Australian Government

Australian Centre for International Agricultural Research

SMALLHOLDER COFFEE PRODUCTION IN PAPUA NEW GUINEA – FARMER TRAINING GUIDE

UNIT 2: MANAGING YOUR COFFEE GARDEN

# MODULE 2:
## MAINTENANCE PRUNING AND REHABILITATION

Curry G, Tilden G, and Aroga L (2023) *Smallholder coffee production in Papua New Guinea: A training package for extension officers and farmers*, ACIAR Monograph No. 220, Australian Centre for International Agricultural Research, Canberra.

ACIAR Monograph Series No. 220 (MN220)

Australian Government

Australian Centre for International Agricultural Research

SMALLHOLDER COFFEE PRODUCTION IN PAPUA NEW GUINEA – FARMER TRAINING GUIDE

UNIT 2: MANAGING YOUR COFFEE GARDEN

# MODULE 2:

## MAINTENANCE PRUNING AND REHABILITATION

## The Smallholder Coffee Production in Papua New Guinea Training Program

The training program contains modules prepared in partnership with the 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.

## 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 Guide<br>Unit 1 Module 1 |
| The extension officer - roles and effectiveness | ACIAR Extension Officer Guide<br>Unit 1 Module 2 |
| Knowing Your Farmers | |
| Getting to know our coffee smallholders | ACIAR Extension Officer Guide<br>Unit 2 Module 1 |
| What factors affect smallholder coffee production? | ACIAR Extension Officer Guide<br>Unit 2 Module 2 |
| Strongim grup: course facilitator guide | CARE Organisational Strengthening 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/publication/MN220-PNG-coffee-manual-1**

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.

## Farmer Training Program

| Title | Module reference |
|---|---|
| Becoming a Coffee Farmer | |
| Knowing your coffee tree | ACIAR Farmer Training Guide<br>Unit 1 Module 1 |
| Coffee nursery development | ACIAR Farmer Training Guide<br>Unit 1 Module 2 |
| Establishing a new coffee garden | ACIAR Farmer Training Guide<br>Unit 1 Module 3 |
| Managing Your Coffee Garden | |
| Weed Control | ACIAR Farmer Training Guide<br>Unit 2 Module 1 |
| Maintenance pruning and rehabilitation | ACIAR Farmer Training Guide<br>Unit 2 Module 2 |
| Shade management | ACIAR Farmer Training Guide<br>Unit 2 Module 3 |
| Drainage | ACIAR Farmer Training Guide<br>Unit 2 Module 4 |
| Pest and disease management | ACIAR Farmer Training Guide<br>Unit 2 Module 5 |
| Coffee berry borer management | ACIAR Farmer Training Guide<br>Unit 2 Module 6 |
| Soil fertility and nutrient maintenance | ACIAR Farmer Training Guide<br>Unit 2 Module 7 |
| Intercropping in your coffee garden | ACIAR Farmer Training Guide<br>Unit 2 Module 8 |
| Harvesting and Processing Coffee | |
| Coffee harvesting and processing | ACIAR Farmer Training Guide<br>Unit 3 Module 1 |
| Coffee grading systems and pricing | ACIAR Farmer Training Guide<br>Unit 3 Module 2 |
| Establishing a mini wet factory | ACIAR Farmer Training Guide<br>Unit 3 Module 3 |
| Coffee Marketing | |
| Understanding the domestic coffee market | ACIAR Farmer Training Guide<br>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<br>Unit 4 Module 2 |
| Fair trade certification | ACIAR Farmer Training Guide<br>Unit 4 Module 3 |
| Family money management | CARE Family Money Management Training |

# CONTENTS



## MODULE TOPICS

# CONTRIBUTING AUTHORS

Leo Aroga, Rauke Buimeng, Michael Kaugam, George Curry
and Geraldine Tilden

# ACKNOWLEDGEMENTS

This module is part of a series of modules developed specifically as a resource for extension officers for training smallholder farmer groups and the training of cadet extension officers. Most of the information provided in this module is from the findings of ACIAR project ASEM/2008/036 and *The Papua New Guinea Coffee Handbook* (2nd Edition), Coffee Industry Corporation Ltd.

The knowledge of the following contributors has been invaluable in the development and writing of this module:

**Coffee Industry Corporation Ltd (CIC)**
Samson Jack, Napu Ratumu, Matilda Hamago, Jenny Bekio, Michelle Bafio, Mark Kenny, Jonah Aranka, the late Tom Kukhang and Bob Kora (illustrations)

**Curtin University**
Tim Sharp

**National Agricultural Research Institute (NARI)**
Johannes Pakatul

**Australian Centre for International Agricultural Research**
The development of this module was supported by the following ACIAR-funded projects:

Improving livelihoods of smallholder families through increased productivity of coffee-based farming systems in the highlands of Papua New Guinea (ASEM/2008/036)

Improving livelihoods of smallholder coffee communities in Papua New Guinea (ASEM/2016/100)

# INTRODUCTION

**Aim of Module:**

The aim of this module is to increase farmers' knowledge of the importance of pruning, and provide information on pruning systems and techniques that can be used to produce strong and healthy coffee trees that will be very productive for a long time.

Pruning is one of the most important maintenance and rehabilitation activities in a coffee garden. Although the labour required is high, the reward from timely and correct pruning can be substantial. Pruning keeps the trees healthy and productive, increases their productive lifespan and improves access for harvesting.

## LEARNING OUTCOMES

By the end of this module you will:

- Understand the importance of pruning coffee trees
- Know the different types of pruning systems and their application
- Understand how farmers can improve their yields of quality coffee by gaining knowledge and skills in coffee tree management

## LESSON PLAN

This module has three parts:

| | |
|---|---|
| Sections 2.1 to 2.3 | The importance of pruning, the growth structure of the coffee tree, and different pruning systems |
| Sections 2.4 to 2.9 | Pruning equipment and practices |
| Sections 2.10 to 2.11 | Pruning debris and CBB management |

## TIME REQUIRED TO COMPLETE THIS MODULE: ONE WEEK

Training begins with learning the key concepts. Participants then spend time in coffee gardens undertaking Field Exercises 1 to 3.

## 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)
- The coffee calendar and stickers
- White board, coloured white board markers and white board eraser
- Butchers paper and coloured marker pens
- Pruning poster
- Pruning tools: secateurs, pruning saw, measuring stick, oil, disinfectant (or hot water and detergent) (Activity 3 and Field Exercises 1 and 2)
- A large diagram of a mature coffee tree (or a mature coffee tree in the field) (Exercises 1 and 2)
- A large diagram of a young coffee seedling and/or young coffee seedlings in polybags (Activity 1)
- Young coffee trees in a coffee garden, which can be capped and skirted, and/or aged seedlings in polybags (Activities 4 and 5)
- Mature coffee trees in a coffee garden that can be pruned by the group (Activity 6 and Field Exercises 1 and 2). Preferably two varieties: one with erect branches, such as Mundo Novo, and one with horizontal branches, such as Typica
- Mature coffee trees approaching the end of a production cycle or past the optimum time for change of production cycle

## PRE-TRAINING ACTIVITIES

- Source pruning tools
- Arrange access to a coffee garden with newly planted coffee seedlings (or aged seedlings in polybags that could be pruned)
- Arrange access to an unmanaged coffee garden that can be fully rehabilitated by participants during training. It would be beneficial if the coffee garden had trees of both an erect coffee variety (e.g., Mundo Novo) and a horizontal variety (e.g., Typica)

## REQUIRED EQUIPMENT

Participants will require the following equipment for training. They may have their own, but the extension officer should bring at least one full set:

- Sharp secateurs
- Pruning saw, bush knife or bow saw
- Measuring stick
- Equipment for sanitising pruning equipment (e.g., hot water and detergent), particularly in areas where pink disease and *Fusarium* bark disease are problematic

## 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

The coffee calendar lists the main events and activities occurring 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

Using the stickers for each of the annual coffee activities listed above, work with the farmer group to attach them to the appropriate rows 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
- Complete the remaining sections linking each activity with the different stages of berry development
- For this module, integrate the activities relating to pruning listed below

### Coffee tree pruning activities

In a new coffee garden:

1. Capping and skirting of young seedlings
2. Handling and desuckering
3. Removal of flowers and fruit
4. Bending overgrown seedlings

In an established coffee garden:

1. Maintenance pruning – main pruning
2. Maintenance pruning – routine pruning including handling and desuckering after rains
3. Change of production cycle – recycle pruning or stumping
4. Sucker selection
5. Nutrient cycling of coffee tree pruning debris

### Quiz

- Before beginning the module topics, ask the farmers to complete the quiz at the end of this module
- Repeat the quiz on completion of the module topics

## Preventing spread of pests and diseases

- People and equipment can carry pests and diseases
- It is important that training participants do not spread pests and diseases within a coffee garden or to other coffee gardens

# 2.1 PRUNING

## What is pruning and why is it important?

Pruning is the removal of dead and unproductive branches and stems to rejuvenate and improve the growth of the coffee tree. Pruning is one of the most important tasks undertaken in the coffee garden and is crucial in maintaining good tree health and maximising the tree's productive capacity and longevity.

## How does a coffee tree grow if it is not pruned?

If a coffee tree is left to grow freely, the stem, or trunk, elongates and many of the lower branches are gradually lost due to poor nutrition, significantly reducing the productivity of the tree.

- Many branches will grow on an unpruned tree and the tree will produce a lot of cherry at the first harvest, but the tree will age very quickly
- Over time the upper branches of the coffee tree grow disproportionately long
- The branches below cannot access light and nutrients, resulting in their death
- Fruiting branches occur high up on the tree and are difficult to harvest
- In a coffee berry borer (CBB) environment, sanitation of the coffee garden is difficult if fruit high on the tree cannot be reached
- The growth of the tree slows, and no more primary branches are produced. New primary branches are essential for flower and cherry production, as cherry development is maximised on wood that is 1–2 years old and declines markedly after this time

A free-growing coffee tree

- Cherry is produced only on the younger wood of long, overgrown branches. Therefore, cherry production will occur only on the outside of the tree, with the inner branches being barren
- The tree uses excessive energy and nutrients to support a lot of unproductive wood
- Cherry production is significantly reduced
- The survival of CBB is enhanced by the heavy shading created by unpruned coffee branches. These conditions are unfavourable for the survival of many of the pest's natural enemies

Unmanaged coffee trees *(Credit: Bob Kora)*

Unmanaged coffee garden *(Credit: Michael Kaugam)*

A well-maintained coffee tree (*Credit: Leo Aroga*)

## What are the benefits of pruning coffee trees?

There are many reasons why it is important for coffee trees to be pruned. Pruning should begin when the trees are young and continue throughout their productive life. Farmers are encouraged to carry out **timely pruning** of coffee trees in order to achieve the following:

- Promote new, healthy wood for the next season's crop. New wood produces more crop than old wood as nutrients are delivered more efficiently to areas of new growth
- Reduce stress on the trees by removing dead wood and unproductive branches and suckers
- Maintain an optimum balance between leaf area and crop
- Prevent overbearing dieback. Overbearing dieback occurs if a tree is put under a lot of stress during cherry production. Excessive movement of nutrients from the roots and shoots to the cherries can have damaging effects on the health of the coffee tree. This may result in the death of some branches or of the whole tree
- Prevent root dieback. When coffee trees suffer from overbearing dieback when they are young, it is likely that root dieback will have already occurred before the symptoms of overbearing dieback are observed in the shoot system of the tree
- Promote regular bearing and reduce biennial bearing. Coffee trees may only produce cherry every second year if the trees are allowed to overbear or produce too much cherry. Biennial bearing results in reduced productivity and income
- Allow sufficient light to encourage flower development
- Maintain good tree shape to facilitate harvesting. Unpruned trees grow tall and bushy, making harvesting of cherries more difficult
- Improve access to the base of the tree for easier application of mulch or fertilisers

- Allow more airflow and reduce humidity. This creates an environment that is less favourable for pests (e.g., CBB) and diseases (e.g., coffee leaf rust and pink disease)
- Enable better sanitation harvesting to reduce the number of CBB-infested berries. Collection of berries both on the ground and on the branches is simpler
- Allow for better coverage of CBB control mechanisms, such as the application of the fungus *Beauveria bassiana*
- The main pruning of coffee trees after harvest generates vegetative growth: the trees will produce more foliage (leaves). The increase in foliage growth resulting from pruning will increase the level of shade underneath the coffee trees thereby suppressing weed growth under the trees
- Short-term intercrops may be grown in the period from pruning up until when coffee tree regrowth creates too much shade. Any fertiliser applied to intercrops may benefit the coffee trees
- Rejuvenate old trees. As coffee trees grow older, cherry production declines. As the trees grow taller, harvesting and pruning become more difficult. When the coffee trees are about 6–7 years old, they require rehabilitation. At this time, they are recycle pruned or stumped to encourage new growth

## Objectives and benefits of timely pruning

| Factor | Objectives and benefits |
|---|---|
| **Yield** | • Pruning stimulates the growth of new stems and fruit-bearing branches<br>• When size is maintained, the trees have sufficient space to grow<br>• Pruning trees improves light access for flower development<br>• Pruning helps to maintain uniformity in reproductive bud production. More buds means the attraction of more bees, which will boost pollination and fruit set<br>• Regular maintenance will generate strong vegetative, dormant and reproductive phases<br>• Regular pruning ensures that nutrients are delivered to the parts of the tree that produce the most cherry. Trees with new regrowth produce more cherries<br>• Pruning promotes more regular bearing and reduces the risk of overbearing dieback and biennial bearing<br>• Trees are less stressed as dead wood, unproductive branches and suckers are removed<br>• Pruning is undertaken to rejuvenate old trees<br>• Pruning extends the productive lifespan of coffee trees<br>• Pruning improves coffee bean quality through increased bean size and weight. Improved quality means more money for the farmer |
| **Labour** | • Labour efficiency is enhanced in pruned coffee gardens, as there is improved access for weeding, mulching, harvesting, garden sanitation, pest and disease control, and future pruning |
| **Pests and diseases** | • Pruning improves airflow and reduces humidity creating less favourable conditions for diseases such as coffee leaf rust and pink disease, and pests such as CBB<br>• In a CBB environment, pruning improves access for sanitation, reducing the number of CBB-infested cherries<br>• Pruning improves access to implement strategies to control pests and diseases, such as Beauveria bassiana to control CBB<br>• Intercropping activities during the coffee off season may alert farmers to the presence of pests or diseases on the coffee trees |
| **Cost** | • Unproductive branches waste valuable nutrients. Removing these branches reduces the need for costly fertilisers<br>• The labour cost in terms of time required to prune trees can be high, but the cost is offset by the reduction in labour required for other maintenance tasks, as well as for harvesting<br>• Income can be obtained from intercropping during the coffee off season<br>• Good pruning practices extend the productive life of coffee trees. The coffee trees will not have to be replaced as early as they would be if pruning was neglected |

**Objective:**

**To understand the importance of pruning coffee trees**

**You will need:**

**Diagrams or living specimens of pruned and unpruned coffee trees, and butchers paper**

# EXERCISE 1

## Why pruning is important

### Discussion

1. Have a discussion with farmers about their pruning protocols. What are their objectives with regards to pruning? How often do they prune and at what stage in the coffee production cycle?
2. Observe and list the differences between the pruned and unpruned coffee trees
3. List the advantages and disadvantages of pruning and not pruning
4. Discuss why cherry production reduces significantly over time if the coffee trees are not pruned

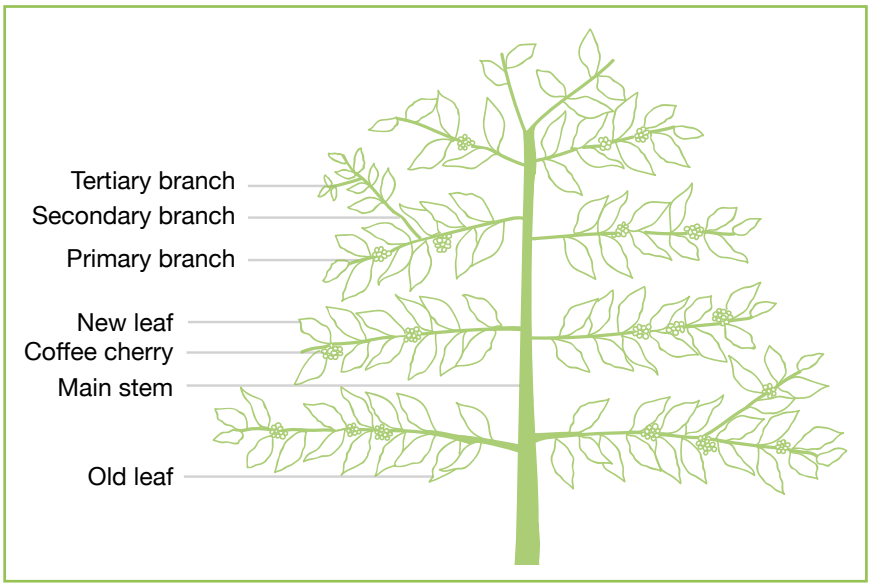
# 2.2 GROWTH OF THE COFFEE TREE

Use the farmer notes on the coffee tree shoot system from Farmer Training Guide Unit 1, Module 1 'Knowing your coffee tree'.

The following information is provided to refresh your knowledge on the growth structure of the coffee tree. *Refer to Farmer Training Guide Unit 1, Module 1 'Knowing your coffee tree' for further information.*

## The shoot system

The shoot system is made up of the **main stem, branches, leaves, flowers** and **fruit** (or cherries). The main stem and branches provide the framework for the tree and are the main structures from which leaves, flowers and fruit grow. Growth of the main stem and branches is referred to as **vegetative** growth. The production of flowers and fruit or cherry is **reproductive** growth.




Coffee tree shoot system

The focus for maintenance pruning is mostly the removal of vegetative growth; however, for good coffee garden sanitation, particularly in CBB-infested areas, it is also important to remove reproductive growth.

## Main stem

The main stem, or trunk, is the main structural support or skeleton of the coffee tree rising vertically above ground. It supports all the branches and determines the height of the tree.

## Branches

Branches contain **nodes** from which leaves, buds, more branches and flowers emerge. Branches can be erect (e.g., Mundo Novo) or horizontal (e.g. Typica) in habit.

The coffee tree has two types of branches: **lateral branches** and **suckers**.

## Lateral branches

Lateral branches grow outwards from the main stem and are the only branches that bear fruit. There are three types of lateral branches: primary, secondary and tertiary.

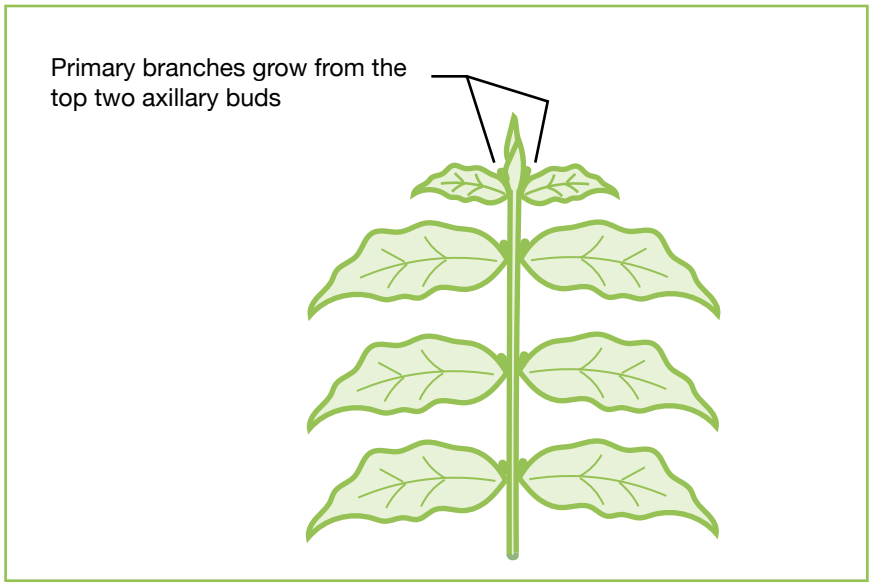
### Primary branches

- In the young seedling, pairs of opposite leaves grow on the main stem from nodes. Axillary buds form in the axils of the leaves (or where the leaves attach to the stem)
- Primary branches grow from the topmost axillary buds. The remaining buds stay dormant or develop into suckers
- Primary branches grow directly from the main stem. These branches never regenerate – once cut, they won't grow again
- Each primary branch has many buds – some will develop into flowers, others into secondary branches

**Activity 1:** Growth structure of a coffee seedling

Use the diagram of the young seedling and/or the young coffee seedlings in the polybags to show:

1. The axillary buds
2. How the primary branches emerge from the top axillary buds
3. Where suckers develop from some of the other axillary buds




The shoot system of a young coffee seedling

### Secondary branches

- Secondary branches grow from the primary branches
- Unlike primary branches, secondary branches can regenerate – if a secondary branch is removed, another secondary branch can replace it
- Secondary branches also have buds. The buds will develop into flowers or tertiary branches

### Tertiary branches

- Tertiary branches grow from the secondary branches
- Like secondary branches, tertiary branches can regenerate

## Suckers

Two types of suckers grow on coffee trees: non-productive and productive.

### Non-productive suckers

- Non-productive suckers are branches that grow from dormant buds on the main stem or branches
- Non-productive suckers do not bear fruit
- Non-productive suckers grow vertically and very quickly – they extract substantial amounts of valuable water and nutrients from the tree
- Non-productive suckers must be removed regularly


A non-productive sucker growing on the shoot system of a mature coffee tree

### Productive suckers

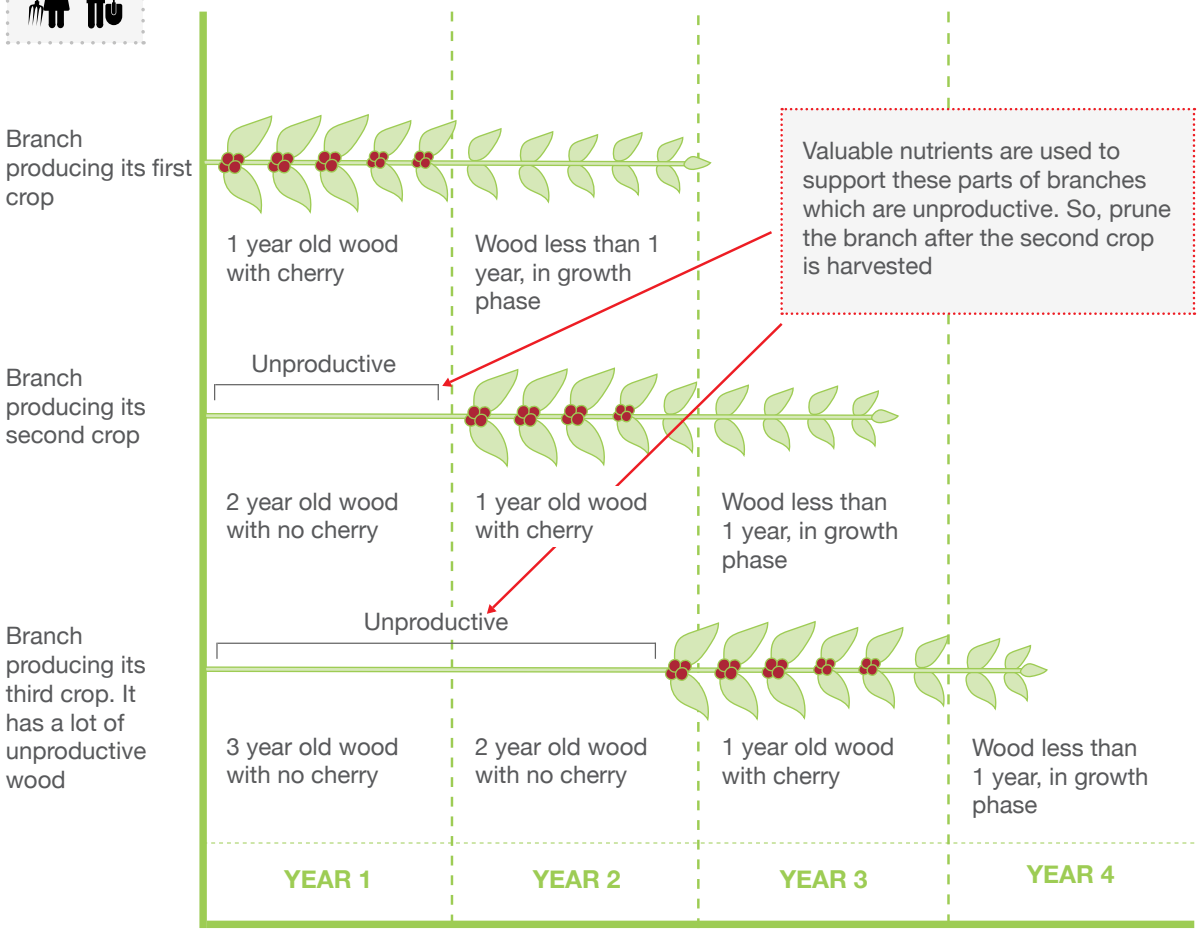
- As primary branches age they become less productive, so they are removed to allow for rejuvenation of the coffee tree
- Productive suckers grow on the main stem after aged primary branches have been removed – this is called **recycle pruning**
- In time, the productive suckers will grow and bear further branches, leaves, flowers and fruit

Productive suckers growing after recycle pruning

## Fruit (cherry)

- Coffee fruit, also known as cherry, develop from flowers that emerge on the branches from nodes
- The wood of a branch will only bear cherry for one year
- The following year, cherry will only grow on the wood of a new section of the branch
- A branch will bear cherry for a number of years, but the cherry will be produced further and further away from the main stem
- It is best to prune the primary branches after they have produced two crops. If the branches are not pruned, valuable nutrients are wasted supporting the inner sections of the branch that will not bear more cherry

**Stages of development of primary branches**




*(Adapted from Lambot and Bouharmont, 2004)*

To understand the types of pruning systems, the techniques used in pruning operations, and to undertake pruning correctly it is important to have a good understanding of the growth structure of the coffee tree. Using these techniques will encourage healthy growth and maximise productivity from the coffee trees.

**Objective:**

**To understand the coffee tree branching system and cherry production**

**You will need:**

- **A diagram of a coffee tree shoot system**

# EXERCISE 2

## The coffee tree shoot system and pruning

### Discussion

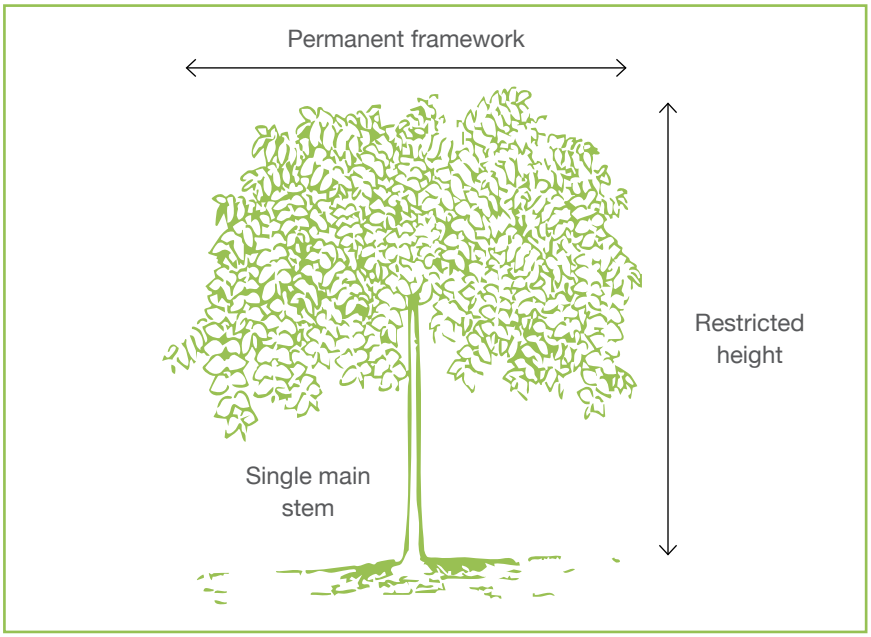
1. Identify where cherry is produced on the coffee tree. Which branches produce cherry? Which part of these branches produce cherry?
2. Identify which branches will not regenerate after removal and which branches will regenerate
3. Discuss why primary branches should be removed after producing two crops
4. Discuss why non-productive suckers should be removed

# 2.3 PRUNING SYSTEMS

There are two recognised systems of pruning used in coffee gardens: single-stem and multiple-stem pruning. There is no economic difference between the two systems in terms of production and monetary gain.

## Single-stem pruning system

- **Single-stem pruning is not recommended for smallholders** as it requires a lot of time and skill
- Single-stem pruning has a restricted height (capped at 1.6–1.8 m) and a permanent framework of lateral branches arising from a single main stem




### Coffee tree with a single stem

- A single stem can have a number of bearing heads – the crop is borne mainly on secondary and tertiary branches
- No formative pruning is required as the coffee tree is maintained on a single stem
- Capping the trunk ensures annual renewal of lateral branches
- Maintenance pruning is undertaken to remove secondary or tertiary branches that have produced cherry and suckers, and to maintain airflow and access for sunlight
- Single-stem pruning is recommended for coffee gardens at lower altitudes, where growth is faster
- When coffee trees are planted at high densities (generally more applicable to dwarf varieties) there is little space for spreading of the branches, so maintaining a single main stem is preferrable
- Single-stem trees can be converted to multiple-stem trees if necessary

**Uniform pruning**

Regardless of the pruning system used, it is more efficient in terms of labour to prune a coffee garden uniformly, rather than pruning individual trees on an ad hoc basis.

**Activity 2:** Pruning systems

Ask the farmers about the types of pruning systems they use and why.

## Multiple-stem pruning system

- The **multiple-stem pruning system is recommended for smallholders** as it is cost effective and easier to manage
- Multiple-stem pruning is recommended for the tall coffee varieties that smallholders prefer
- Multiple-stem pruning is limited to the permanent main stump – there are two or more bearing uprights or stems per tree, with no restriction on height, and the crop is borne largely on primary branches
- New stems are allowed to develop from suckers (or new shoots) growing on the main stump
- Multiple-stem pruning is suitable when coffee is planted at lower densities, as more space is required for the multiple branches to spread
- Planting density determines the number of uprights. Three bearing uprights or heads per tree are appropriate for the lower planting density recommended for smallholders (2,667 trees per hectare, meaning plant spacing of 2.5 m x 1.5 m)
- The crop is harvested by bending the stems outwards
- The lower branches are removed each year, after bearing two crops
- The production cycle is changed every 6–7 years, depending on the coffee variety and management. At this time, **all uprights are completely removed**

Multiple-stem coffee tree with three bearing heads *(Credit: Leo Aroga)*

**Objective:**

**To understand the different pruning systems and why the multiple-stem pruning system is recommended for most smallholders**

# EXERCISE 3

## Pruning systems

### Discussion

1. Discuss the differences between the single-stem and multiple-stem pruning systems
2. In what situations is the single-stem system of pruning recommended? Discuss locations in PNG and in what situations this system may be used
3. Why does the single-stem pruning system require more time and skill than the multiple-stem pruning system?
4. Why is the multiple-stem pruning system recommended for most smallholders?

# 2.4 PRUNING EQUIPMENT

It is important to have the correct pruning equipment so that that every pruning operation can be carried out efficiently and to the highest standard.

Recommended pruning equipment includes:

- Sharp pair of secateurs to cut smaller branches
- Pruning saw to cut larger branches
- Bow saw for recycle pruning or stumping thick branches
- Bush knife used as an alternative to a bow saw for stumping. A saw is better than a bush knife because cuts are neater and less likely to become infected by disease
- Axe to cut larger branches and remove suckers
- Oil to lubricate the secateurs and pruning saw
- Measuring stick to determine the height of branches from the ground, the distance between branches, the height of suckers, etc.
- Disinfectant (or hot soapy water) to sterilise pruning equipment and prevent the spread of disease

Secateurs for pruning smaller branches (*Credit: Michael Kaugam*)

Pruning larger branches using a pruning saw (*Credit: Michael Kaugam*)

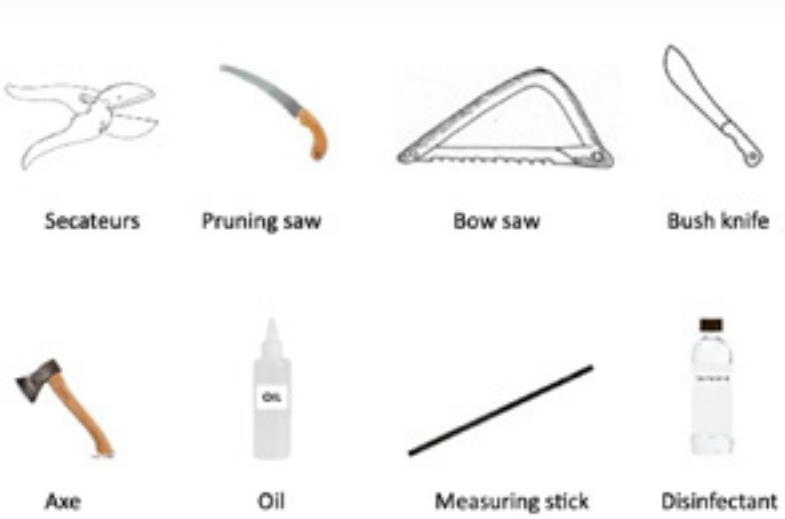
Recycle pruning using a bow saw (*Credit: Bob Kora*)

Complete stumping using a sharp bush knife (*Credit: Michael Kaugam*)

**Activity 3:** Pruning equipment

Display the equipment required for pruning and describe the operations each one is used for.

## Pruning equipment




## Maintenance of pruning equipment

- Secateurs (or bush knives) and pruning saws should be kept sharp and well oiled
- To prevent injury, a lot of care must be taken when maintaining and using this equipment

## Preventing the spread of disease

In areas with pink disease and *Fusarium* bark disease, disinfect the pruning saw and secateurs after pruning each tree, using one of the following methods:

- Dip in fungicide
- Hold over a naked flame
- Wash thoroughly in hot soapy water

Burn all infected material on site.

# 2.5 PRUNING YOUNG COFFEE TREES

**Pruning techniques**

- All saw cuts to the main stem should be made at a 45° angle to the ground. Cutting at this angle assists in shedding water from the stem and reducing the risk of wood rot
- Pruning cuts must be made cleanly without tearing or peeling the bark. This is why it is essential to use sharp tools. If the cut is not clean, the wound may take longer to heal, and the jagged edge or tear is a potential entry point for pests and diseases


**Activity 4:** Pruning technique
Using a seedling in a polybag:

- Demonstrate how to make a clean cut and explain why this is necessary
- Break a branch off leaving a jagged edge or tear. Show how this can be an entry point for pests and diseases

Pruning in the coffee garden begins soon after the seedlings are planted and continues for the productive life of the trees. It is important to establish a regular pruning routine to maximise the production potential of the trees and, therefore, income. Overgrown seedlings require special treatment.

## Formative pruning

**Formative pruning** is done during the first two years to enhance tree establishment and to train the trees for future production. It is important to begin pruning within the first year of seedlings being planted in the field. **Capping**, **skirting**, **handling** and **desuckering, and the removal of flowers and fruit** should be carried out at this early stage to prevent cropping and achieve the required canopy structure.

## Capping

- Capping removes the growing tip and encourages the growth of branches
- It is best to cap young trees **during the first year**
- Cap maturing wood, which can be identified by the presence of brown bark
- Cap young seedlings at 30–45 cm above ground level and 5 cm above a pair of primary branches
- Two uprights will grow from the buds that develop below where the stem is cut
- If more than two uprights are required, the process of capping can be repeated on one or both of the developing uprights. For a tree density of 2667 trees per hectare, which is the density recommended for smallholders, three uprights are recommended
- Capping minimises flowering and enables the young coffee trees to **establish a strong and healthy root system**. This will mean fewer cherries in the first two years but is crucial for the future health and productivity of the coffee trees. Ensuring coffee trees establish well means **more income in the future**

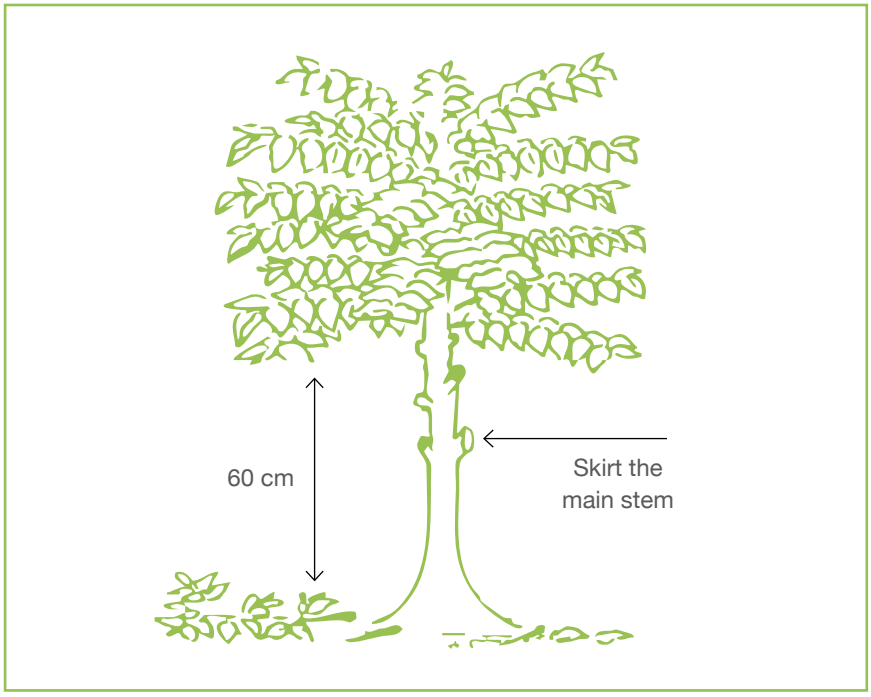

Capped young coffee tree

Smallholders are often reluctant to cap young healthy coffee trees before they produce their first crop of cherries. Uncapped trees will maintain a single main stem.

Single-stem trees can be converted to multiple-stem trees after the first production cycle, at the first recycle pruning.

## Skirting

- As the young coffee tree grows it will require skirting, which is the removal of primary branches growing on the main stem up to 60 cm from ground level
- Skirting keeps branches off the ground, helping prevent infestation by pests and diseases, and improves access for mulching, harvesting and future pruning




Remove branches growing up to 60 cm from the ground

## Handling and desuckering

Regular handling and desuckering should be carried out when the coffee tree is young, to achieve the required canopy structure and to prevent the growth of flowers and fruit.

**Handling** is the removal of secondary branches along the primary branches within 20 cm of the main stem to improve airflow and access for sunlight. Secondary branches growing close to the main stem receive little light, making them poor and unproductive. Removing them also allows for better ventilation, reducing susceptibility to diseases.

**Desuckering** is the removal of suckers growing on branches and at the base of the main stem. Remove all suckers to maintain a limited number of stems, to avoid competition for nutrients, moisture and light. This will also make conditions less favourable for pests and diseases.

## Removal of flowers and fruit

To prevent the coffee trees from cropping at this young age, remove any flowers and fruit that appear on the trees.

**Activity 5:** Pruning a coffee seedling

Use a seedling in a polybag to show farmers how to prune a young seedling. Pay attention to:

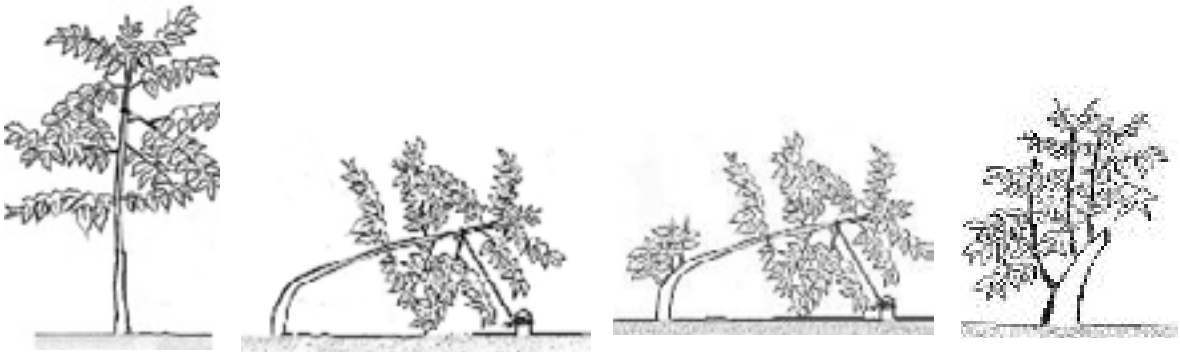
- Capping
- Skirting
- Handling and desuckering
- Removal of flowers and fruit, if present

## Training overgrown seedlings

Some seedlings may have been overgrown when transplanted and will require attention so they can develop into strong healthy trees with the required canopy structure.

When they are well established, or about 2–3 months after transplanting, tall, weak overgrown seedlings can be bent over and pegged to produce 2–3 uprights. This will encourage growth of new suckers from the base of the main stem. When the suckers are 8–12 months old, the end of the old stem can be removed.

Planting of overgrown seedlings and subsequent bending will delay cropping by at least one season.



Overgrown seedling | Bend seedling over | New suckers develop | Old stem is removed

**Objective:**

**To understand why it is important to prune young coffee trees, when to begin pruning and how to prune them**

**You will need:**

**Young coffee trees recently planted in a coffee garden (or aged seedlings in polybags) and pruning equipment**

# FIELD EXERCISE 1

## Formative pruning

### Discussion

1. What is formative pruning?
2. When do you begin formative pruning?
3. Why is it important to begin pruning a young coffee tree soon after it is planted in the coffee garden?
4. What will be the result if young trees are not pruned at the right time?

### Practical activity

Under the guidance of the extension officer, participants prune some of the young trees.

# 2.6 MAINTENANCE PRUNING

**Pruning of shade trees**

- The best time to prune shade trees is just prior to the onset of coffee flowering
- If shade trees need additional pruning to ensure they are providing optimum shade, do this before pruning the coffee trees

*Refer to Farmer Training Guide Unit 2, Module 3 'Shade management' for further information.*

Once the coffee trees are well established and have produced their first crop, it is important to continue to keep them healthy so that they have a long and productive lifespan. After the first crop of cherry, and any subsequent crops, the trees must undergo regular **maintenance pruning.**

Maintenance pruning is the removal of unhealthy, aged and dead wood and any interlocking branches or branches growing upright, down or inwards towards the stem.

## Benefits of maintenance pruning

- Damaged or broken branches are removed during pruning
- Promotes fruit production by keeping the trees vigorous and healthy
- Improves air circulation and light access, helps prevent nutrient deficiencies and creates unfavourable conditions for pests and diseases
- Maintains adequate productivity of coffee trees for 6–7 years
- Preserves the basic tree shape, which has been determined in the first and second year after planting

## Annual maintenance pruning

Annual maintenance pruning prepares the trees for the next flowering. It is done **after harvest,** during the dry period. Annual maintenance pruning operations are handling, desuckering and centring.

- Trees use a lot of energy during flowering and fruiting – removing unwanted branches directs energy to newer wood that will produce flowers and cherry in the next season
- Remove any berries from the trees. Bury or burn the berries on site to prevent CBB infestation
- Remove all broken, dead and unhealthy branches, including any damaged by pests or diseases

Removing soft new suckers from the base of the main stem

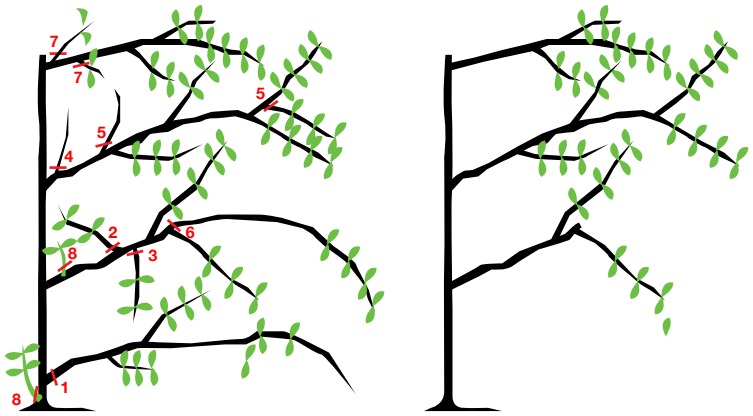
Removing interlocking branches

**Activity 6:** Annual maintenance pruning

Use a mature tree in the coffee garden to demonstrate how to conduct the annual maintenance pruning. Pay attention to:

- Removal of flowers and berries
- Capping
- Skirting
- Desuckering
- Removal of primaries that have produced two crops of cherry
- Removal of dead and unhealthy branches
- Opening up the tree to improve ventilation

- Remove any lower branches that have produced two crops
- Cut back any long, drooping primary branches to the nearest secondary branch
- Remove all suckers by hand or using secateurs
- Cap the main stems about 1.6 m from the ground, cutting above a primary shoot. This keeps the trees at an adequate height for easy harvesting
- Space primary branches in the top section of the tree about 10 cm apart
- Allow a maximum of six well-spaced secondary branches on each primary branch
- Remove suckers and secondary branches within 20 cm of the main stem. This is referred to as **centring.** Secondary branches close to the main stem receive little light and are typically poor or unproductive. Centring opens the tree canopy improving air circulation, light penetration and access for pest and disease control
- Remove any secondary and tertiary branches growing towards the stems, downwards and upwards
- Remove interlocking branches
- Remove any flowers from the remaining branches




Before pruning | After pruning

After removing flowers and berries, remove the following:

1. Branches too close to the ground (skirt up to 60 cm from the ground)
2. Branches growing towards the stem
3. Branches growing downwards
4. Dead, disease-infected, old or stunted branches
5. Weak branches (they compete with other fruit bearing branches for light and nutrients)
6. Old branches that are expected to produce fewer cherries in the next harvesting season (nutrients can then be used by stronger fruit-bearing secondary branches)
7. Secondary branches growing above the main canopy or close to the main stem (provides more light to the lower canopy)
8. All suckers

## Routine maintenance pruning

Routine pruning is undertaken at regular intervals throughout the off season to remove vegetative growth and out-of-season flowers and berries.

### Vegetative growth (stems, leaves and suckers)

- Coffee trees flower after the onset of rains. Along with flowering comes a surge of secondary vegetative growth and the growth of suckers. The vegetative growth competes with the developing cherries for both water and nutrients. This in turn affects the size of the beans and bean quality
- The unwanted vegetative growth and suckers should be removed. Young soft suckers can be removed by hand

### Reproductive growth (flowers and berries)

- All flowers and berries should be removed from the coffee trees during the final harvest. However, if any are left on the trees they should be removed soon afterwards as these will provide habitat for CBB
- Out-of-season flowers and berries should also be removed to help maintain the health of the coffee trees and eliminate habitat for CBB

**Objective:**

**To understand the significance of timely and correct maintenance pruning, and how to prune mature coffee trees**

**You will need:**

**Mature coffee trees ready for annual maintenance pruning, and pruning equipment**

# FIELD EXERCISE 2

## Maintenance pruning

### Discussion

1. What is maintenance pruning?
2. Why is maintenance pruning so important?
3. Why is the timing of maintenance pruning, particularly the main pruning, so important?
4. Why should there be follow-up or routine pruning after the main pruning?

### Practical activity

Under the guidance of the extension officer, participants undertake the main pruning of the coffee trees using the correct pruning techniques

# 2.7 REHABILITATING MATURE COFFEE TREES

## Change of production cycle

Each year, during maintenance pruning, primary branches that have produced two crops are removed and the height of the tree is maintained at 1.6 m. After 6–7 years, there will be fewer productive primary branches remaining. When the lower branches have been removed up to a height of 1.4 m, the tree is less productive and major pruning is required to rejuvenate it.

This results in a change of the production cycle of the tree, which does mean reduced income for up to two years. However, if it is not done, there will be a continual decline in production and the productive lifespan of the tree will be shortened.

- After the main harvest, the trees are cut back and allowed to regrow in order to restore a good level of productivity

- To ensure regularity of production, pruning for a change of the production cycle can be done in different sections of the coffee garden each year, so that the farmer always has some coffee income. However, this practice is not recommended in areas with high infestations of CBB as it provides a continual habitat and food source for the pest
- It is particularly important in this period of rejuvenation that the shade trees have been well maintained, and are growing at optimum density and height above the coffee trees. Heavy shade can result in the growth of tall, thin and weak suckers on the coffee trees. *Refer to Farmer Training Guide Unit 2, Module 3 'Shade management' for further information*

## Multiple-stem pruning

Rejuvenation of multiple-stem coffee trees can be achieved by **complete stumping** or **recycle pruning**.

### Complete stumping

Complete stumping is the removal of all bearing uprights, meaning the trees will not produce any crop for two years. If there is not too much shade, marketable intercrops can be grown during the coffee regrowth period to replace some of the lost income. *Refer to Farmer Training Guide Unit 2, Module 8 'Intercropping in your coffee garden' for further information.*

| Advantages and disadvantages of complete stumping | |
|---|---|
| **Advantages** | **Disadvantages** |
| Produces stronger suckers, as sunlight penetrates to the base of coffee stem | The farmer may be without coffee and income for about two years |
| Simplest, quickest and cheapest method of pruning | Stumps may die without sucker generation |
| Marketable intercrops can be grown to replace some lost coffee income | Weeds may grow and shade the suckers |

### Complete stumping process

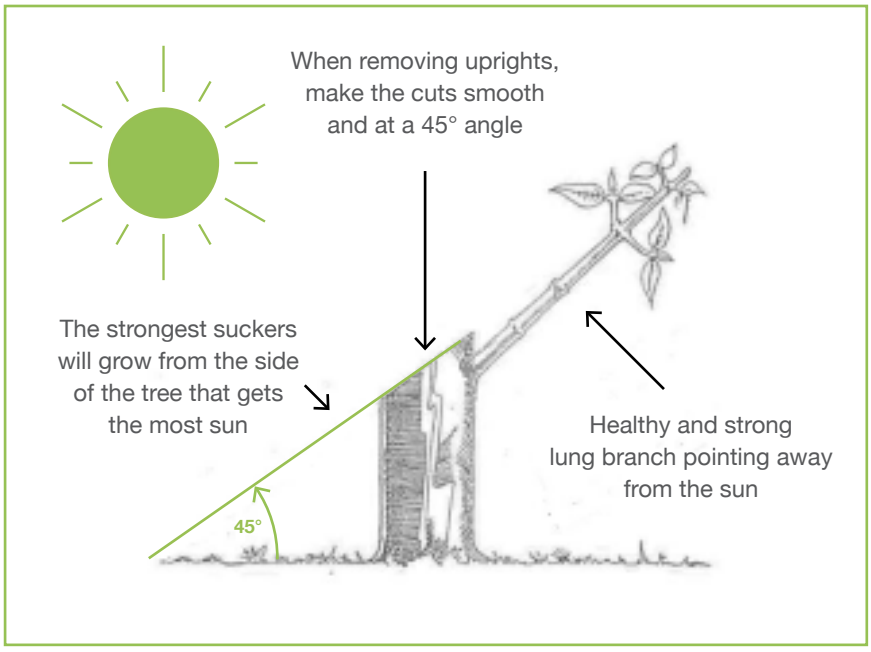
- Remove all stems 30–45 cm above ground level
- Allow suckers to grow, then select the best suckers to become the new stems and remove those not required
- Intercrops or a leguminous cover crop can be grown under the stumped trees until the new stems create too much shade – the coffee trees may benefit from any fertiliser added to intercrops

## Recycle pruning

Recycle pruning is the removal of all bearing uprights, except one. New suckers are allowed to grow and develop into new bearing uprights. The remaining upright continues to produce crop and income for the farmer until the new uprights come into production.

### Recycle pruning process

- Using a pruning saw, cut all bearing uprights, except for one. The remaining upright is called the **lung branch**
- When removing the uprights, make the cuts smooth and at a 45° angle, sloping away from the stump
- The lung branch should be 0–45 cm from the ground, as close as possible to the top of the stump, healthy, strong and high yielding
- It is preferable that the lung branch faces away from the rising sun, so that it does not shade the new suckers
- If the lung branch does overshadow the suckers, cut off any branches on the lung branch above the growing tips of the new suckers




All bearing uprights are removed, except for one

Recycle pruning of a tall coffee variety *(Credit: Bob Kora)*

Recycle pruning of a whole coffee garden (*Credit: Michael Kaugam*)

Suckers growing on a coffee tree after recycle pruning

## Sucker growth and selection

**Sucker growth** can be encouraged by notching the main stem and lung branch – making a deep cut in the bark with a pruning saw. Another effective method is to repeatedly knock the stem or branch with the blunt edge of the secateurs. In addition, capping the tip of the lung branch can also promote the growth of suckers.

To ensure the development of strong and healthy suckers, it is important to practice general coffee garden maintenance. This includes weeding, drainage, pest and disease control, shade regulation and general hygiene

**Sucker selection** is the identification and maintenance of the best suckers and the removal of the others.

- Multiple suckers may grow after rain – it is important to begin sucker selection early and remove unwanted suckers as soon as possible so that they do not compete for water, nutrients and sunlight
- Preferred suckers are those growing 30–45 cm from the ground and no less than 10–15 cm tall
- Begin sucker selection at four months after the initiation of sucker growth, then again at eight months, and make the final selection at 12 months. If an old bearing head still remains, it can also be removed at this time
- The best outcome is to have three healthy suckers evenly spaced around the stem


Removing weaker suckers and keeping a strong sucker.

## Rejuvenating a mature multiple-stem coffee tree by recycle pruning

**1.** Coffee tree ready for recycle pruning.

**2.** Remove all bearing uprights, except one.

**3.** Remove the lower branches from the remaining upright (or lung branch).

**4.** Cut a small notch in the remaining branch 40 cm above ground level to stimulate the growth of suckers, or repeatedly knock the branch with a blunt blade to cause injury.

**5.** Cap the growing tip of the remaining upright, also to stimulate the growth of suckers.

**6.** Allow new suckers to grow.w

**7.** After 4 months, select suitable suckers to use as new bearing uprights.

**8.** Remove weeds from around the coffee tree.

**9.** After 8 months, carry out sucker selection again.

**10.** After 12 months, carry out final sucker selection, ensuring the three remaining branches are evenly spaced around the tree.

**11.** Remove the old upright and allow the selected suckers to grow.

**12.** The remaining suckers have now become bearing uprights and the change of production cycle is complete.

## Single-stem pruning

Although not common, some farmers have single-stem coffee trees. The rejuvenation pruning methods described above will convert the trees to three uprights, which is the recommended pruning system for smallholders. However, some farmers prefer to retain the single stems. For these farmers, rejuvenation methods are described below.

Rejuvenation of single-stem coffee can be achieved by **complete stumping** or by removing parts of the unproductive stem over a two-year period, known as **rejuvenation in phases**.

### Complete stumping

Complete stumping of single-stem coffee trees has the same advantages and disadvantages as it does for multiple-stem trees.

#### Complete stumping process

- Remove the entire single-stem 30–45 cm from the ground
- As suckers grow, select the best sucker to become the new single-stem and remove the others
- Intercrops or a leguminous cover crop can be grown until the new stem creates too much shade

### Rejuvenation in phases

Rejuvenation in phases requires more labour than complete stumping, but the coffee trees continue to produce crop during the transition period from the old stem to the new.

#### Rejuvenation in phases process

- In the first year, remove all primary branches on one side of the tree – preferably on the eastern side, to prevent shading of the new suckers
- After three months, select the best two developing suckers and remove the others (see ‘Sucker growth and selection’ above)
- After a further three months, select the best of the two suckers and remove the other
- When the first crop is produced on the new stem, remove the old stem completely

## Rejuvenating a mature single-stem coffee tree in phases

**1.** Single-stem coffee tree ready for recycle pruning (umbrella shape).

**2.** Prune lateral branches.

**3.** To induce growth of suckers, cut a small notch in the sunny side of the tree or repeatedly knock to cause injury.

**4.** Allow new suckers to develop.

**5.** After three months, select the best two suckers and remove the remainder.

**6.** After a further three months, select the better of the two suckers.

**7.** When the new stem has produced its first crop, the old stem can be removed

**Objective:**

**To identify when a change of production cycle is required for coffee trees and understand the pruning processes involved**

**You will need:**

**Mature coffee trees approaching the end of a production cycle or past the optimum time for change of production cycle**

# FIELD EXERCISE 3

## Change of production cycle

### Discussion

1. What indicates when coffee trees require a change of production cycle?
2. What pruning practices are used to change the production cycle? (Discuss both removal of all uprights with the exception of one, and complete stumping)
3. In which situations would you use each type of pruning?
4. What is the process of sucker selection?

### Practical activity

Observe the trees in the coffee garden and identify the factors that suggest they may require rehabilitation (a change of production cycle).

# 2.8 PRUNING TIMELINE

These tables summarise the pruning practices required over the lifespan of a coffee tree to keep it healthy and productive, and easily accessible for harvesting.

## Pruning young coffee trees

| Training or formative pruning – shape canopy and prevent cropping | | |
|---|---|---|
| **Type of pruning** | **Description** | **Timing** |
| **Capping** | Removal of the tip of the main stem of the maturing seedling | First year |
| **Skirting** | Removal of any primary branches growing on the main stem up to 60 cm from the ground | Second year |
| **Handling** | Removal of excessive secondary growth | |
| **Desuckering** | Removal of all suckers | First two years |
| **Crop stripping** | Removal of all flowers and fruit | |

## Pruning mature coffee trees

| Main pruning – prepare trees for the next flowering | | |
|---|---|---|
| **Type of pruning** | **Description** | **Timing** |
| **Crop stripping** | Removal of all flowers and fruit | Soon after main harvest |
| **Handling** | Removal of:<br>• Unproductive, unhealthy, damaged and dead wood<br>• Interlocking branches<br>• Secondary and tertiary branches growing toward the stems, downwards and upwards.<br>• The top of the stem to a desired height to facilitate harvesting | |
| **Centring** | Removal of suckers and secondary branches along the primaries growing within 20 cm of the main stem | |
| **Desuckering** | Removal of suckers (upright growth) on the main stem and lateral branches | |

| Routine pruning – maintain open canopy for healthier growth and remove CBB habitat | | |
|---|---|---|
| **Type of pruning** | **Description** | **Timing** |
| **Crop stripping** | Removal of all out-of-season flowers and fruit | During the off season |
| **Handling and desuckering** | Removal of unwanted vegetative growth | Every 2–4 months or after rain |

| Change of production cycle – rejuvenate when production declines | | |
|---|---|---|
| **Type of pruning** | **Description** | **Timing** |
| **Recycle pruning** | Multiple-stem tree:<br>• Removal of all but one of the bearing uprights, and all primary branches from the remaining upright that will shade new suckers<br>• Sucker growth and selection<br>• Removal of remaining upright<br>Single-stem tree:<br>• Removal of branches on the sunny side of the tree<br>• Sucker growth and selection<br>• Removal of remaining upright | After 6–7 years |
| **Stumping** | • Removal of all bearing uprights<br>• Sucker growth and selection | After 6–7 years |

# 2.9 UNSATISFACTORY RESPONSES TO PRUNING

Pruning is one of the most labour-intensive tasks in a coffee garden so it must be done **correctly** and at the **right time**. This is vital for optimising productivity.

Pruning will only bring rewards if other management tasks are also done correctly. This begins when the nursery is established and continues until the trees are in the cherry production phase. **The best responses to pruning** will be achieved if the coffee trees are **strong and healthy**.

There are several reasons why productivity after correct and timely pruning may not meet expectations.

## Failure to respond to pruning

- The root system of the tree is malformed or has not established properly, possibly due to poor planting of the seedling
- The climate is unsuitable
- Soil fertility is poor
- The soil is waterlogged
- The trees are inherently weak (e.g., the variety is unsuitable)
- The trees may be nearing the end of their productive life – the average lifespan of a coffee tree grown for commercial production is 30 years

In the future, higher temperatures resulting from climate change may reduce yields of Arabica coffee trees.

## Development of weak suckers

New suckers become new cropping heads on a coffee tree after a change of production cycle. Healthy suckers maximise annual production from the new cropping heads, and maximise the length of time needed between each change of production cycle. If suckers are weak, the tree's productivity may be significantly reduced.

Weak suckers most commonly result from **too much shade.** It is important that light reaches the base of the coffee tree at the spot where the suckers will develop.

- Shade trees must be kept at the **optimum tree density, shade level** and **height** above the coffee trees. *Refer to Farmer Training Guide Unit 2, Module 3 'Shade management' for further information*
- Coffee trees must be pruned correctly to prevent self-shading which can result in the growth of weak suckers
- Lung branches may shadow the new suckers causing them to be weak

# 2.10 PRUNING DEBRIS

After coffee trees have been pruned, it is important that the cut branches and suckers are dealt with appropriately. **Do not burn prunings unless they are diseased.**

- Pruning debris contains **valuable nutrients.** It is important to retain any pruning debris in the coffee garden so that these valuable nutrients are not lost
- Where possible, use prunings as mulch around the coffee and shade trees
- Bulky pruning debris can be stacked in rows between the rows of coffee trees and large stems can be used for fencing
- Burning of coffee prunings:
  - results in the loss of nutrients through leaching
  - affects soil temperature, pH, moisture, organic matter and microbial populations
  - might burn the coffee trees

## Diseased coffee prunings

- Diseased coffee prunings must be **buried or burnt on site**. Carrying them through the coffee garden may spread disease to uninfected trees

# 2.11 CBB MANAGEMENT

Pruning is a very important aspect of coffee management in a CBB environment.

## Maintenance pruning

- Removes potential CBB habitat, such as gaps or openings in the bark
- Reduces the number of residual berries infested with CBB
- Simplifies collection of residual berries both on the ground and on the branches
- Enables better coverage if applying *Beauveria bassiana* as a control mechanism

## Stumping

- A drastic measure used in areas with heavy and widespread infestations of CBB
- All potential CBB habitat on the trees is removed, disrupting the pest's life cycle and eliminating, or significantly reducing, the CBB population
- Leads to a loss of production, and therefore income, for up to two years
- It is best to change the production cycle of all coffee trees in the garden at the same time, as the presence of old and new trees could promote the spread of CBB
- Requires coordination across all coffee gardens, using an area-wide strategy

## Garden sanitation

- Fallen berries and berries left on the trees or on pruned branches are potential breeding grounds for CBB – before any pruning begins, remove all berries in the coffee garden, including immature, out-of-season, ripe, overripe and raisin berries
- All berries must be buried or burnt on site
- If buried, it must be at a depth of at least 30 cm and the soil must be well compacted to prevent CBB escaping

# 2.12 KEY MESSAGES

- If coffee trees are not pruned, they will become very unhealthy and unproductive, meaning less income for the farmer
- Pruning rejuvenates the coffee trees promoting new healthy wood that is required for cherry production
- Correct and timely pruning prevents overbearing dieback and reduces biennial bearing, allows light penetration for flower initiation, improves access for harvesting and sanitation, and allows for better ventilation, creating an unfavourable environment for pests and diseases
- The two recognised pruning systems for coffee trees are single-stem and multiple-stem pruning. Multiple-stem pruning is recommended for smallholders because it is easier to manage and is more cost effective. Single-stem pruning is more suited to coffee grown at high densities and requires a lot of time and skill
- Formative pruning begins soon after the coffee seedlings are planted in the coffee garden. The main purpose of formative pruning is to achieve the required canopy structure and prevent fruit production in the first two years of tree establishment
- Maintenance pruning is undertaken annually, soon after the main harvest period, to remove aged and dead wood and encourage new growth for the next season
- It is best to prune the primary branches after they have produced two crops. If the branches are not pruned, valuable nutrients are wasted supporting the inner unproductive sections of the branch
- Overshading by poorly managed shade trees will result in the development of weak suckers. Shade trees must be kept at the optimum tree density, shade level and height above the coffee trees. If pruning of shade trees is required, this should be undertaken prior to pruning the coffee trees
- A change of production cycle is required when productivity from the coffee trees begins to decline, usually after 6–7 years. The trees are pruned severely to rejuvenate them and encourage new, vigorous growth
- In some instances, pruning may not improve productivity from the coffee trees. Coffee trees will only respond to pruning if the trees or suckers are strong and healthy
- Coffee tree pruning debris can be retained in the coffee garden and used as mulch around the coffee trees. Diseased debris should be buried or burnt on site
- Pruning is an important tool used in CBB management. It is required to remove CBB habitat and enable easier access for harvesting and sanitation of coffee gardens. In a CBB environment, all berries should be removed from branches prior to pruning, and buried or burnt on site. Flowers and berries should be removed throughout the coffee off season

# 2.13 QUIZ

**Place a '✓' in the correct box.**

## 1 One of the main reasons for pruning coffee trees is:

- A To encourage the growth of fruit (cherries) instead of leaves
- B To promote biennial bearing
- C To remove unwanted wood and promote the growth of new wood for the next season's crop
- D To enable intercropping with food crops during the off season

## 2 On a bearing upright, which of the following branches **does not** produce cherry?

- A Primary branches
- B Secondary branches
- C Tertiary branches
- D Suckers

## 3 What is the main purpose of formative pruning?

- A To encourage growth of suckers
- B To improve seedling establishment and train seedlings for future production
- C To encourage growth of secondary and tertiary branches
- D To stop the bearing uprights growing above 1.6 m

## 4 When is the best time to begin formative pruning of coffee seedlings?

- A In the nursery prior to planting
- B While planting the seedlings
- C Within the first year of establishment
- D Two years after planting

## 5 On a coffee tree, how old is the wood that produces cherry?

- A 1 year
- B 2 years
- C 3 years
- D All the above

6 To keep trees strong, healthy and productive, primary branches should be removed after producing how many cherry crops?

- A One
- B Two
- C Three
- D Four

7 Why is it important to remove flowers and developing cherry from young coffee trees during the first two years of establishment?

- A So the young trees will not grow too quickly
- B To improve airflow around the branches
- C Cherries on young trees are of poor quality
- D To promote growth of a strong and healthy shoot and root system

8 When should the annual maintenance pruning be undertaken?

- A Soon after harvest
- B At the end of the dry season
- C At the beginning of the wet season
- D Any time

9 What is removed from the coffee trees during the annual maintenance pruning?

- A Unhealthy, aged and dead wood
- B Suckers and all remaining flowers and cherry
- C Interlocking branches, and branches growing down, upright and inward towards the stem
- D All the above

10 After the annual maintenance pruning, why should routine pruning be undertaken at regular intervals throughout the off season?

- A To keep the coffee trees at a manageable height for the next harvest
- B To enable better growth of intercrops
- C To remove vegetative growth and out-of-season flowers and berries
- D To promote new sucker development

## 11 When pruning, why is it important to make the cuts clean and at an angle?

A To prevent sunlight reaching the cut
B To prevent moisture building up on the cut, which may cause rotting
C To encourage growth of suckers
D To improve airflow around the cut, which will help deter pests

## 12 The single-stem pruning system is recommended in which **one** of the following situations?

A For smallholders growing tall coffee varieties planted at low densities
B For smallholders growing tall coffee varieties planted at high densities
C For coffee grown at high altitudes with high planting densities
D For coffee grown at lower altitudes with high planting densities

## 13 Why is the multiple-stem pruning system recommended for smallholders growing the tall coffee varieties?

A It requires less labour and specialised skills, so it is more cost effective
B The stems only have to be pruned every 6-7 years so is more cost effective
C The trees grow faster and produce more cherry
D Harvesting is simpler as the stems are rigid and do not bend

## 14 After major pruning (change of production cycle), old bearing uprights are replaced by new suckers growing from the main stem of the coffee tree. What is the best way to encourage the growth of strong and healthy suckers?

A If necessary, prune lower branches on the remaining bearing uprights so they do not shade the new suckers
B Maintain shade trees at the optimum density and height above the coffee trees to allow sunlight to reach the new suckers
C Cap the suckers as soon as they emerge so they will produce lots of branches
D A and B

## 15 A change of production cycle is required when:

A Growth on the coffee trees changes from vegetative (leaves and branches) to reproductive (flowers and cherry)
B Cherry production changes from annual to biennial
C Productivity begins to decline and the coffee trees need to be rejuvenated
D The pruning system is changed from single-stem to multiple-stem

## 16 For smallholders, when will coffee trees need to undergo a change of production cycle?

A After 2 to 3 years
B After 4 to 5 years
C After 6 to 7 years
D After 8 to 10 years

## 17 When undergoing recycle pruning, a coffee tree may be stumped or one bearing upright may be left remaining. What is the purpose of leaving one upright?

A To reduce the risk of the stumps dying and provide the farmer with income until the new bearing uprights begin to produce cherry
B To shade the new suckers and prevent them from drying out
C To stop weeds growing under the coffee trees and competing for nutrients
D To lure pests away from the new suckers

## 18 In an area where CBB infestation is a problem, when undergoing a change of production cycle, it is better to:

A Stump all the trees at the same time to eliminate all habitat for CBB
B Stump only the trees that have cherries infested with CBB
C Stump every second row of trees so the farmer retains some income
D Leave a lung branch on each stump

## 19 When selecting suckers during a change of production cycle:

A Allow all the suckers to grow for 12 months then begin sucker selection
B Choose those suckers that are shaded from the sun so that they do not dry out and burn
C Begin sucker selection early but do not remove those not required in case you have a change of mind later
D Begin sucker selection early and remove unwanted suckers regularly so they do not compete for water, nutrients and sunlight

## 20 After pruning a coffee tree infected with disease, the debris:

A Can be removed from the coffee garden and used as firewood
B Should be burnt or buried at the site
C Should be stacked in rows between the rows of coffee trees
D Can be used as mulch in the coffee garden

21 The best mechanism for control of CBB is to break the pest's life cycle by removing habitat for it to survive and reproduce. What is the best measure to take to achieve this when pruning the trees in the coffee garden?

A Remove any flowers and berries on the coffee trees before pruning begins
B Remove flowers and berries from the pruning debris
C Remove all the pruning debris from the coffee garden
D Burn all the pruning debris

22 After a change of production cycle, the most common reason for poor sucker development is:

A Disease infection
B Pest infestation
C Nutrient deficiency
D Too much shade

## Answers to quiz questions

1. One of the main reasons for pruning coffee trees is:

   **Answer = C**. To remove unwanted wood and promote the growth of new wood for the next season's crop

   Section 2.1: New wood produces more crop than old wood because nutrients are delivered more efficiently to areas of new growth.

2. On a bearing upright, which of the following branches does not produce cherry?

   **Answer = D**. Suckers

   Section 2.2: Lateral branches (primary, secondary and tertiary branches) grow outwards from the main stem and are the only branches that bear fruit. Any suckers growing on a bearing upright will be unproductive.

3. What is the main purpose of formative pruning?

   **Answer = B**. To improve seedling establishment and train seedlings for future production

   Section 2.5: Formative pruning is undertaken to enhance tree establishment and to train the young coffee trees for future production. If pruned well right from the start, the coffee trees will be strong and healthy and have more chance of being productive well into the future.

4. When is the best time to begin formative pruning of coffee seedlings?

   **Answer = C**. Within the first year of establishment

   Section 2.5: Formative pruning is undertaken during the first two years of field establishment and should begin during the first year.

5. On a coffee tree, how old is the wood that produces cherry?

   **Answer = A**. 1 year

   Section 2.2: Cherry will only grow on a new section of wood that has grown on the branch during the year. The wood will only bear cherry for one year. The following year, that part of the branch will not bear any cherry.

6. To keep trees strong, healthy and productive, primary branches should be removed after producing how many cherry crops?

   **Answer = B**. Two

   Section 2.2: It is best to prune the primary branches after they have produced two crops. If the branches are not pruned, valuable nutrients are wasted supporting the inner unproductive sections of the branch.

7. Why is it important to remove flowers and developing cherry from young coffee trees during the first two years of establishment?

   **Answer = D**. To promote growth of a strong and healthy shoot and root system

   Section 2.5: Removing flowers and fruit enables the young coffee trees to establish a strong and healthy root system. This will mean fewer cherries in the first two years but is crucial for the future health and productivity of the coffee trees. Ensuring coffee trees establish well means more income in the future.

8. When should the annual maintenance pruning be undertaken?

   **Answer = A**. Soon after harvest

   Section 2.6: The trees use a lot of energy during flowering and fruiting and removing unwanted branches soon after harvest means energy can be directed to newer wood that will produce flowers and cherry in the next season.

9. What is removed from the coffee trees during the annual maintenance pruning?

   **Answer = D**. All the above

   Section 2.6: The annual maintenance pruning is a general tidying up of the coffee trees to maintain their shape. Its main purpose is to keep the trees vigorous, healthy and productive.

10. After the annual maintenance pruning, why should routine pruning be undertaken at regular intervals throughout the off season?

    **Answer = C**. To remove vegetative growth and out-of-season flowers and berries

    Section 2.6: Routine pruning is undertaken at regular intervals to remove vegetative growth and out-of-season flowers and berries.

11. When pruning, why is it important to make the cuts clean and at an angle?

    **Answer = B**. To prevent moisture building up on the cut, which may cause rotting

    Section 2.5: Cutting clean and at an angle assists in shedding water from the stem and reduces the risk of the wood rotting.

12. The single-stem pruning system is recommended in which one of the following situations?

    **Answer = D**. For coffee grown at lower altitudes with high planting densities

    Section 2.3: Coffee growing at lower altitudes tends to grow faster and when planted at high densities there is less room for spreading of multiple primary branches, so a single-stem pruning system is preferrable.

13. Why is the multiple-stem pruning system recommended for smallholders growing the tall coffee varieties?

    **Answer = A**. It requires less labour and specialised skills, so it is more cost effective

    Section 2.3: Specialised skills and a lot of labour is required in maintaining single-stem coffee trees. The single-stem system is usually applied to coffee trees planted at higher densities as there is little space for spread of the branches. Smallholders prefer to plant tall coffee varieties because they are easier to manage. When grown under the multiple-stem system, tall varieties require more space for growth of the multiple stems.

14. After major pruning (change of production cycle), old bearing uprights are replaced by new suckers growing from the main stem of the coffee tree. What is the best way to encourage the growth of strong and healthy suckers?

    **Answer = D**. A and B

    Sections 2.7 and 2.9: To ensure development of strong and healthy suckers, it is important that general coffee garden maintenance is practised. This includes management of shade trees to ensure sufficient light is reaching the suckers. If a remaining upright (lung branch) is shading the developing suckers, it is best to prune the lower branches on the upright so that the suckers have access to sunlight.

15. A change of production cycle is required when:

    **Answer = C**. Productivity begins to decline, and the coffee trees need to be rejuvenated

    Section 2.7: When productivity begins to decline, major pruning is required to rejuvenate the coffee trees. This is referred to as a change of production cycle.

16. For smallholders, when will coffee trees need to undergo a change of production cycle?

    **Answer = C**. After 6 to 7 years

    Section 2.7: Each year, during maintenance pruning, primary branches that have produced two crops are removed and the height of the coffee tree is maintained at 1.6 m. After 6–7 years, there will be fewer productive primary branches remaining. To rejuvenate the trees and restore productivity major pruning is required at this time.

17. When undergoing recycle pruning, a coffee tree may be stumped or one bearing upright may be left remaining. What is the purpose of leaving one upright?

    **Answer = A**. To reduce the risk of the stumps dying and provide the farmer with income until the new bearing uprights begin to produce cherry

    Section 2.7: Stumping has the advantage of producing much stronger suckers because they have more access to sunlight, and it is simpler and quicker than if leaving one upright behind. However, the farmer is without a crop for about two years, the stumps may die and there is more weed growth requiring a higher input of labour for their removal.

18. In an area where CBB infestation is a problem, when undergoing a change of production cycle, it is better to:

    **Answer = A**. Stump all the trees at the same time to eliminate all habitat for CBB

    Section 2.11: It is important that all habitat for CBB is eliminated in order to disrupt the pest's life cycle.

19. When selecting suckers during a change of production cycle:

    **Answer = D**. Begin sucker selection early and remove unwanted suckers regularly so they do not compete for water nutrients and sunlight

    Section 2.7: Multiple suckers may grow after rain. If sucker selection does not begin early and is not done regularly there will be a lot of competition between the multiple suckers for water, nutrients and light. Removing unwanted suckers will ensure strong and healthy growth of those that remain.

20. After pruning a coffee tree infected with disease, the debris:

    **Answer = B**. Should be burnt or buried at the site

    Section 2.10: Diseased coffee prunings must be buried or burnt on site, as carrying them through the coffee garden may spread the disease to uninfected trees.

21. The best mechanism for control of CBB is to break the pest's life cycle by removing habitat for it to survive and reproduce. What is the best measure to take to achieve this when pruning the trees in the coffee garden?

    **Answer = A**. Remove any flowers and berries on the coffee trees before pruning begins

    Section 2.11. In a CBB environment, before any pruning is begun, remove all berries remaining in the coffee garden including immature, out-of-season, ripe, overripe and raisins.

22. After a change of production cycle, the most common reason for poor sucker development is:

    **Answer = D**. Too much shade

    Section 2.9: Strong healthy suckers will not develop if they are overshaded. Overshading may be caused by poorly managed shade trees, overshading by the coffee trees if not pruned correctly, or a lung branch shading the suckers.

# 2.14 SOURCES OF FURTHER INFORMATION

Aristizábal L F, Johnson M, Shriner S, Hollingsworth R, Manoukis N C, Myers R, Bayman P and Arthurs S (2017) Integrated Pest Management of Coffee Berry Borer in Hawaii and Puerto Rico: Current Status and Prospects. *Insects* 8(123)

Aroga L (2007) *Coffee Rehabilitation & Management Notes: A Guide for Coffee Extension Workers & Farmers of the Coffee Industry in PNG*. Ukarumpa, Eastern Highlands Province, PNG: Coffee Industry Corporation (CIC) Ltd

Coffee Industry Corporation (2016) *The Papua New Guinea Coffee Handbook* (2nd Edition)
www.cic.org.pg/wp-content/uploads/2021/08/52029_CIC-Handbook.pdf

Coste R (1992) *Coffee: The Plant and the Product*. The MacMillan Press Ltd, London

Curry G N, Webb M, Koczberski G, Pakatul J, Inu S M, Kiup E, Hamago M R, Aroga L, Kenny M, Kukhang T, Tilden G and Ryan S (2017) *Improving Livelihoods of Smallholder Families through Increased Productivity of Coffee-based Farming Systems in the Highlands of PNG*. Project Final Report FR2017-08 for ACIAR project ASEM/2008/036. ISBN: 978-1-86320-028-8. Available at:
https://espace.curtin.edu.au/handle/20.500.11937/54174
www.aciar.gov.au/publication/asem-2008-036-final-report

Dufour B P, Kerana I W and Ribeyre F (2019) Effect of coffee tree pruning on berry production and coffee berry borer infestation in the Toba Highlands (North Sumatra). *Crop Protection* 122: 151-158

Johnson M A, Fortna S, Hollingsworth R G and Manoukis N C (2019) Postharvest Population Reservoirs of Coffee Berry Borer (Coleoptera: Curculionidae) on Hawai'i Island. *Journal of Economic Entomology* 112(6): 2833–2841

Kuit M, Jansen D M and Nguyen V T (2004) *Manual for Arabica cultivation*. Tan Lam Agricultural Product Joint Stock Company, Vietnam

Lambot C and Bouharmont P (2004) Chapter 8.3 'Pruning'. In Wintgens J N (ed.) *Coffee Growing, Processing, Sustainable Production*. Wiley-VCH, Weinheim

Robinson J B D (1985) *A Practical Guide to Growing Arabica Coffee in Papua New Guinea.* Agricultural Development Services Pty. Ltd., Singapore

Talopa P (1998) CIC and CRI *Technical Advisory Circular No. 4* (Second edition)

Vega F E, Infante F and Johnson A (2015) The Genus Hypothenemus, with Emphasis on *H. hampei*, the Coffee Berry Borer. In Vega F E and Hofstetter R W (eds.), *Bark Beetles, Biology and Ecology of Native and Invasive Species*, 1st ed. Elsevier, London

Winston E, Op de Laak J, Marsh A, Lempke H and Chapman K (2005) Arabica coffee manual for Lao, FAO, Bangkok. www.fao.org/3/ae939e/ae939e00.htm#Contents

Wintgens J N (2009) *Coffee: Growing, Processing, Sustainable Production: A Guidebook for Growers, Processors, Traders, and Researchers*, 2nd Ed. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim

### Video

Coffee stumping and pruning: www.youtube.com/watch?v=2_i2Qw0Ozkc

Australian Centre
for International
Agricultural Research

Australian
Aid