and for each weed discuss:

1. Habit
2. Method of dispersal
3. Appropriate method of control

EXERCISE 2

Mature coffee garden

Observe and discuss:

1. The current weed status
2. Current weed management strategies
3. Whether or not a long-term goal of 30% shade has been achieved
4. The existing level of shade and how it is impacting the current weed status in the coffee garden

Identify weeds that are present and for each weed discuss:

1. Habit
2. Method of dispersal
3. Appropriate method of control and recycling

1.8 KEY MESSAGES

- Weeds are harmful to coffee trees as they compete directly for water, nutrients, sunlight and space
- Weeds can also compete indirectly by impacting management practices, encouraging pests and diseases, having toxic effects on the coffee trees and delaying the age when coffee trees first bear cherries
- The labour input required for weed control is high when a new coffee garden is first established but with good management, particularly of shade, the labour requirements will decline over time
- Both annual and perennial weeds will be present in the coffee garden. Perennial weeds typically have a complex system of underground stems and/or roots and are the most difficult weeds to control
- Integrated Weed Management is the best approach to controlling weeds. This practice integrates the use of a mix of control measures including mechanical removal of weeds, mulching, composting, growing a cover crop or intercrops, and shade trees
- In the short-term, when the coffee garden is first established, weed control will mostly be undertaken using physical or mechanical removal of weeds and mulching. This is the period of high labour demand
- In the long-term, as the coffee garden matures, shade trees will suppress many weeds, meaning much less labour will be required to mechanically remove weeds
- Weeds are not rubbish, they contain valuable nutrients that should be recycled to benefit your coffee and shade trees

1.9 QUIZ

Place a '✓' in the correct box.

1. Weeds have a negative impact on coffee trees because they

- A Compete with the coffee trees for water and shade
- B Produce leaf litter
- C Compete with the coffee trees for water, nutrients, sunlight and space
- D Have deep root systems

2. Root systems of most weeds are located

- A Deep below the roots of the coffee trees
- B In the surface soil (same location as coffee tree feeder roots)
- C Above the roots of the coffee trees
- D At long distances from the main stem of the weed

3. What is the potential cost to the farmer of poor weed management?

- A Reduced bearing capacity of the coffee trees
- B Reduced coffee quality due to smaller bean size
- C Suppressed sucker development on stumped coffee trees
- D All of the above

4. In a CBB environment it is particularly important to control weeds because

- A The coffee trees produce fewer cherries
- B Berries dropped during harvesting that may contain CBB are difficult to find
- C There is less moisture in the soil
- D The weeds produce chemicals that protect CBB

5. What is the difference between annual weeds and perennial weeds?

A Annual weeds complete their life cycle in one season whereas perennial weeds persist and continue to grow each year

B Perennial weeds produce abundant seed but annual weeds do not

C Annual weeds have rhizomes, perennial weeds do not

D Annual weeds are grasses whereas perennial weeds are broad-leafed plants

6. Which of the following are characteristics of many weeds?

A Abundant quantities of seed, short-term seed viability, long roots and stems

B Abundant quantities of seed, grow well in shade, short-term seed viability

C Ability to colonise disturbed soils, grow well in shade

D Abundant quantities of seed, long-term seed viability, ability to colonise disturbed soil, roots and stems have food reserves, prefer full sun

7. What is the meaning of Integrated Weed Management (IWM)?

A Combining weed management with pest management

B Using a variety of methods to control weeds

C Integrating shade trees into the coffee garden to control weeds

D Combining intercrops with shade trees to control weeds

8. What is the main objective of using an IWM approach to weed control?

A Working hard to control weeds throughout the productive life of the coffee trees to maximise production

B Minimising weed growth by making compost and spreading mulch and compost around the coffee trees

C Minimising weed growth by growing intercrops and cover crops

D Minimising weed growth using the least amount of labour

9. What are two short-term methods of weed control?

A Use of hands or hand tools for removal of weeds, and mulching
B Temporary shade trees and permanent shade trees
C Permanent shade trees and the occasional manual removal of weeds
D Temporary shade trees and intercrops

10. What are two medium-term methods of weed control?

A Use of hands or hand tools for removal of weeds, and mulching
B Temporary shade trees and permanent shade trees
C Permanent shade trees and the occasional manual removal of weeds
D Temporary shade trees and intercrops

11. What are two long-term methods of weed control?

A Use of hands or hand tools for removal of weeds, and mulching
B Temporary shade trees and permanent shade trees
C Permanent shade trees and the occasional manual removal of weeds
D Temporary shade trees and intercrops

12. In a smallholder coffee garden, for long term control of weeds and maximum coffee tree productivity what is the most suitable level of shade?

A 10% shade
B 30% shade
C 60% shade
D 80% shade

13. When is the best time to control most annual weeds?

A Before the onset of rain
B Early in the morning
C Before they flower and set seed
D After they flower and set seed

14. What is the best method to use in controlling perennial weeds?

A Remove the whole root system to prevent regeneration then bury the debris
B Burn them in place
C Slash the weeds to prevent regeneration
D Slash the weeds then burn the debris

15. What is the best strategy of weed control when preparing an area for a new coffee garden?

A Burn the area where the coffee trees are to be planted
B Let all of the weeds flower and set seed, then remove them
C Water the area well to encourage weed growth, then remove the weeds
D Remove perennial weeds, and plant temporary and permanent shade trees

16. How does removing weeds make coffee trees less vulnerable to pests and diseases, including CBB?

A Improves the health of the coffee trees by increasing the soil temperature around the trees
B Improves the health of the coffee trees by reducing the soil moisture around the trees
C Improves airflow, and reduces humidity and potential habitat for pests and diseases
D All of the above

17. After removal of weeds, what is the most important reason why the debris should be retained in the coffee garden?

A To reduce the labour required to move the debris elsewhere
B Weed debris is a valuable source of nutrients that can be used by both the coffee and shade trees
C Weed debris is of no use so can be left in a large heap in the coffee garden
D To retain moisture in the coffee garden

18. How can the weed debris be recycled in the coffee garden?

A. Depending on the types of weeds, the debris can be either spread on the soil surface or buried in a pit and left to decompose, providing nutrients to the coffee and shade trees

B. All of the debris can be piled into a large heap and left to decompose

C. Weeds can be composted in small piles around the coffee garden

D. It can be used by pigs foraging in the coffee garden

19. Which of the following is a problematic perennial weed because it produces abundant quantities of seed and has invasive rhizomes that can lay dormant for long periods?

A. Couch grass

B. Karakap

C. Kunai grass

D. Broomstick

20. The key to good long-term weed management in the coffee garden is to

A. Establish permanent shade trees that produce a good amount of leaf litter and provide 30% shade cover

B. Continually replenish mulch in the coffee garden using weed debris

C. Plant intercrops in the coffee garden that suppress weeds and provide mulch

D. Plant the coffee trees very close together so that weeds cannot grow

1.10 SOURCES OF FURTHER INFORMATION

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