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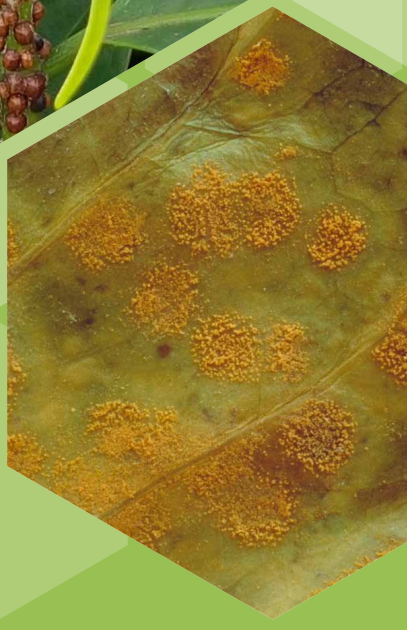
SMALLHOLDER COFFEE PRODUCTION IN PAPUA NEW GUINEA – FARMER TRAINING GUIDE

UNIT 2: MANAGING YOUR COFFEE GARDEN

MODULE 5:
PEST AND DISEASE MANAGEMENT



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PEST AND DISEASE MANAGEMENT

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.

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 Guide Unit 1 Module 1
The extension officer - roles and effectiveness	ACIAR Extension Officer Guide Unit 1 Module 2
Knowing Your Farmers	
Getting to know our coffee smallholders	ACIAR Extension Officer Guide Unit 2 Module 1
What factors affect smallholder coffee production?	ACIAR Extension Officer 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
Fair trade certification	ACIAR Farmer Training Guide Unit 4 Module 3
Family money management	CARE Family Money Management Training

CONTENTS

MODULE TOPICS

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

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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)

Protecting the coffee industry from coffee berry borer in Papua New Guinea and Australia (HORT/2018/194)

For detailed information specific to the coffee berry borer, refer to the *Farmer Training Guide Unit 2, Module 6 'Coffee berry borer management'*.

INTRODUCTION

Aim of Module:

The aim of this module is to increase farmers' knowledge of the common pests and diseases of coffee, the farming practices that can be implemented to minimise the impact of incursions, and the strategies that can be used to produce strong and healthy coffee trees that are resilient in the face of attack.

Pests and diseases have the capacity to create significant problems for farmers in their coffee gardens by reducing tree health and lowering cherry quality and yield. By implementing good farm management practices and measures for control, the incidence and impact of many pests and diseases of coffee can be minimised. It is important that farmers can identify the common pests and diseases of coffee and understand the conditions that favour increases in their populations to levels causing economic losses.

LEARNING OUTCOMES:

By the end of this module you will:

- Have knowledge of the common pests and diseases of coffee
- Know the farm management practices that can be implemented to minimise the impact of pests and diseases of coffee
- Understand the factors that regulate and favour incursion and proliferation of plant pests and diseases
- Develop skills in managing an attack by a pest or disease

It is recommended that farmers contact CIC for further information on individual pests or diseases.

For detailed information on coffee berry borer (CBB) refer to the *Farmer Training Guide Unit 2, Module 6 'Coffee berry borer management'*.

LESSON PLAN:

The module has two parts:

Sections 5.1 to 5.3	Understanding pests and diseases of coffee, the farm management practices used to minimise their impact and factors that regulate outbreaks
Sections 5.4 to 5.6:	Pests and diseases of coffee and their natural enemies

TIME REQUIRED TO COMPLETE THIS MODULE: 4 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 and the Plant Health Troubleshooting Guide (one copy for each participant plus extra copies)
- The coffee calendar and stickers
- Coloured white board markers and white board eraser
- Posters and factsheets of pests and diseases of coffee (e.g., CBB, green scale, CLR and pink disease)
- Posters of beneficial insects (e.g., CIC posters 'Friends of coffee' and 'Natural enemies of green scale')
- Specimens of pest or disease affected coffee leaves, branches and cherries (e.g., green scale on a seedling, CLR on a leaf, coffee cherry with a hole bored into it by CBB)
- An insect pest collection (if available)

PRE-TRAINING ACTIVITIES:

- Confirm number of training participants
- Source all teaching aids
- Arrange access to a coffee garden that uses good pest and disease management practices. Identify some trees that are infested with pests for Exercise 3
- Source a simple guide to common pests and diseases of coffee and the damage they cause (there may be one available from the CIC Library)

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 to 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 pest and disease management listed below

Pest and disease management

In a new coffee garden:

1. Grow coffee varieties suitable for your area. There may be coffee varieties that are more tolerant of pests and diseases that typically occur in your area
2. Plant appropriate shade trees in the new coffee garden at the recommended spacing
3. Plant strong and healthy coffee seedlings at the recommended spacing in deep, well-drained fertile soil
4. Mulch seedlings to minimise weed growth and moisture stress
5. Grow a cover crop of pumpkin or cucumber to attract ladybirds which control green scale
6. Remove and replace unhealthy seedlings
7. Keep seedlings well maintained during establishment (weeding, watering, shade management, removing flowers, etc.)
8. Monitor for pests and diseases

In an established coffee garden:

1. Pruning (burn pest-infested or diseased pruning debris)
2. Shade management
3. Weeding
4. Regular harvesting (every 1–2 weeks)
5. Post-harvest sanitation (at end of coffee season remove all berries from trees, ground and pruning debris)
6. Sanitation of coffee processing area
7. Continually monitor for pests and diseases and attempt control at the earliest occurrence

For information specific to CBB refer to Farmer Training Guide Unit 2, Module 6 ‘Coffee berry borer management’.

Quiz

- Before beginning the module topics, have the farmers complete the quiz located 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

5.1 THE IMPACT OF COFFEE PESTS AND DISEASES

What are pests and diseases?

A coffee pest or disease is an organism that disrupts the growth and normal functioning of all or part of a coffee tree. This interference may result in the coffee tree failing to thrive and produce cherry, or it may damage parts or all of the plant.

Impact of pests and diseases on coffee production in PNG

For smallholder coffee farmers, pests and diseases may account for 30–40% of lost production. Coffee berry borer (CBB) can be used as an example of the impact that pests and diseases can have on coffee production. From its incursion in Papua New Guinea (PNG) in 2017, CBB infestation levels have escalated progressively in all CBB-infested coffee growing provinces, causing huge economic losses, totalling K206.1 million by 2023. Exponential increases in infestation levels occurring throughout the country puts the PNG coffee industry under serious threat in terms of production and foreign exchange earnings.

Understanding and identifying the impacts of pests and diseases

- The impact of pests and diseases on coffee trees is very much dependent on environmental conditions. Even though a pest or disease may be prevalent in a coffee growing area, it does not mean it will cause a serious economic problem. To implement measures to prevent or minimise the impact of pests and diseases on coffee production, it is important to:
    1. Be familiar with which pests and diseases impact coffee production in PNG
    2. Understand what factors favour the development and proliferation of pests and diseases
    3. Be familiar with plants and environments that can host or favour coffee pests and diseases
- When assessing symptoms thought to be caused by pests or diseases, it is important to first consider whether or not the symptoms could be the result of other factors such as temperature extremes, nutrient deficiencies or waterlogging

- It is also important to remember that conditions within a cropping system are constantly changing. Factors that contribute to the dynamics of the cropping system include:
  1. Natural growth stages of the crop (seedling, mature tree, vegetative growth, flowering, fruiting)
  2. Management practices (e.g., pruning, drain and shade management, weeding)
  3. Changes in pest and disease types and numbers
  4. Seasons (changes in temperature and rainfall within and between seasons)

Chemical control of pests and diseases

- Many pests and diseases can be controlled in the short term by the application of chemicals
- **SAFETY**
  Chemicals are usually **expensive** and require the use of **specialised equipment** for application to **protect** the person applying them and to ensure that the pest or disease being controlled is targeted appropriately
- **RESISTANCE**
  Continuous insecticide application by farmers may build resistance over time for targeted pests and diseases. Those that are considered a minor pest or disease now may in fact develop into a **major problem** in the future if excessive chemicals are used

5.2 PEST AND DISEASE MANAGEMENT IN COFFEE GARDENS

Pests and diseases are major challenges faced by coffee farmers. Pests and diseases have the potential to cause **significant damage** to coffee trees and therefore **loss of income** for farmers. Loss of income is due to **reduced yields** and **downgrading of coffee quality**.

The impact of pests and diseases on productivity and quality depends on:

1. The pest or disease involved
2. The part of the coffee tree that is being attacked
3. The severity of the attack

Pest and disease management comprises the use of a wide range of measures to prevent and control pests and diseases to reduce their impact on crop production.

Pest and disease control

- This includes methods used to reduce a pest or disease problem once it already exists
- Many control measures are costly in terms of price and the labour and equipment required to apply them
- Some control measures can be bad for the farmer's health and the environment

Preventative measures

- The main objective of this module is to provide farmers with preventative measures to stop pests and diseases becoming established, although some methods of control will also be included
- Emphasis will be placed on practices that:
    1. Encourage growth of healthy coffee trees
    2. Create an environment that is unfavourable for pests and diseases
    3. Interrupt the life cycle of pests and diseases to reduce their populations and spread
    4. Provide an environment that favours natural enemies of pests and diseases

Good crop management

The best way to combat pests and diseases is through good general crop management. Strong, healthy and resilient coffee trees are less susceptible to attack by pests and diseases compared with weak and unmanaged trees. In addition, if attack does occur, healthy trees are more likely to overcome the impact.

Good farm practices may not prevent attack by pest and diseases, nor eradicate them, but they can reduce **the risk of them developing** and **the level of impact**, if attack does occur.

Pest and disease management begins when the coffee nursery is first established and continues through the productive life of the coffee trees. Good crop management practices, many of which have been discussed in previous farmer training modules, are also applicable as strategies in pest and disease management.

Good crop management is linked to the following aspects of crop production:

1. Nursery

- Whether coffee seedlings are grown in a bare root or polybag nursery, it is important that the soil mix is pest and disease-free and is free draining
- To avoid pests and diseases, such as damping off, it is best to locate the nursery in an area where seedlings have not been grown in the past 3–5 years
- Good airflow is required in the nursery to prevent the incidence of disease. Ensure there is sufficient space between seedlings to allow free airflow
- Manage shade so that there is 90–100% shade cover when the seed is first sown. Then, gradually reduce the shade as the seedlings become more advanced to a final cover of about 30% shade. The level of shade provided in the final stages of seedling establishment in the nursery should be very similar to the level of shade in the coffee garden into which the seedlings will be transplanted
- Keep the seedlings well maintained so that they remain strong and healthy. Regularly monitor moisture and nutrition, and check for weeds, and pests and diseases
- Remove and dispose of seedlings affected by pests and diseases

2. Coffee variety

- In most circumstances it is preferable to grow the coffee varieties recommended for smallholders
- In some areas where certain diseases are prevalent it may be advisable to grow a variety that is resistant to, or more tolerant of, the disease
- The semi-dwarf variety, Catimor, is recommended in areas where coffee leaf rust (CLR) is a serious problem. It must also be noted that this variety requires a high level of management inputs
- It would be best to seek advice on the best coffee variety to grow in your area

3. Certified seed

- If growing coffee seedlings from seed, it is preferable to use certified seed from the Coffee Research Institute of the Coffee Industry Corporation
- Certified seed is reasonably priced and is selected from pest and disease-free trees. The surface of the seed is also sterilised prior to packaging
- If collecting seed from your own coffee trees it should be taken from the healthiest and most productive coffee trees. Avoid trees infested with pests or with obvious symptoms of disease

4. Soil fertility and land use

- Establish a new coffee garden in deep, well-drained fertile soil to ensure good establishment and growth of the coffee seedlings
- To encourage strong and healthy growth of the coffee trees it is beneficial to grow a leguminous cover crop of peanuts, pigeon peas or soybeans prior to planting the coffee seedlings as these will improve the fertility of the soil
- After planting the seedlings, a cover crop of pumpkin or cucumber will attract ladybirds which help to control green scale, which commonly infests young seedlings. A cover crop will also suppress weed growth, and debris remaining after harvest will improve soil fertility
- Avoid planting in old kaukau gardens because these are susceptible to pests, such as coffee ring borer, and there is also a risk of weevil attack. Leave the soil from an old kaukau garden for a year before planting coffee
- Delay planting coffee seedlings for at least 3 years in areas where any trees have suffered from root diseases
- As the coffee trees mature and there are signs of nutrient deficiency, apply well composted plant material around the base of the trees but maintain a gap between the compost and the tree stem to prevent stem rot
- Fresh coffee pulp is a very beneficial form of natural fertiliser as it is high in nutrients
- *Refer to Farmer Training Guide, Unit 2, Module 7 'Soil fertility and nutrient maintenance' for further information*

5. Land preparation

- Clear the site of any unwanted vegetation including that which is known to harbour pests and diseases of coffee (e.g., maize harbours CBB). Retain any usable shade trees
- Construct a good drainage system to prevent erosion or waterlogging of the soil as the coffee trees will not grow well under either of these conditions. They cannot access appropriate amounts of moisture and nutrients for healthy growth
- *Refer to Farmer Training Guide, Unit 1, Module 3 'Establishing a new coffee garden' for further information*

6. Shade trees

- Plant suitable temporary and permanent shade trees prior to planting the coffee seedlings as these will provide many nutritional benefits for healthy growth of the coffee seedlings
- Shade trees also provide a habitat for natural enemies of coffee pests
- It is important to plant shade trees at the recommended density to achieve an optimum level of shade. Too much or too little shade may encourage some pests and diseases
- Do not plant shade trees that may harbour pests or diseases of coffee
- *Refer to Farmer Training Guide Unit 2, Module 3 'Shade management' for further information*

7. Plant spacing and density

- In a new coffee garden, it is preferable to plant coffee seedlings at the recommended plant spacing for smallholders, which is 2.5 m x 1.5 m
- Coffee trees planted at high densities are more susceptible to pests and diseases as trees may become weak due to nutrient and moisture deficiencies
- Close spacing of trees also provides an ideal micro-climate for the build-up of many pests and diseases

8. Planting seedlings

- Plant only strong and healthy seedlings that are pest and disease free. This will ensure that the seedlings establish well in the field
- Avoid planting seedlings with bent taproots as these will become weak trees that are susceptible to pests and diseases
- The seedlings should be planted at the optimum age and stage of growth which is at 6–9 months old when they have 8–9 leaf pairs or 3–4 primary branches
- The best time to plant the seedlings for good establishment is at the beginning of the wet season
- Avoid damaging the seedlings when planting as this may create entry points for pests and diseases
- Apply mulch around the base of the seedlings but do not allow it to touch the stems. This will maintain moisture, add nutrients, enhance the activity of soil microorganisms, suppress weed growth and prevent erosion. Good sources of mulch include coffee pulp, banana leaves, and dried grasses and weeds
- Maintain newly planted seedlings so that they establish well and rapidly develop a strong root system
- *Refer to Farmer Training Guide, Unit 1, Module 3 'Establishing a new coffee garden' for further information*

9. Pruning of coffee trees and removal of out-of-season flowers

- Pruning of mature coffee trees should be carried out correctly and soon after the main coffee season
- When maintenance and recycle pruning is undertaken, pest and disease affected wood is removed. These operations will also promote the growth of new healthy wood keeping the trees strong and resistant to or tolerant of attack by pests and diseases

- Pruning allows more airflow and reduces humidity. This creates an environment less favourable for pests, such as CBB, and diseases such as coffee leaf rust and pink disease

- In CBB environments, pruning enables better sanitation harvesting to reduce the number of CBB-infested cherries. Collecting cherries from the tree branches and finding those that have fallen to the ground during harvesting is simpler

- Pruning allows for better coverage of pest control substances, such as the application of the fungus *Beauveria bassiana* for control of CBB
- It is important that equipment used for pruning is sanitised, particularly in areas where diseases, such as pink disease, are prevalent. This will prevent the spread of disease to other trees in the coffee garden
- Correct techniques should be used when pruning. It is important to make clean cuts and avoid jagged edges or tears as they can be entry points for pests and diseases
- *Refer to Farmer Training Guide, Unit 2, Module 2 'Maintenance pruning and rehabilitation' for further information*

- Any out-of-season flowers on the coffee trees should be removed. If these flowers are left on the trees and develop into fruit they will provide a habitat for CBB, enabling it to survive and infest the next crop

10. Disposal of pest and disease-affected plant material (sanitation)

- When pest-infested or diseased plant material is removed from coffee trees it is important that it is disposed of correctly and without delay
- It is best to burn or bury pest or disease affected prunings on site as carrying them through the coffee garden may spread the pest or disease to unaffected trees

- In a CBB environment it is important to maintain a high level of sanitation. Good sanitation techniques should be practised while harvesting, processing and pruning. All CBB-infested berries should be destroyed. *Refer to Farmer Training Guide, Unit 2, Module 6 'Coffee berry borer management' for further information*

11. Weeding (sanitation)

- It is important to keep the coffee garden weed free by applying mulch when seedlings are young and planting shade trees that provide good leaf litter. Leaf litter will suppress weed growth
- Avoid damaging shallow roots and the base of the stem of the coffee trees when removing weeds as they may become entry points for diseases
- Weeds provide a refuge and an ideal environment for pests and diseases to flourish
- In the presence of weeds the health of the coffee trees will suffer as they will be competing for space, light, nutrients and moisture
- The presence of weeds can hide from view coffee trees that are affected by pests or diseases

- Weeds make it difficult to find cherries dropped during harvesting that may be infested with CBB
- *Refer to Farmer Training Guide, Unit 2, Module 1 `Weed control' for further information*

12. Pruning of shade trees

- Keeping shade trees pruned so that they provide an optimum level of shade will ensure that the coffee trees can access appropriate amounts of light, nutrients and moisture for healthy growth
- Keeping an optimum level of shade will also maintain a less favourable environment for many pests and diseases
- Shade tree prunings can be used as mulch around the coffee trees
- *Refer to Farmer Training Guide, Unit 2, Module 3 'Shade management' for further information*

13. Intercropping and cover crops

- Intercropping and cover crops can improve biodiversity in the coffee garden and encourage natural enemies of pests. For example, pumpkin and cucumber attract lady beetles which can control green scale; and cabbage deters nematodes
- Suitable cover crops and intercrops may improve soil nutrition thereby improving the nutritional status of the coffee trees making them less susceptible to pests and diseases. Examples include leguminous crops, which add nitrogen to the soil such as peanut, pinto peanut and soybean. The coffee trees may also benefit from any fertiliser that is applied
- Intercrops and cover crops help prevent weed growth and erosion
- Care must be taken when cultivating these crops to avoid damaging feeder roots or stem bases of the coffee trees as this may predispose the trees to attack by some pests and diseases
- Regular activity in the coffee garden when maintaining intercrops will alert the farmer to the presence of pests or diseases in the coffee as well as encourage the removal of out-of-season coffee flowers
- *Refer to Farmer Training Guide, Unit 2, Module 8 `Intercropping in your coffee garden' for further information*

14. Post-harvest sanitation

- All berries remaining in the coffee garden after the last harvest of the coffee season, should be removed so that they do not provide habitat for pests and diseases
- Pest or disease-affected berries should be composted, buried, burnt or solarised in dark-coloured sealed containers for at least 2 weeks in direct sunlight
- All harvesting equipment including bags, baskets and buckets should be cleaned
- Pest or disease-affected cherries should never be transported through pest or disease-free areas unless in a sealed container such as a sealed *GrainPro® bag*

15. Monitoring

- It is important that farmers regularly monitor their coffee trees for any signs of attack by pests (particularly CBB) and diseases so that measures can be implemented swiftly to minimise the impact before the problem becomes too big
- Even if, at any particular time, the threat of a certain pest or disease has disappeared it is important to remain vigilant

Objective:

To understand the best crop management practices to minimise the impact of pests and diseases in a coffee garden

EXERCISE 1

General crop management and pests and diseases

Discuss with the group:

1. The crop management measures that the farmers have implemented to minimise the impact of pests and diseases
2. The pros and cons of each measure

Objective:

To learn how to identify symptoms caused by pests and diseases

You will need:

- **Cherries infested with CBB**
- **Branch with green scale**
- **Leaves with brown eye leaf spot**
- **Other specimens from pest or disease-affected coffee trees**

EXERCISE 2

Recognising the effects of pests and diseases

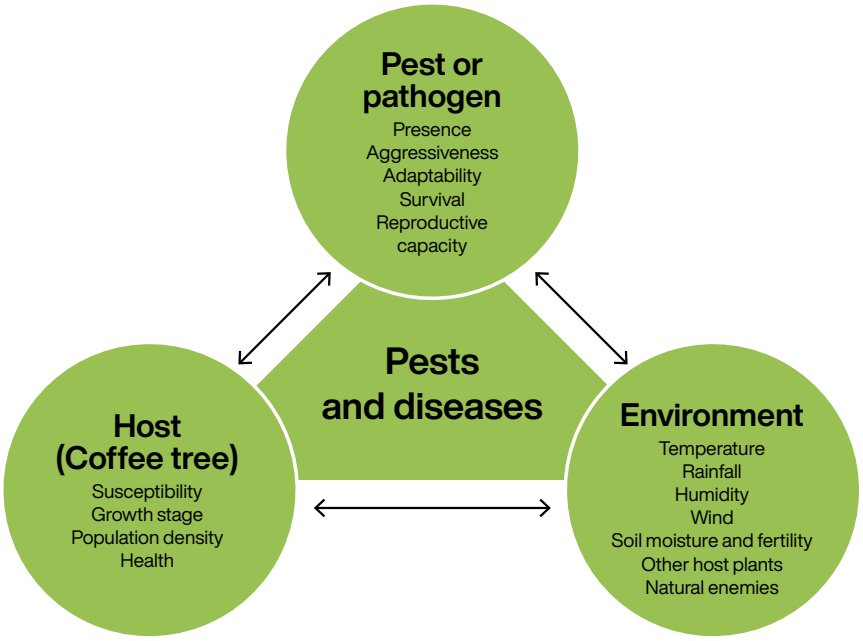
Discuss with the group:

1. What pests or diseases may be causing particular symptoms
2. Have the farmers experienced these problems?
3. What were the environmental conditions at the time: stage of the coffee production cycle, condition of the coffee trees, etc.?
4. Have the farmers ever confused the effects of pests or diseases on coffee trees with other problems such as nutrient deficiencies?

5.3 WHAT ARE THE FACTORS THAT REGULATE THE OUTBREAK OF PLANT PESTS AND DISEASES?

There is a combination of three factors that will determine the risk of outbreak and severity of a pest or disease. These factors are:

1. The **pest** or **pathogen** (the organism that causes the problem or the disease)
2. The host (the plant that is being attacked by the pest or pathogen, that is, the coffee tree)
3. The **environmental conditions**



The interacting factors that affect the risk and severity of a pest or disease (adapted from: Kerr and Keane, 1997).

Pest or pathogen

- A pest or pathogen must be present for infestation or infection to occur
- If the pest or pathogen is aggressive, adapts well to the environment and has a high capacity to reproduce, then the pest or disease can quickly have a major impact on the coffee trees

Host (coffee tree)

- Not all coffee varieties are susceptible to all coffee pests and diseases. For example, many coffee varieties are highly susceptible to coffee leaf rust, causing major impact if the environmental conditions favour the disease. Catimor, on the other hand, is more tolerant of this disease so the impact of infection will be much less
- Coffee trees may only be susceptible at certain stages of growth. For example, coffee seedlings are more susceptible to brown eye leaf spot than are mature coffee trees
- If the population density of the coffee trees is high, or the trees have a dense growth habit, humidity may be higher, favouring the spread and severity of some pests and diseases. Also, the greater the number of coffee trees, the greater the food supply for the pest or pathogen increasing its capacity to survive and reproduce
- In many instances the health of the coffee tree will determine the susceptibility to and severity of impact of a pest or disease. Unhealthy trees are usually more susceptible to pests and diseases than are healthy trees

Environmental conditions

- Some pests and diseases may be prevalent in certain areas but may not impact the coffee trees if environmental conditions do not favour attack. Temperature, rainfall, humidity and wind are the conditions most likely to influence the impact of a pest or disease. For example, many diseases are favoured by prolonged periods of warm wet weather, but they may not cause a problem if these conditions do not occur

- CBB is favoured by high humidity following a dry spell, and higher temperatures
- Soil moisture and fertility will influence the health of the coffee trees and therefore their susceptibility to pests and diseases
- Biodiversity within the environment will also influence whether a pest or disease will have an impact on the coffee trees, such as the presence of other hosts or natural enemies

5.4 PESTS OF COFFEE

Coffee plants have a wide range of pests, most of which are insects. Pests can be a problem for farmers as they can cause widespread damage with some being difficult to control. It is important for farmers to use good crop management practices to limit their impact.

What are the factors affecting pest populations?

- Being a perennial crop, the coffee tree remains in the field for many years and for some pests this means they have an ongoing food supply enabling them to continually reproduce for many generations. This is unlike annual crops where the pest has to move elsewhere once the crop is harvested or dies
- Some pests have a very narrow host range meaning they can survive and reproduce on only one type of plant while others can survive and reproduce on a range of plants
- Many pests are kept under control by natural predators, diseases and starvation when their food supply disappears
- The main regulator of pests are environmental conditions where just a small change can have a large effect on the growth of a pest population

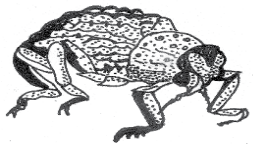
Which are the main pests to look out for?

While there are a range of pests of coffee, some have a greater impact than others. The table on the following pages shows the main pests that you should look out for.

Pests of coffee

Pest and target parts of the coffee plant	Description	Spread	Impact	Management focus for prevention and control
Coffee berry borer Leaves & shoots — Berries ✓ Roots — 	• A small black beetle, less than 5 mm in length • The most destructive pest of coffee	• Flight • Survives in berries left on trees, fallen on ground and on pruning debris • Survives in harvesting bags, processing equipment and in infested bags transported to processors • Persists with continuous coffee flowering	• Adult female bores hole in cherry • Larvae feed on developing bean • Reduces cherry weight and quality, in turn reduces yield and price	• Regular harvesting, pruning and sanitation to remove all residual cherry • Optimum shade
Green scale Leaves & shoots ✓ Berries ✓ Roots — 	• A soft green flat scale insect, 4 mm x 2 mm • Associated with black sooty mould and ants • A major pest of coffee	• Newly hatched mobile crawlers (adults are immobile) • Also thought to be spread by ants	• Suck sap on new growth • Mostly confined to seedlings and young trees causing weakness and sometimes death • Reduces cherry yield in mature trees	• Infested seedlings should not be taken to the coffee garden • Regular weeding (to reduce ants) • Maintenance pruning • Shade trees • Intercrop or cover crop with species that attract lady beetles
Brown scale Leaves & shoots ✓ Berries ✓ Roots — 	• A robust brown dome-shaped scale, 2 mm across • Associated with black sooty mould and ants • A major pest of coffee	• Newly hatched mobile crawlers (adults are immobile) • Also thought to be spread by ants	• Suck sap on new growth • Mostly confined to seedlings and young trees causing weakness and sometimes death • Reduces cherry yield in mature trees	• Infested seedlings should not be taken to the coffee garden • Regular weeding (to reduce ants) • Maintenance pruning • Shade trees • Intercrop or cover crop with species that attract lady beetles

Pests of coffee

Pest and target parts of the coffee plant	Description	Spread	Impact	Management focus for prevention and control
Coffee ring borer Stems ✓ Berries — Roots — 	• A flightless brown/black weevil, 7 mm in length • Primary host is kaukau	• Flight • Adult lays eggs in crevices or wounds in bark	• Larvae feed on the bark, tunnelling around the stem, causing wilting, leaf fall and dieback • Delays cropping • May kill tree	• Keep kaukau and tapiok separate from coffee garden • Fallow is required between kaukau and tapiok, and planting coffee • Regular maintenance pruning • Affected stems should be quickly removed and burnt
Oribius weevil Leaves & shoots ✓ Berries ✓ Roots ✓ 	• Dark brown/grey beetles, 5 mm in length • Not a major pest of coffee	• Are flightless but mobile over small areas • Survive in soil within crop • Migrate from adjacent weedy areas	• Adults feed on leaves and young shoots; make holes in berries • Larvae may feed on roots • Reduce growth and yield	• Optimum shade • Regular weeding, as many weeds are its main hosts
Aphid Leaves & shoots ✓ Berries — Roots — 	• Sap sucking insect • Not a problem pest of coffee	• Crawling or flight if winged	• Cause loss of vigour and in some cases yellowing, stunting or distortion of plants	• Keep coffee trees healthy and resilient to attack

Pests of coffee

Pest and target parts of the coffee plant	Description	Spread	Impact	Management focus for prevention and control
Leafhopper Leaves & shoots ✓ Berries — Roots — 	• Long slender sucking insect • Females brown, males dark blue-green • A minor pest	• Flight • Eggs are laid in the internodes (between leaves) of the primary and secondary branches	• Suck sap • Coffee growth is reduced, leaves yellow and wilt	• Remove sugarcane and grasses that attract leafhoppers • Optimum shade • Regular weeding and pruning
Cicada Branches ✓ Berries — Roots ✓	• Long insects with wide set apart eyes, membranous wings and loud 'song' • An occasional pest	• Flight • Lay eggs in primary branches, hatched nymphs fall to the ground and burrow into soil	• Adult females damage bark when laying eggs • Nymphs suck sap from feeder roots • Cause leaf and fruit fall, dieback of branches and possibly tree death	• Optimum shade • Suitable shade trees that provide adequate leaf fall preventing nymphs from burrowing into the soil
Armyworm Leaves & shoots ✓ Berries ✓ Roots — 	• Brightly coloured caterpillar, 40 mm in length, stripe on each side from head to tail • Adult a light brown moth • A seasonal pest	• Adult flight	• Larvae feed on leaves, growing points and expanding berries • Impede growth and reduce yield	• Optimum shade • Good weed management • Birds, insects, and other larvae predators keep numbers low
Cutworm Leaves & shoots ✓ Berries — Roots — 	• Caterpillars, of several moth species	• Adult flight	• Pest of young seedlings • Make holes in leaves • May sever stems at or near ground level	• Good weed management • Good drainage

Pests of coffee

Pest and target parts of the coffee plant	Description	Spread	Impact	Management focus for prevention and control
Coffee centre borer or red stem borer **Branches** ✓ **Berries** — **Roots** —	• A grey/white moth with small black dots on wings and body • Strong red bodied larvae with black head • A minor pest of coffee	• Flight • Adult lays single eggs in bark crevices	• Larvae make cylindrical tunnels along branches, excrete red/brown frass through holes on branch surfaces • Attacked branches usually die	• Prune and burn infested branches • If severe, remove and burn whole tree
Coffee leaf roller **Leaves & shoots** ✓ **Berries** — **Roots** — 	• Pale brown moth • Larvae dull green with a dark head	• Flight • Adult lays multiple eggs in rolled leaf	• Larvae feed on leaves • Trees can be partially defoliated	• Keep coffee trees healthy and resilient to attack
Mealy bug **Leaves & shoots** ✓ **Berries** ✓ **Roots** ✓	• Sucking insect • Soft bodied with a white waxy coat • Not a problem pest of coffee	• Active immature stages • May also be spread by ants	• Feed on sap of all plant parts • Leaves yellow, flower buds abort, berries fail to develop	• Adequate shade (30%) • Control ants that protect their colonies
Root-knot nematode **Leaves & shoots** — **Berries** — **Roots** ✓	• Microscopic worm (<1 mm in length) • Not a problem pest of coffee	• Spread in infested soil	• Stunting and yellowing of leaves • Knots or galls on roots • Tendency to wilt	• Keep coffee trees healthy and resilient to attack

Impact and description of the main pests of coffee

Leaves & shoots	—
Berries	✓
Roots	—

CIC Resources

Use CBB factsheets and flyers

Coffee berry borer (CBB)

Insect: *Hypothenemus hampei*

Order: Coleoptera – beetles and weevils

Coffee berry borer is the most serious insect pest of coffee worldwide, causing severe economic damage. Its presence in PNG was first reported in 2017 and it has since spread throughout most coffee growing areas.

Impact

- The adult female CBB bores a hole in the developing berry, reproduces inside the berry and then the immature CBB (larvae) feed on the developing coffee beans. CBB damage is confined to the berries, it does not impact any other part of the coffee tree
- Damaged berries become vulnerable to infection by disease and further pest attack
- May cause premature berry fall
- Loss of coffee bean weight and quality, and therefore lower yield and price. The loss caused by CBB can be up to 90% if the pest is unmanaged
- Increased cost of labour to manage the pest, particularly for coffee garden sanitation
- The loss of income caused by CBB may put the food security of farmers at risk

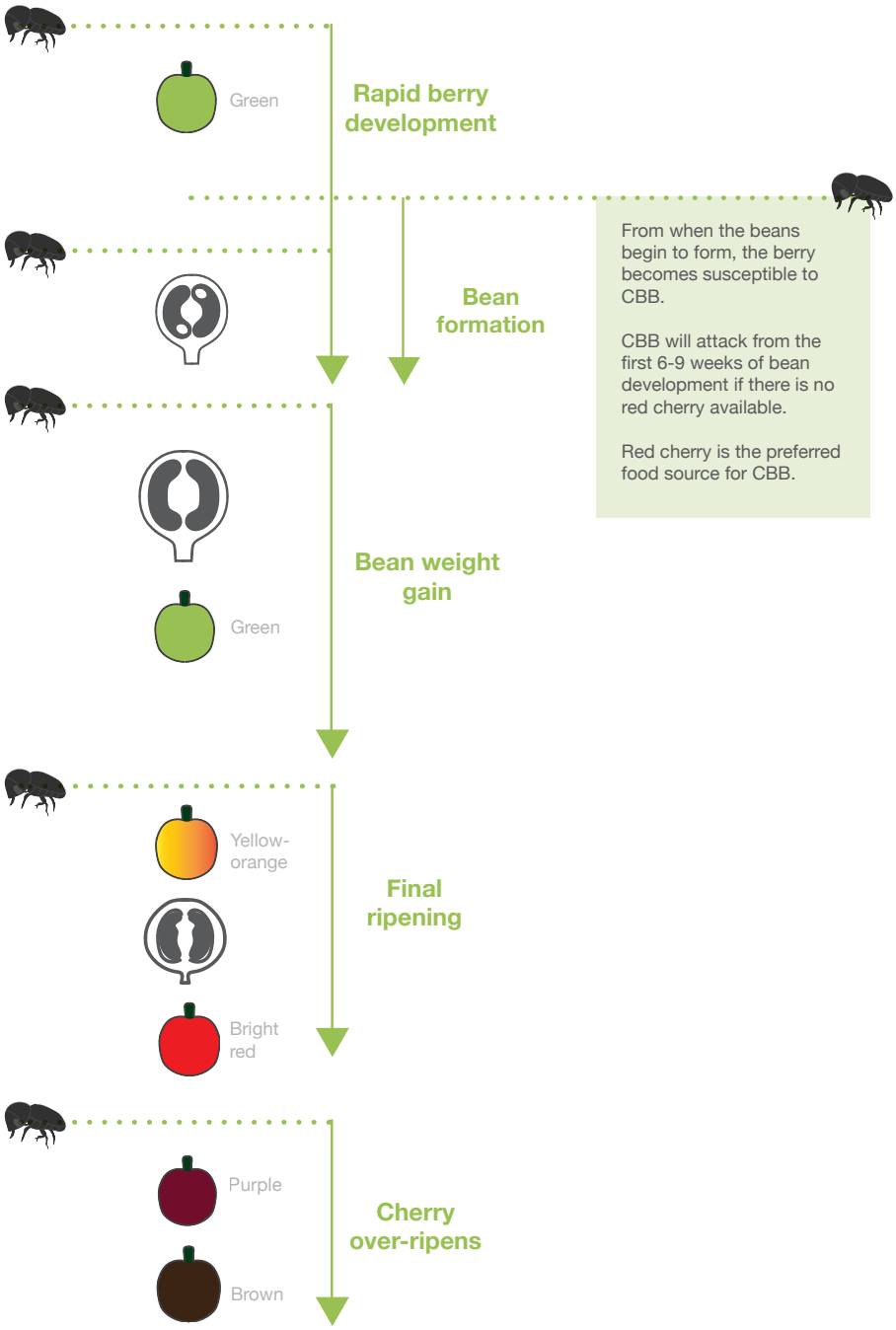
Description

- The female adult beetle is 1.5–2.0 mm long and 1 mm wide, black in colour with a reddish tinge towards the front of the body. The larvae, or immature form, are a similar length with a white body and brown head

Adult female coffee berry borer.
(Source: A.J. Johnson (UF/IFAS) in Vega et al. 2015)

- All life stages of the insect develop inside the coffee berries
- Infestation begins when adult females bore holes in the tip of green berries. This occurs about 4 months after the coffee trees have flowered, when the bean is beginning to form inside the green berry
- Females lay eggs inside the berries and the young offspring feed on the developing beans (often only one of the two beans inside a berry is infested)
- Males remain inside the berry and cannot fly; females have wings. Once mated, females either lay eggs in the same berry or leave the berry in search of another to infest

Stages of berry development susceptible to infestation by CBB



Holes bored into green and red coffee berries by CBB (*Credit: Bob Kora*).

Damage to a berry after infestation by CBB (*Credit: Bob Kora*).

Factors favouring the pest

- Close planting of coffee trees
- Attacks are more severe where coffee is grown under heavy shade which creates warm humid conditions
- Where shade and coffee tree pruning has been neglected, humidity is greater which creates a better environment for CBB to thrive
- Where coffee tree pruning has been neglected, cherries infested with CBB may be difficult to find or too high to reach during harvesting
- Continuous coffee flowering and berry production provides a continuous food supply for CBB
- Berries left on trees after harvest or on pruning debris, and berries dropped while harvesting, provide the pest with continuous opportunities for feeding and breeding throughout the year. These berries become a reservoir of CBB that will infest the next coffee berry cycle
- A dry period followed by high humidity, particularly after rainfall, and higher temperatures favour the spread of the pest. Females in fallen berries that have become dry are stimulated to emerge and find new berries when wetting occurs
- Abandoned coffee gardens provide a continuous food supply for CBB
- High risk areas for CBB infestation occur adjacent to facilities where the harvested coffee is processed, and near roads and neighbouring coffee gardens

Mechanism of dispersal

- CBB living inside berries left on trees after harvest and on pruning debris
- CBB living inside berries that have fallen on the ground or dropped during harvesting serve as a source for subsequent dispersal and infestation of newly formed berries
- CBB spreads by flight over short and sometimes long distances and is also aided by wind, animals and humans
- In CBB-infested harvesting bags and during transport of cherry or parchment

Natural enemies

- *Beauveria bassiana*, a naturally occurring fungus
- Some ant species

Management

- The key to controlling CBB is removal of every potential breeding site of the pest, in order to break its life cycle
- Collecting mature, overripe and raisin (dried) berries and preventing berries falling during harvesting will contribute significantly to CBB control
- Frequent harvesting (every 1 to 2 weeks). This will break the life cycle of CBB. Frequent harvesting will also increase cherry quality and, therefore, price and income
- Remove **all berries** from the coffee trees during the final harvest
- Post-harvest – tie off and move harvesting bags to the processing site as soon as possible, and sanitise harvesting facilities
- Overripe berries are often heavily infested with CBB. These will float during processing and must be destroyed
- Prune the coffee trees adequately and remove all residual berries from pruning debris
- Destroy all CBB-infested berries collected during harvesting, processing or pruning. They can be destroyed by solarising, composting, burying or by burning:
    a. A cheap method of solarising is to place the berries in a large dark coloured bucket (or a bucket that has been spray painted black), seal with a lid and leave in the sun for several days
    b. If composting, dump the infested berries in a pile on a large plastic tarpaulin. Wrap the pile in the tarpaulin and **carefully secure the edges** to stop CBB escaping. Leave the pile to compost for many weeks
    c. If burying, the hole should be dug to a depth of at least 45 cm and the soil covering the berries must be **very well compacted** by stomping on it to prevent CBB escaping
    d. If burning, take extreme care
- Provide appropriate shade to help synchronise flowering (shorten the flowering period by having most of the coffee trees flowering at a similar time) and enhance the health and productivity of the coffee trees. Optimum shade will also improve the survival of natural enemies of CBB
- Remove all off-season flowers
- Provide adequate weed management to enable easy access for harvesting and for collection of berries dropped while harvesting
- Continually monitor for the presence of CBB
- Apply *Beauveria bassiana,* if available

Other hosts

- There are numerous reported alternative hosts of CBB for feeding, however, evidence suggests that it is unlikely they are hosts for breeding
- *Refer to Farmer Training Guide, Unit 2, Module 6 'Coffee berry borer management' for further information*

Leaves & shoots	✓
Berries	✓
Roots	—

CIC Resources

Show participants the following:

- Green scale, Kofi Pepa No. 1
- A field guide manual of coffee green scale crop injury in Papua New Guinea

Coffee green scale (CGS)

Insect: *Coccus celatus* and *Coccus viridis*

Order: Hemiptera – sucking insects

Scale insects are a serious pest of coffee and are widely distributed in PNG, occurring in most coffee growing areas. Infestation levels are greatest at elevations above 1500 m, particularly in the Eastern Highlands.

Impact

- The insect sucks the sap, weakening the coffee plant
- May cause leaf yellowing, defoliation and death of the plant if infestation is severe
- Poor nutrition exacerbates the decline of the trees
- Serious damage is mostly confined to seedlings and young coffee trees
- In mature trees, the scales and associated sooty mould affect the number of fruiting nodes on the trees, reducing yield of cherry

Description

- The soft scale is bright pale green, oval in shape, fairly flat, and about 4 mm long by 2 mm wide
- Usually present in clusters along the main vein and the underside of leaves or green shoots. The adults remain in one location
- Unlike the adults, the immature stages or crawlers have legs and are mobile
- Plants infested with green scale often have blackened, sticky leaves, where sooty moulds have grown on the honeydew (a sweet sticky liquid) excreted by the scale
- The mould covers the leaves reducing light and preventing photosynthesis, impacting tree health (if leaves cannot access sunlight the plants cannot make their own food)
- The honeydew attracts ants which may protect the scales from their natural enemies
- Green scale and its associated sooty moulds are recognised mainly for infesting the leaves and shoots of the coffee trees but may also infest the berries
- Scale are most abundant from October to January in the Eastern Highlands

Factors favouring the pest

- New growth – young seedlings, new shoots, and suckers
- Breeds in suckers during the dry season
- Too little shade or heavy shade

Mechanism of dispersal

- Green scale spreads from plant to plant as newly hatched crawlers

Crawlers and adult green scales

Adult scale insects.

Red ant attracted to honeydew excreted by scale insects.

Black sooty mould that has grown on honeydew excreted by scale insects.

Green scale and sooty moulds covering coffee cherries.

CIC Resources

Show participants the poster 'Natural enemies of green scale'.

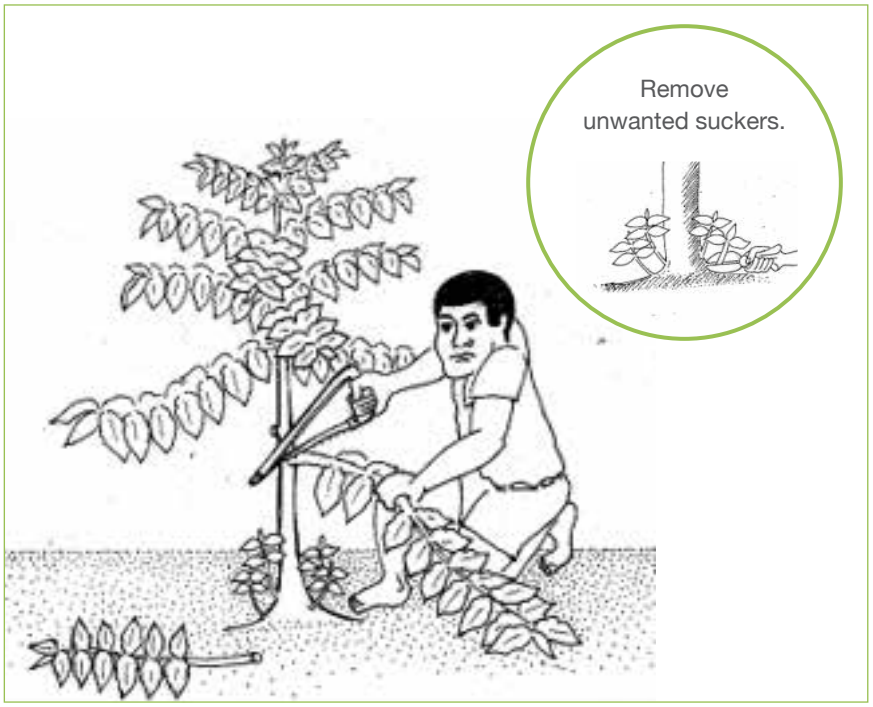
Natural enemies

- Parasitic wasps, lady beetles and fungi

Lady beetles are a natural enemy of green scale.

Management

- Seedlings infested with green scale should not be taken to the coffee garden
- Remove unwanted suckers
- Optimum shade
- Adequate pruning to reduce shading and improve airflow. Remove unwanted secondary branches and shoots, particularly in the lower canopy where scale insects are most commonly found



Remove branches touching the ground as they allow easy access to honeydew by ants.

White oil

Thoroughly mix the following:

- 1/3 cup cooking oil
- 1/2 teaspoon dishwashing detergent
- 4 L water

Soap solution

Thoroughly mix the following:

- 5 tablespoons of pure soap
- 4 L water

OR

- 2 tablespoons dishwashing liquid
- 4 L water

- Good drainage and weed management
- Grow pumpkin or cucumber to attract lady beetles (natural enemies of scale)
- Some ants protect the scale from natural enemies. Destroy ant nests with boiling water (Note: Do not pour boiling water on the coffee plant as it could cause damage)
- Green scale can be sprayed with white oil or soap solution both of which can be made by the farmer. It is important to cover the underside of leaves, stems and terminal buds as this is where the scale commonly occurs. Sprays may need to be repeated several times

Other hosts

- Green scale has a wide range of host plants including citrus, tea, mango, cassava, guava and Casuarina (Yar)
- Citrus is the most common host

Leaves & shoots	✓
Berries	✓
Roots	—

Coffee brown scale

Insect: *Saissetia coffeae*

Order: Hemiptera – sucking insects

Scale insects are a serious pest of coffee and are widely distributed in PNG, occurring in most coffee growing areas. Infestation levels are greatest at elevations above 1500 m, particularly in the Eastern Highlands.

Impact

- Similar to green scale

Description

- The body of the adult is more robust than green scale and is shiny brown and dome-shaped (sometimes called helmet scale), oval, approximately 2 mm across
- The scale remains in place feeding and producing large numbers of offspring. The adults live for about 8 days
- The scales are found on leaves, shoots and green berries, often in large numbers
- As for green scale, brown scale produces a lot of honeydew and is associated with sooty mould and ants

Brown scale insects on a young coffee seedling.

Ants attracted to honeydew excreted by brown scale insects.

Factors favouring the pest

- Hot, dry conditions
- New growth – young seedlings, new shoots and suckers
- Too little shade or heavy shade

Mechanism of dispersal

- As for green scale, newly hatched pale-coloured crawlers spread from plant to plant. Adults are immobile
- Crawlers can also spread on the wind as well as on plant material and humans

Natural enemies

- Parasitic wasps, lady beetles and fungi

Management

- As for green scale

Other hosts

- Breadfruit, citrus, guava, soursop, ornamental plants, and especially cycads and ferns

Stems	✓
Berries	—
Roots	—

Coffee ring borer

Insect: *Meroleptus cinctor*

Order: Coleoptera – beetles and weevils

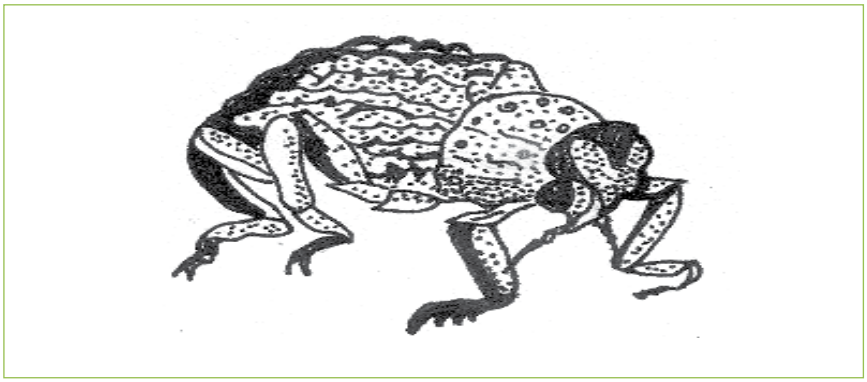
The main host of this insect is kaukau but it also attacks coffee. It is not a major pest in the highlands and occurs more in areas around Lae and areas where there is high rainfall and heavy shade.

Impact

- Attacks coffee in the nursery and in the field
- May kill young trees and severely weaken older trees by ring-barking stems

Description

- The adult insect is a small flightless beetle (weevil), brown to black in colour and about 7 mm in length. The larva, or immature form, is short, flat and off-white with a dark head
- Adults lay eggs in crevices in the bark and the larvae feed on the inner bark and outer layer of wood, forming a tunnel around the trunk
- Wilting occurs above the ring (or tunnel) in young trees causing new shoots to develop from below. General yellowing, leaf fall and dieback follow wilting, resulting in delayed cropping



Coffee ring borer *(Credit: Bob Kora)*

Factors favouring the pest

- Presence of kaukau and tapiok

Mechanism of dispersal

- After mating, female weevils fly around laying eggs, often in crevices of bark or around wounds made previously by another weevil

Management

- Grow kaukau and tapiok away from the coffee garden
- Before planting coffee, a fallow period of at least 12 months is required if kaukau or tapiok have been grown at the site
- Regular maintenance pruning
- Affected stems to be removed quickly and burnt on site

Other hosts

- Kaukau and tapiok

Leaves & shoots	✓
Berries	✓
Roots	✓

Oribius weevil

Insect: *Oribius* spp.

Order: Coleoptera – beetles and weevils

Oribius inimicus and *Oribius destructor* are the most abundant species in the highlands.

Also known as grey weevil or shot hole weevil.

This insect is found in most coffee growing regions but appears to cause insignificant damage to coffee.

Impact

- The adult weevils are the damaging stage, feeding on young leaves and soft shoots particularly when there is a flush of new growth. Feeding on the leaves results in many small holes scattered over the leaf surface
- May cause some growth loss and decline in yield
- Although most damage is caused by adults feeding on the leaves, larvae may feed on the roots
- The adult weevil also makes holes in coffee berries which are sometimes mistaken for holes bored by CBB. CBB, however, only bores holes into the tip of the berry whereas oribius weevils will make holes anywhere on the berry
- Damaged berries become vulnerable to infection by disease and further pest attack

Damage to coffee berries caused by the oribius weevil (*Credit: Bob Kora*).

Description

- Adults are dark brown, dark grey or black in colour and about 5 mm long and are found mainly in the tree canopy often on the tops of leaves

Oribius weevil (*Oribius* sp.)

Coffee leaves damaged by the oribius weevil (*Credit: Bob Kora*)

Factors favouring the pest

- Damage caused by the weevil can be particularly severe where weeds are plentiful, as high weed levels are believed to affect larval populations
- Thick head (*Crassocephalum crepidioides*), a common weed in coffee gardens, is a major host of the weevil
- Oribius weevils are present throughout the year, but are highest during the rainy season, November to April

Thick head (*Crassocephalum crepidioides)*, a major host of the oribius weevil (*Source: Pacific Pests, Pathogens & Weeds*)

Mechanism of dispersal

- Movement of adult populations is limited, as the beetles are flightless
- Infestations are thought to arise from emergence of adult weevils from the soil within the crop, or migration of adults from weedy areas close to the crop
- Despite being flightless, the beetles can be highly mobile over patches within a garden

Management

- Clear crop edges and surrounding areas to prevent movement of adult weevils
- Weed management to eliminate hosts and minimise the adult population
- Optimum shade and suitable shade trees that produce significant leaf fall, minimising weed growth

Other hosts

- Many weed species
- A range of vegetable and orchard crops including broccoli, capsicum, celery, bean, potato, lettuce, citrus and strawberry

Leaves & shoots	✓
Berries	—
Roots	—

Aphid

Insect: A large number of species

Family: Aphididae

Order: Hemiptera – sucking insects

A minor pest of coffee. Mostly a problem at the seedling stage.

Impact

- Cause loss of vigour and in some cases yellowing, stunting or distortion of plants
- They excrete honeydew which is associated with the growth of sooty mould on the leaves which can reduce photosynthesis

Description

- A small, soft-bodied sap-sucking insect that excretes honeydew and may be associated with ants

Aphids on coffee berries (*Credit: Donna Chambers*)

Factors favouring the pest

- Healthy new growth on seedlings or mature trees

Mechanism of dispersal

- Crawling or flight, if winged

Natural enemies

- Many natural enemies including hoverflies and ladybirds

Management

- Wash off with water

Other hosts

- Many plant species

Leaves & shoots	✓
Berries	—
Roots	—

Leafhopper

Insect: *Batrachomorphus szentivanyi, Batrachomorphus blotei* and *Archeguina* spp.

Order: Hemiptera – sucking insects

Leafhoppers are often found on coffee trees but are only an occasional pest. They can be a problem under certain conditions such as when there is a lot of grass or lots of palm trees in the coffee garden. Sugarcane can also attract leafhoppers.

Impact

- Coffee tree health and productivity declines

Description

- Leafhoppers have small, long, slender bodies, two pairs of wings and sucking mouthparts, which allow them to suck the sap from the coffee trees
- Females are brown in colour and the male is either dark bluish to dark green
- If the insect is abundant, coffee trees may show a lack of vigour, retarded growth and, in most cases, yellowing of leaves. There may also be warping of the wood where eggs are laid on primary or secondary branches

Leafhopper *Batrachomorphus* sp. Adult (left) and nymphs (immature stage)(right) (*Credit: Donna Chambers*)

Factors favouring the pest

- Rainfall and high humidity
- Grasses and weeds can host leafhoppers

Mechanism of dispersal

- Adult flight and hopping/jumping, usually over short distances

Natural enemies

- Wasps that attack the nymphs (immature hoppers) and fungi

Management

- Optimum shade
- Weed management
- Removal of sugarcane and grasses that attract leafhoppers
- Adequate pruning

Other hosts

- Grasses

Branches	✓
Berries	—
Roots	✓

Cicada

Insect: Cicadidae

Order: Hemiptera – sucking insects

Cicadas only become a problem on the odd occasion.

Impact

- Coffee trees become weak reducing fruit production and yields
- Severe attack can result in leaf and fruit fall and even death of the tree, similar to the symptoms of overbearing dieback

Description

- Adults are rarely seen but can be recognised by their very shrill, high-pitched call
- First signs of damage are roughness and punctures in the bark 15–20 cm from the tip of young primary branches resulting from laying of eggs
- After hatching, young ant-like nymphs (immature stage) drop to the ground, burrow down into the soil and suck the sap from the feeder rootlets
- If infestation levels are high, coffee trees cannot take up nutrients causing them to lose vigour and suffer dieback and possibly death
- Nymphs remain in the soil for at least a year, but some species can spend several years underground

Factors favouring the pest

- A lack of shade and leaf litter allows the nymphs to burrow into the soil
- A lack of predators when there is no leaf layer

Mechanism of dispersal

- Flight by the adult

Natural enemies

- Beetles and ants eat the nymphs. Some fungi also infect and feed on nymphs eventually leading to their death

Management

- Suitable shade trees that provide a good layer of leaf litter and prevent the nymphs from burrowing into the soil
- Ensure the coffee trees are healthy and resilient to attack by the pest

Other hosts

- Eucalypts

Leaves & shoots	✓
Berries	✓
Roots	—

Armyworm

Insect: *Spodoptera* spp.

Order: Lepidoptera – butterflies and moths

Armyworm is a seasonal pest of coffee.

Impact

- Feeding damage to foliage, growing points and young stems impacts growth and reduces yields. Although most damage is caused by feeding on these plant parts caterpillars also feed on expanding berries thereby reducing quality and yields
- Damage depends on stage of development of the crop, prevailing weather conditions and the density of caterpillars present, and the area of the tree affected

Description

- The adult is a moth with a robust light brown or grey body about 15–18 mm in length and a wingspan of about 30–40 mm
- A fully grown caterpillar has a soft body 30–40 mm in length. It has a creamy yellowish stripe on each side that extends from the head to the tail. The caterpillar is the stage that causes crop damage
- Normally, only small numbers of this pest occur, usually on grasses. However, periodically the populations increase dramatically

Fall armyworm: adult (left) and mature caterpillar (right)
(*Source: Pacific Pests, Pathogens & Weeds*).

Factors favouring the pest

- Outbreaks can occur in areas where there is a distinctive dry period followed by some rainstorms as this stimulates a lot of new growth and a food supply for caterpillars
- Dry and sunny periods following storm events promote survival and rapid development of the caterpillars

Mechanism of dispersal

- Adult flight

Natural enemies

- Birds, insects (e.g., parasitic wasps) and other larvae predators

Management

- Weed management to reduce the presence of grasses and other primary hosts of the pest
- Optimum shade and suitable shade trees that produce significant leaf fall, minimising weed growth

Other hosts

- Grasses, sedges, legumes, cocoa, sugarcane, a few fruit trees, and some root and vegetable crops

Leaves & shoots	✓
Berries	—
Roots	—

Cutworm

Insect: Many species of moth

Order: Lepidoptera – butterflies and moths

Cutworm is a common pest of coffee seedlings.

Impact

- Feeding damage to foliage, growing points and young stems impacts development of young coffee seedlings

Description

- The adult is a moth, but it is the larvae or caterpillar stage that causes damage to coffee
- Young caterpillars feed on the seedlings and make holes in the leaves
- Older caterpillars hide in the soil and feed at night. They cut through the stems just above soil level. They will sometimes pull the seedlings out

Cutworms on coffee seedlings: underside of leaf (left) (*Credit: Bob Kora*) and damage caused by cutworm (right).

Factors favouring the pest

- Presence of young seedlings
- Moist conditions

Mechanism of dispersal

- Adult flight

Natural enemies

- Birds, insects, and other larvae predators

Management

- Manage weeds to reduce alternative hosts
- Check for cutworms on the leaves and in the soil at the base of seedlings. If cutworms are found, handpick and kill them
- Ensure good drainage as they are often present in higher numbers if the soil is wet

Other hosts

- Seedlings and young plants of many crops

Branches	✓
Berries	—
Roots	—

Coffee centre borer or red stem borer

Insect: *Zeuzera coffeae*

Order: Lepidoptera – butterflies and moths

The adult is a moth occurring in most coffee growing areas of PNG although it is only considered a minor pest. The damage to coffee is caused by the **caterpillar stage** of the pest.

Impact

- Leaves of the affected branches wither and eventually die

Description

- The adult moth is grey or white with many small black dots or marks on the wings and body. It has a wingspan of about 4–5 cm. The adults fly to lights at night. It lays a single egg in crevices in the bark on coffee tree branches
- The caterpillars or larvae are strong bodied and reddish in colour with a black head. When they emerge, they bore into the branch of the coffee tree. They burrow their way along the branch making cylindrical tunnels and excrete reddish brown frass which is found at holes on the surface

Factors favouring the pest

- Unhealthy or stressed plants are susceptible to boring insects

Mechanism of dispersal

- Flight by the adult moth

Management

- Prune and burn infested branches
- If infestation is severe remove and burn the whole tree

Other hosts

- Coffee is the main host, but others include citrus, cocoa, tea, kapok and various ornamental trees and shrubs

Leaves & shoots	✓
Berries	—
Roots	—

Coffee leaf roller

Insect: *Homona coffearia*

Order: Lepidoptera – butterflies and moths

The adult is a moth distributed widely throughout coffee growing areas of PNG, and the damage is caused by the larval or **caterpillar stage** of the pest.

Impact

- Coffee trees are defoliated to a degree

Description

- The female adult moth is pale brown and the male dark brown. Larvae are dull green to bluish green with a dark head
- Adults lay eggs in rolled leaves and the hatched larvae feed on new leaf tissue

Coffee leaf roller

Mechanism of dispersal

- Flight by the adult moth

Natural enemies

- Parasitic wasps are common natural enemies of leaf rollers

Management

- Ensure the coffee trees are healthy and resilient to attack by the pest

Other hosts

- Crotalaria, Albizia (mar mar), dahlia, wild hops and silky oak

Leaves & shoots	✓
Berries	✓
Roots	✓

Mealy bug

Insect: *Planococcus* spp.

Order: Hemiptera – sucking insects

A minor pest of coffee, closely related to scale insects.

Impact

- Mealy bugs feed on the sap of the coffee plant and excrete honeydew that attracts ants. This substance also leads to the formation of a black mould that covers leaves and can reduce photosynthesis
- May cause wilting and shedding of leaves and possibly branch dieback. They may also feed on flowers and berries

Description

- Small wingless sucking insects closely related to scale insects
- The body is oval-shaped, flattened, and is covered with a white waxy secretion

Mechanism of dispersal

- Dispersal within and between trees most likely occurs at the immature stage as this is when they are most active
- It is also likely that they are carried short distances by ants that tend to them

Management

- Spray with white oil or soap solution (see recipes on page 32)
- Control ants that tend to their colonies. Destroy ant nests with boiling water

Other hosts

- Many plant species including other crop plants and weeds

Leaves & shoots	–
Berries	–
Roots	✓

Root-knot nematode

Worm: ***Meloidogyne*** **spp.**

Nematodes are not a serious pest of coffee in PNG. Root-knot nematodes are seen in coffee nurseries but are not a serious problem.

Impact

- Infested roots have swellings or galls (like knots)
- Causes stunting and yellowing of the leaves
- Infested plants have a tendency to wilt when under moisture stress

Description

- Nematodes, or eelworms, are small (less than 1 mm in length) round worms that cannot be seen with the naked eye
- They are a soil-borne pest that attack the roots of a wide range of plant species

Objective:

To learn how to identify individual pests and become familiar with appropriate measures to prevent or control them

You will need:

1. **Pest infested coffee trees**
2. **A drop sheet**

EXERCISE 3

Identifying pests in the coffee garden

Discuss with the group:

1. Pest problems being experienced by farmers in the local area
2. Have any of the participating farmers experienced any of these problems?

Observe some coffee trees infested by pests:

1. What are the symptoms of infestation?
2. Place a drop sheet under an infested tree. Shake some branches and observe if any pests fall onto the drop sheet
3. For each tree, use the information in this section of the module and the Plant Health Troubleshooting Guide
   a. Identify the pest/s by:
      - Observing the part of the tree that is infested
      - Using the description of the effects of pests that infest this part of the tree in this module and the Plant Health Troubleshooting Guide
   b. Discuss:
      - The likely causes of infestation
      - Measures that could prevent infestation
      - Methods of control of the pest/s
      - Presence of natural enemies
      - The general health of the coffee trees. How has their health been impacted by the pest/s?

5.5 DISEASES OF COFFEE

Most diseases of coffee are caused by microorganisms called plant **pathogens**. Pathogens include viruses, bacteria and fungi. Some diseases, such as root rot disease, rusts and coffee berry disease (not yet reported in PNG) can impact healthy coffee trees but most diseases only affect trees that have been weakened.

Types of diseases

Fungal diseases

- Most plant diseases are caused by fungi
- Fungi damage plants by killing cells and/or causing plant stress
- Sources of fungal infections include infected seed, soil or crop debris or nearby crops and weeds
- Fungi are spread most commonly by wind and water splash and through the movement of contaminated soil, animals, humans, tools, seedlings and other plant material
- They enter plants through:
  1. Natural openings, such as the tiny pores (stomata) on leaf surfaces where the trees take up carbon dioxide required for photosynthesis
  2. Wounds caused by pruning, harvesting, hail, insects or other diseases

Bacterial diseases

- Bacteria enter plants through wounds or natural openings
- Bacterial diseases can multiply very quickly. Conditions that favour bacterial diseases include high humidity, crowding, poor air circulation, plant stress, poor soil health and a deficiency or excess of nutrients

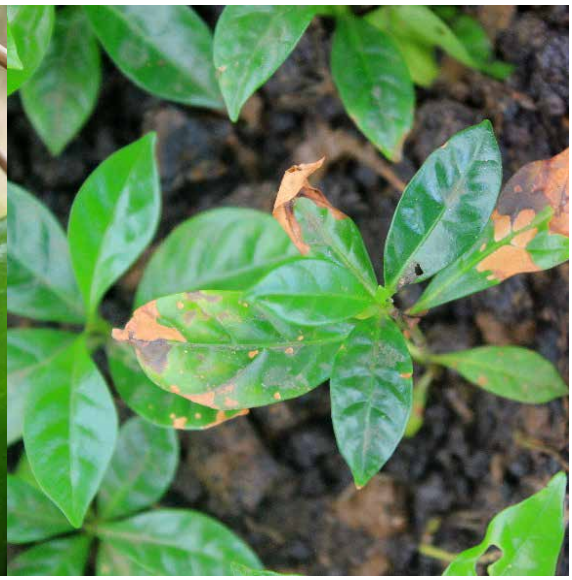
Viral diseases

- Viruses can cause major damage to coffee trees
- They are usually transmitted from one crop to another by an organism called a vector or carrier
- Viruses can also be transmitted by other microorganisms, infected pollen, contact between plants, or by infected seeds or other propagating material

Nutrient disorders

- Nutrient disorders are caused by a deficiency or excess of plant nutrients
- These disorders are not typical diseases but symptoms appear to be disease-like, therefore, they are often mistaken for diseases caused by pathogens
- Often as a result of nutrient disorders, plant growth is slowed, and susceptibility to diseases may increase

Symptoms of nutrient deficiency (*Credit: Bob Kora*).



Symptoms of excessive nutrients applied as a foliar spray (*Credit: Bob Kora*).

Carriers or vectors of disease

- A carrier or vector is an organism that transmits a disease from one host to another
- Many insects are vectors of plant diseases. The most common insect vectors of plant diseases are aphids, thrips and leaf hoppers which are all capable of transmitting diseases using their piercing sucking mouthparts
- Examples of vectors are:
    1. Human disease vector: The Anopheles mosquito transmits malaria from one person to another. It sucks blood containing the malaria pathogen (a parasite) from one person and injects it into another
    2. Plant disease vector: The taro planthopper transmits taro viruses from plant to plant

Which diseases should you look out for?

Although there are many diseases of coffee, some are more common than others. The common diseases that you should look out for are:

Diseases of coffee

Disease	Symptoms	Spread	Harm	Management focus for prevention and control
Coffee leaf rust (CLR) Leaves & shoots ✓ Berries — Roots — 	• Yellow-orange powdery and uneven circles on the underside of mature leaves	• High humidity • Rain • Insects • People • Wind	• Rusted leaves fall to the ground • Low yields • Trees die within a few years	• Weeding • Drainage • Pruning • Shade • Fencing
Leaf and berry spot Leaves & shoots ✓ Berries ✓ Roots — 	• Small brown spots with grey centre on leaves, surrounded by yellow halo • Small, depressed spots on green berries	• Wind • Rain • Contaminated tools and plant material	• Mainly in nursery but can occur on mature trees • Leaf fall, stem dieback if severe • Cherries damaged and may fall	• Shade • Plant spacing
Pink disease Stems & branches ✓ Leaves & shoots — Berries — Roots — 	• Cobweb like strands on stem or branches • White swellings on bark. Later, pink crusts surround stem or branches	• Rain • Wind • Contaminated tools and plant material	• Dieback • Trees may eventually die	• Shade • Pruning • Sanitation (garden & tools)

Diseases of coffee

Disease	Symptoms	Spread	Harm	Management focus for prevention and control
Sooty moulds Leaves & shoots ✓ Berries ✓ Roots — 	• A dark threadlike growth resembling a layer of soot on leaves and also berries	• Sap sucking insects • Air movement • Water splash	• Prevent photosynthesis • Stunt growth • Reduce berry quality	• Manage sap-sucking insects • Shade
Black rot (or tawny thread blight) Leaves & shoots ✓ Berries ✓ Roots —  Thread blight on leaves	• Silvery web on underside of leaves, later, on leaf stalk and stem • Leaves blacken and fall but remain hanging onto the branch by brown fungal threads • Can spread to berries	• Warm and moist conditions • Rain	• Rotting of trees and cherries	• Shade • Sanitation
White thread blight Leaves & shoots ✓ Berries ✓ Roots —  Thread blight on berries	• White threads on stems and under-side of leaves • Leaves dry out and fall but remain hanging onto the branch by white fungal threads • Can spread to berries	• High humidity • Wind • Rain	• Trees lose their leaves • Dieback may result	• Shade • Sanitation
Anthracnose Leaves & shoots ✓ Berries ✓ Roots —	• Leaf yellowing and leaf drop • Small brown-black sunken spots on mature cherries	• High humidity • Rainfall • Poor nutrition	• Leaves defoliate and die at tips • Berries become brown and may fall	• Shade • Pruning

Diseases of coffee

Disease	Symptoms	Spread	Harm	Management focus for prevention and control
Damping off (in the nursery) Stem ✓ Berries ✓ Roots ✓ 	• The seedling stem is soft and rotten	• Contaminated soil • Soil is too wet • Seedling density is too high • Too much shade	• Patches of seedlings quickly die	• Fresh, clean soil • Drainage • Planting density • Watering • Shade
Stem canker Stem ✓ Berries — Roots —	• Confined infection in bark at ground level • Bark becomes soft, dead bark is red-brown to purple when cut • Yellowing, wilting and eventual death of leaves	• Seedlings planted too deeply • Waterlogging	• Trees unhealthy due to yellowing and eventually death of leaves	• Seedling planting depth • Sanitation • Weeding • Correct mulching • Drainage
Root disease Leaves & shoots — Berries — Roots ✓	• Gradual yellowing and wilting of leaves and root decay • Brown, black or red threads or staining below bark	• Root injury, tree stumping • Root contact underground	• Loss of leaves, followed by death of the tree	• Remove whole tree including roots • Delay tree replacement
Overbearing dieback Stems & branches ✓ Leaves & shoots ✓ Berries ✓ Roots ✓ 	• During heavy cropping, twigs and leaves die at tips, then leaf loss and branch dieback • Later, infection by diseases causing brown-black sunken spots on mature and sometimes green berries	• Poor tree nutrition	• Trees dieback and cherries are spoiled by brown spots	• Drainage • Shade • Pruning • Weeding • Mulching

Where are these diseases most likely to occur in PNG?

Whether a disease occurs in an area and how likely it is to persist is determined by the environmental conditions and the pathogen's ability to survive and reproduce. For example, CLR occurs in all coffee growing areas in PNG but is more likely to have greater impact at lower altitudes.

Impact and description of the main diseases of coffee

Coffee leaf rust (CLR)

Leaves & shoots	✓
Berries	–
Roots	–

Fungus: *Hemileia vastatrix*

First reported in PNG in 1986, coffee leaf rust is the most severe disease of coffee plants in PNG.

Impact

- Causes premature leaf fall, meaning trees are unable to carry out photosynthesis (make their own food)
- The trees have to use food reserves in their roots and stems and as a result become undernourished
- The trees may be unable to produce cherry and if they do, the cherries will not ripen fully, producing light beans with a bitter taste
- Dieback of the roots and branches occurs reducing yield and the tree may eventually die
- Increasing temperatures are likely to increase rust severity at higher altitudes

Symptoms

- The first symptoms are small pale-yellow spots on the underside of the leaves
- As the spots increase in size they become powdered with yellow-orange spores
- The spots may merge to form irregular shapes on the underside of the leaves with pale green patches on the upper leaf surfaces
- The presence of just one or two spots on a leaf is likely to cause premature leaf fall
- Young leaves that have not yet fully expanded are not affected

Coffee leaf rust (CLR) *(Source: Pacific Pests, Pathogens & Weeds)*

Factors favouring the disease

- Water on the leaf surface
- Temperature range 15–28 °C
- Poor nutrition
- Heavy shade
- Young fully expanded leaves
- Old or poorly managed trees

Mechanism of dispersal

- Wind
- Rain splash
- Insects
- Humans and equipment

Management

- In areas where CLR is prevalent, it is best to grow CLR tolerant coffee varieties such as Catimor
- Appropriate shade
- Adequate pruning and burning of infected pruning debris
- Adequate soil fertility
- Good drainage and weed management

Other hosts

- None

Leaves & shoots	✓
Berries	✓
Roots	–

Leaf spot and berry spot

Fungus: *Cercospora coffeicola*

Also known as brown eye leaf spot.

This is mainly a disease of seedlings in the nursery but can also occur on poorly managed mature trees.

Impact

- Causes leaf fall and possibly stem dieback, if severe
- Can also infect the berries. Berries are damaged and may shrivel and fall to the ground
- Berries ripen before the beans are mature, resulting in poor coffee quality

Symptoms

- Small brown spots on the leaves. Spots usually have a light brown or grey centre surrounded by a wide reddish-brown ring and a yellow halo
- Causes small, depressed spots on the berries, and if the infection spreads, the whole berry is damaged and may drop to the ground

Brown eye leaf spot

Factors favouring the disease

- Wet weather and high humidity
- Insufficient shade
- Poor nutrition
- Competition from weeds

Mechanism of dispersal

- Wind
- Rain splash
- Survives on undecomposed plant debris and weeds
- Can spread via movement of contaminated soil, animals, humans, tools, seedlings and other plant material

Management

- In the nursery – appropriate shade and adequate nutrition (particularly N and K) and spacing of seedlings to enable good airflow
- Mature coffee – appropriate shade management and pruning to allow good air circulation and adequate nutrition
- Burn any infected pruning debris

Stems & branches	✓
Leaves & shoots	—
Berries	—
Roots	—

CIC Resources

Show participants the poster 'Pink Disease (Sik Pink), Kofi Pepa No. 3

Pink disease

Fungus: *Phanerochaete salmonicolor*

This fungus is widely distributed in PNG, occurring on many tropical crops but it is considered only a minor disease of coffee.

Impact

- Infects mainly the branches of the trees and causes dieback and occasionally death of the tree

Symptoms

- Infection initially appears as fine white threads like cobwebs on stems and branches
- Small white raised swellings appear through cracks and natural openings in the bark
- Later, pink crusts form on the underside of the branches which eventually surround the whole stem or branch causing the outer parts of the stem or branch to die
- Occasionally the fungus appears as orange-red cushion-like structures on the upper surfaces of the branches

Pink disease (*Credit: Bob Kora*)

Factors favouring the disease

- Wet, humid conditions
- Moderate to cool temperatures
- High density plantings
- Inadequate pruning
- Heavy shade

Mechanism of dispersal

- Wind and rain

Management

- If in a pink disease prevalent area, avoid planting the variety Mundo Novo which is known to be susceptible to pink disease
- Appropriate shade. Avoid planting *Leucaena* spp. as a shade tree as it is a host of pink disease
- Adequate pruning to increase airflow
- Disinfection of pruning equipment used to prune diseased trees (could use household bleach, rubbing alcohol, or soapy water)
- Remove and burn infected branches. Do not drag them through the coffee garden as this will spread the disease
- If severe, trees should be stumped
- Remove other infected hosts of the disease if they are growing too close to the coffee trees
- Wash all tools, clothes, and hands before and after dealing with infected trees
- Slashing grasses may increase humidity and the spread of the disease

Other hosts

- There are many hosts but they include cocoa, citrus, rubber, tea, mango, and species of Eucalyptus, Acacia and Hibiscus
- Lamantro or *six mun* (*Leucaena* spp.) which is commonly used as a shade tree in coffee together with Casuarina

Leaves & shoots	✓
Berries	✓
Roots	—

Sooty moulds

Fungi: Many fungal species

Sooty moulds are fungal diseases that grow on plants covered in honeydew, a sweet sticky substance excreted by sap sucking insects such as scales and aphids. Sooty mould grows on the plant parts where the honeydew accumulates; it does not infect the plant.

Impact

- The sooty mould covers the leaves reducing light and preventing photosynthesis (plants cannot make their own food), impacting tree health and stunting plant growth
- Coated leaves may prematurely age and die, causing premature leaf fall
- Sooty moulds may also cover the coffee berries reducing their quality

Symptoms

- A dark threadlike growth resembling a layer of soot
- Commonly found on new growth and leaves, since the insects associated with sooty moulds prefer soft tissues. Black mould may also be found on berries

Sooty mould covering coffee leaves (*Credit: Bob Kora*).

Coffee berries coated in sooty mould (*Credit: Bob Kora*).

Factors favouring the disease

- Presence of sap sucking insects that excrete honeydew such as aphids, scale insects, mealy bugs and leafhoppers

Mechanism of dispersal

- Air movement and water splash

Management

- Manage the insect creating the honeydew. See above for management of aphids, green scale, mealy bugs and leafhoppers
- Sooty mould can be washed off with water, or soap and water
- Keep plants healthy

Other hosts

- Any plants that become infested with sap sucking insects

Stems & branches	✓
Leaves & shoots	✓
Berries	✓
Roots	—

Black rot or tawny thread blight

Fungus: *Koleroga noxia, Corticium koleroga* or *Pellicularia koleroga*

Most common at mid-altitudes and rarely has economic impact in the highlands. The disease spreads quickly in warm and moist conditions.

Impact

- The coffee trees become unhealthy due to leaf fall
- Berries rot and turn black and then drop to the ground when disease is advanced

Symptoms

- Blackening and rotting of affected leaves and young twigs (and berries)
- The fungus grows on the under-side of coffee leaves as a silvery web and later spreads to the leaf stalk and then down the stem
- The stalk dies and the leaf turns black and falls off
- Usually leaves remain hanging from the branch by brown fungal threads
- Green twigs and berries can also be affected

Factors favouring the disease

- Warm, humid conditions
- Excessive shade

Mechanism of dispersal

- Contact between leaves and rain splash

Management

- Appropriate shade and good shade management
- Adequate drainage depending on soil type
- Good weed control
- Adequate pruning to enable good airflow
- Cutting out and burning infected branches on site

Other hosts

- Black pepper, capsicum, citrus, ginger, mahogany and tea

Stems & branches	✓
Leaves & shoots	✓
Berries	✓
Roots	—

White thread blight

Fungus: *Marasmius* spp. and *Corticium* spp.

This disease is similar to back rot. It could be a problem in high rainfall areas

Impact

- The tree loses its leaves and dieback may result

Symptoms

- The white strands of the fungus spread from the stems onto the under-side of the leaves. The affected leaves dry out and detach but do not fall as they are held by the white fungal threads

Factors favouring the disease

- High humidity
- Excessive shade

Mechanism of dispersal

- Air movement and rain splash

Management

- As for black rot

Other hosts

- Many tropical tree crops and herbaceous crops such as pumpkin and pigeon pea

Thread blight on leaves (*Credit: Gure'ahafo Tumae*)

Thread blight on berries (*Credit: Gure'ahafo Tumae*)

Leaves & shoots	✓
Berries	✓
Roots	—

Anthracnose

Fungus: *Colletotrichum* spp.

Most common fungal species causing this disease in PNG are *C. gloeosporioides* and *C. acutatum*

These species are related to the fungus, *C. kahawae*, which causes coffee berry disease in Africa but are not as pathogenic, meaning the impact is much less severe.

Impact

- Yellowing of leaves. Twigs wilt, defoliate and die at the tips
- Also affects ripening berries. If berries are damaged severely, they may turn completely brown then eventually fall to the ground

Symptoms

- Early symptoms are leaf yellowing and leaf drop
- Dark browning of stems and dieback of tips
- Small brown-black sunken spots on mature cherries
- Occurs occasionally on green berries but this is more likely to occur in cooler temperatures at higher altitudes

Factors favouring the disease

- High humidity and rainfall
- Poor nutrition leading to secondary infection by anthracnose causing diseases

Mechanism of dispersal

- Water droplets

Management

- Optimum shade
- Adequate pruning to enable good airflow

Other hosts

- Avocado, mango, papaya

Stems	✓
First leaves (cotyledons)	✓
Roots	✓

Damping off

Fungi (soil-borne): *Pythium* spp., *Rhizoctonia* spp., *Fus*arium spp. or *Phytophthora* spp.

This disease occurs on young seedlings in the nursery.

Impact

- Patches of seedlings die quickly

Symptoms

- Seedlings may fail to emerge or if they emerge the base of the seedling stems near the soil line are soft and rotten, and collapse
- Young leaves (cotyledons) wilt and turn green–grey to brown
- The fungus may be visible as a whitish growth of mould on the rotting plants
- Symptoms may be confused with damage caused by pests such as cutworms, snails or slugs

Young coffee seedling suffering from damping off
(Credit: Michael Kaugam)

Factors favouring the disease

- Wet soil, poor drainage
- Too much shade
- High seedling density; sowing or transplanting too deeply
- Use of green compost or mulch

Mechanism of dispersal

- Water splash
- Wind

Management

- Avoid using soil from old nursery beds
- It is best to establish a new nursery at a different site to those previously used for growing seedlings of any species
- Provide good drainage and avoid overwatering
- Sow seeds at a density that will allow for good air circulation

Other hosts

- Seedlings of almost all crops

Stem	✓
Leaves & shoots	—
Roots	—

Stem canker (collar rot)

Fungus: ***Fusarium*** **sp. and many other fungal pathogens**

Impact

- Once the trees are severely infected, dieback occurs as the leaves turn yellow, wilt, and fall off

Symptoms

- The fungus infects the stem at ground level and grows in the bark around the stem
- Spread of the infection on the inner bark is faster than on the outer bark
- The infected sites are confined and the bark above the infection is usually soft
- The region under the infected bark is reddish brown to purple when cut

Factors favouring the disease

- Seedlings planted too deeply
- Waterlogging

Mechanism of dispersal

- Water splash

Management

- Avoid planting seedlings too deeply
- Keep weeds and mulch well clear of the main stem
- Remove weeds from around stems
- Provide good drainage
- Uproot and burn affected plants at the site

Stem	–
Leaves & shoots	–
Roots	✓

Root disease or root rot

Fungi: Caused by several different fungi

Includes: *Phellinus noxius* (brown root rot), *Rosellinia* sp. (black root rot), *Fomes lignosus* (red root rot) and *Fusarium* sp.

Root rot diseases are not a serious problem in PNG.

Impact

- Unhealthy trees due to leaf wilt and decay of the roots

Symptoms

- General yellowing and wilting of the leaves on the whole tree
- There may be brown, black or red threads or staining below the bark depending on the fungus causing the infection

Factors favouring the disease

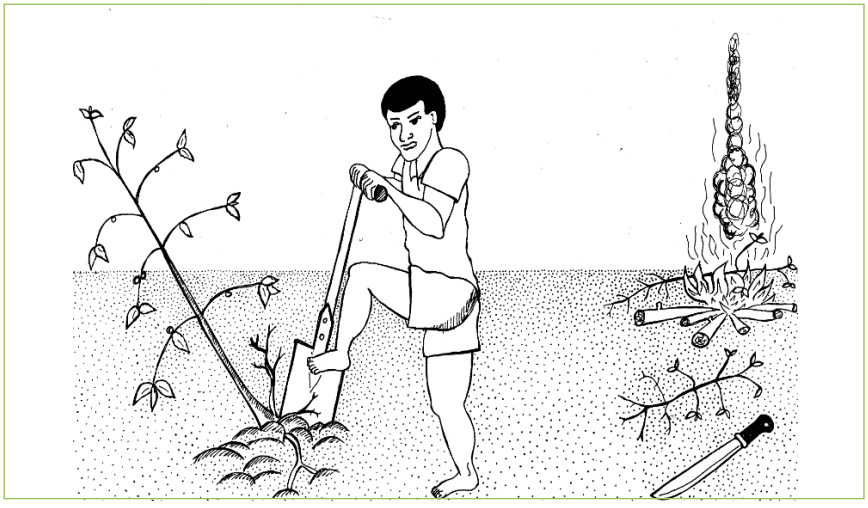
- Poorly managed trees
- Inappropriate shade
- Poor soil nutrition
- Poor drainage
- Root injuries caused by equipment, insects or nematodes

Mechanism of dispersal

- Contact with the root system of a recently infected tree or the roots of a tree that has been left to decay when clearing the coffee garden

Management

- Keep trees healthy as stressed trees are more susceptible to infection
- Remove and burn any diseased trees, including the roots, on site. Do not move the infested trees around the coffee garden
- Delay replacement of diseased trees for 3–4 seasons to ensure the disease has disappeared
- If the neighbouring trees are healthy, it is advisable to dig a separation drain to prevent spread



Trees affected by root rot should be completely uprooted and burnt on site (*Credit: Bob Kora*).

Stems & branches	✓
Leaves & shoots	✓
Berries	✓
Roots	✓

Dieback

This is not a disease but a condition where the **coffee trees are under a lot of stress**, making them **susceptible to infection** by fungal diseases such as anthracnose, leaf spot and Fusarium wilt. Dieback is often the result of overbearing and insufficient nutrition.

Impact

- Branches die back and leaves wilt and fall
- Berries ripen prematurely and become hard and black and susceptible to disease
- Dieback causes alternating bearing (heavy crop one year and poor crop the next)
- Plants weaken and eventually die if the problem is not corrected in the early stages
- Infections cause brown-black sunken spots on mature berries and occasionally on green immature berries
- In a more advanced stage on the affected branches, the berries die and fall to the ground

Symptoms

- First signs of dieback are when twigs and leaves begin dying at the tips
- The stressed trees become infected by disease turning the stems and branches dark brown
- In later stages there is severe leaf loss and branch dieback
- Fungal diseases cause brown-black sunken spots on mature and occasionally on green immature berries

Coffee trees suffering from severe dieback (*Credit: Bob Kora*).

Factors favouring the condition

- Poor nutrition
- Inadequate shade
- Waterlogging

Management

- In young trees, formative pruning is essential (*Refer to Farmer Training Guide Unit 2, Module 2 'Maintenance pruning and rehabilitation' for further information*)
- Good weed control, mulching
- Leguminous cover crops
- Adequate shade
- Suitable drainage

Objective:

To learn how to identify a disease and be familiar with the appropriate measures to prevent or control it

You will need:

Specimens of disease affected coffee leaves, branches and cherries and coffee disease posters

EXERCISE 4

Identifying diseases in the coffee garden

Discuss with the group:

1. Disease problems being experienced by farmers in the local area
2. Have any of the participating farmers experienced any of these problems?

Observe some coffee trees infected by disease/s:

3. What are the symptoms of infection?
4. For each tree, use the information in this section of the module, the pest and disease posters and the Plant Health Troubleshooting Guide
   a. Identify the disease/s by:
      - Observing the part of the tree that is infected
      - Using the description of the effects of diseases that infect this part of the tree in this module, the posters and the Plant Health Troubleshooting Guide
   b. Discuss:
      - The likely causes of infection
      - Measures that could prevent infection
      - Methods of controlling the disease/s
      - The general health of the coffee trees. How has their health been impacted by the disease/s?
      - Is the disease a secondary infection? Is it a result of the tree firstly being infested by a pest?

5.6 NATURAL ENEMIES 'FRIENDS OF COFFEE'

What are natural enemies?

- Natural enemies of pests and diseases are organisms that kill, decrease the ability to reproduce, or otherwise reduce the numbers of a pest or disease
- Types of natural enemies of pests and diseases include:
  1. **Parasites:** A parasite is an organism that lives in or on a pest or disease (a host) and depends on the host for food and shelter. The parasite obtains these things at the expense of the host impacting its health and sometimes causing its death
  2. **Pathogens:** Disease-causing organisms
  3. **Predators:** Animals that hunt, kill and eat other animals
- Natural enemies may be considered 'friends of coffee' as they help to control some of the pests and pathogens that commonly attack coffee and reduce its health and productivity

What is the mode of action of natural enemies?

- The mode of action of natural enemies is to either eat or parasitise the pest or disease

What are some examples of natural enemies?

- Natural enemies may include birds, insects, spiders, mites, nematodes or disease pathogens (e.g., bacteria, viruses and fungi)

- An example of a natural enemy of CBB is the fungus *Beauveria bassiana.* When it makes contact with a CBB it germinates and grows throughout the insect's body. While growing, it produces toxins and drains the insect of nutrients, eventually killing it
- Parasitoids are insects whose larvae develop on or within their hosts eventually killing them. They have characteristics of both predators and parasites and there are many that attack insect pests of coffee. The most common parasitoids are certain species of wasps

How to encourage the presence of natural enemies in your coffee garden

- Many natural enemies of coffee pests and diseases exist in nature and can be encouraged by certain management practices
- Having a diversity of plants in your coffee garden along with optimum shade cover, good drainage and a covering of mulch will encourage a diversity of natural enemies of coffee pests and diseases
- See previous sections of this module on how to encourage natural enemies of some of the individual pests and diseases of coffee

CIC Resources

Show participants the poster 'A field guide manual of friends of coffee farmers in Papua New Guinea'

The following are some of the natural enemies that should be encouraged in your coffee garden:

Lady beetles

Parasitic wasps sting their host (e.g., scale insect) to inject their eggs. The larvae develop inside the host then emerge, usually killing the host, (left) parasitic wasp; (right) parasitic wasp exit hole from a dead scale.

White fungus killing coffee green scale

Spider killing an insect

Green coffee berry infected with the CBB-killing fungus, *Beauveria bassiana* (*Credit: Donna Chambers*)

Objective:

To understand good crop management practices that minimise the impact of pests and diseases and encourage their natural enemies

You will need:

Access to a healthy and productive coffee garden

EXERCISE 5

Good practices in crop management

Discuss with the group:

1. The health status of the coffee garden
2. The good crop management practices used in prevention of attack by pests and diseases or in minimising their impact (e.g. coffee variety, plant spacing, shade trees, mulch, drainage, pruning, weed status, plant diversity, etc.)

5.7 KEY MESSAGES

The important messages for farmers are:

- For smallholder coffee farmers, pests and diseases can account for 30–40% of lost production. Losses from CBB can be up to 90% if the pest is not managed
- It is important to know which pests and diseases to look out for and understand the factors that favour their development
- Conditions in the coffee garden are always changing so it is important to remain vigilant. These changes are in the growth stage of the crop, management practices, changes in pest and disease types and populations, and seasonal changes
- 'Prevention is better than cure' – It is better to manage the coffee garden appropriately to prevent pests and diseases becoming established, rather than trying to control them once they have impacted the crop
- To prevent attack by pests and diseases, or to minimise their impact, it is important to encourage growth of healthy trees, produce an environment that is unfavourable for pests and diseases and provide an environment that favours natural enemies
- Strong and healthy coffee trees are less susceptible and more resilient to attack by pests and diseases than are weak trees
- Good farming practices used at all stages of the coffee production process are the key to minimising the impact of pests and diseases. Key elements in the process include the coffee variety and seed, soil fertility and land use, land preparation, shade trees, garden establishment, pruning, disposal of affected plant material, weeding, sanitation during harvest and post-harvest, and constant monitoring
- While there are a number of coffee pests to look out for, the most significant are the coffee berry borer, which is the most destructive pest of coffee, and green scale which is a major pest, particularly of seedlings and young coffee trees
- There are also several diseases of coffee with the most severe being coffee leaf rust. Brown eye spot is also a significant disease, particularly of seedlings and poorly managed mature trees

5.8 QUIZ

Place a '✓' in the correct box.

1. The impact of pests and diseases on coffee is **primarily** dependent on:

- A Soil fertility
- B Plant spacing
- C Environmental conditions
- D Shade levels

2. What is the key to minimising the impact of pests and diseases in a coffee garden?

- A Using the chemical that is most effective against the pest or disease
- B Good general crop management to keep trees strong and healthy
- C Good pruning technique to encourage new, healthy growth
- D Effective nutrient recycling so trees are provided with sufficient nutrients for healthy growth

3. In areas where coffee trees have suffered from root diseases, delay replanting with new coffee seedlings in the same location for at least:

- A 6 months
- B 1 year
- C 2 years
- D 3 years

4. When pruning coffee trees that have been attacked by pests or diseases:

- A Burn or bury the pruning debris on-site
- B Leave the pruning debris on-site so that it provides the coffee trees with nutrients as it decomposes
- C Carry the pruning debris out of the coffee garden
- D It is better not to prune as this will spread the pest or disease to other trees

5. The **risk of outbreak** of a pest or disease in a coffee garden is determined by a combination of **three** factors. These include:

- A The age and health of the coffee garden and the presence of other host plants
- B The point in the coffee production cycle and the presence and abundance of a pest or disease in the area
- C The pest or pathogen, the host (coffee trees) and the environment
- D The time of year, temperature and humidity

6. Attack by which pest of coffee is mostly confined to new growth, seedlings and young coffee trees?

A Coffee berry borer (CBB)
B Green scale
C Leaf hoppers
D Coffee ring borer

7. Attack by which pest of coffee is mostly confined to the berries?

A Coffee berry borer (CBB)
B Green scale
C Leaf hoppers
D Coffee ring borer

8. The key to control of CBB is:

A Having strong and healthy coffee trees
B Providing optimum shade
C Removal of all weeds from the coffee garden that may harbour the pest
D Removal of all potential breeding sites for the pest

9. Which disease of coffee is characterised by the following symptoms: Circular brown spots with grey centres surrounded by yellow halos?

A Coffee leaf rust (CLR)
B Pink disease
C Black rot
D Brown eye leaf spot

10. Which disease of coffee is characterised by the following symptoms: Yellow spots powdered with yellow-orange spores on the underside of leaves?

A Coffee leaf rust (CLR)
B Pink disease
C Black rot
D Brown eye leaf spot

11. The majority of plant diseases are caused by fungi. The **most common** mechanisms of dispersal of coffee fungal diseases are:

- A Wind and insect vectors
- B Rain splash and insect vectors
- C Wind and rain splash
- D Wind and movement of old plant material

12. Which of the following crops should not be intercropped with coffee trees as it is also a host of coffee ring borer?

- A Cabbage
- B Kaukau
- C Peanut
- D Pumpkin

13. Which of the following measures will **not** help to prevent attack by pests and diseases in a coffee garden?

- A Using recommended plant spacings
- B Pruning coffee and shade trees
- C Spraying coffee trees with chemicals
- D Controlling weeds

14. Which of the following are natural enemies of a coffee pest?

- A *Beauveria bassiana* fungi
- B Parasitic wasps
- C Lady beetles
- D Birds
- E All the above

15. True or False

	True	False
a. To avoid infestation by pests, coffee seedlings should not be planted in old kaukau gardens for at least 12 months after kaukau was last grown.	☐	☐
b. Coffee trees planted at high densities are less likely to be attacked by pests and diseases.	☐	☐
c. Heavy shade is favourable for the survival of many pests and diseases of coffee.	☐	☐
d. Growing cover crops increases the diversity of pests and diseases of coffee.	☐	☐
e. The coffee berry borer only attacks mature red cherries.	☐	☐
f. It is better to implement measures that prevent attack by pests and diseases of coffee than implement control measures after attack has occurred.	☐	☐

Answers to quiz questions

Multiple choice

1. The impact of pests and diseases on coffee is primarily dependent on:

   Answer = C. Environmental conditions

   Section 5.1: Even though a pest or disease may be prevalent in a coffee growing area does not mean it will cause a serious economic problem. Soil fertility, plant spacing, and shade levels may have some effect on pests and diseases, but their impact on coffee is primarily dependent on environmental conditions.

2. What is the key to minimising the impact of pests and diseases in a coffee garden?

   Answer = B. Good general crop management to keep trees strong and healthy

   Section 5.2: Strong, healthy and resilient coffee trees are less susceptible to attack by pests and diseases compared with weak and unmanaged trees. Also, if attack does occur, they are more likely to recover faster and overcome the impact.

3. In areas where coffee trees have suffered from root diseases, delay replanting with new coffee seedlings in the same location for at least:

   Answer = D. 3 years

   Section 5.2: Root diseases may persist in the soil for some time after diseased trees have been removed. It is best to delay planting coffee trees for at least 3 years in areas where any trees have suffered from root diseases.

4. When pruning coffee trees that have been attacked by pests or diseases:

   Answer = A. Burn or bury the pruning debris on-site

   Section 5.2: It is best to burn or bury the prunings on site as carrying them through the coffee garden may spread the pest or disease to unaffected trees.

5. The risk of outbreak of a pest or disease in a coffee garden is determined by a combination of three factors. These include:

   Answer = C. The pest or pathogen, the host (coffee trees) and the environment

   Section 5.3: The three interacting factors affecting the risk and severity of a pest or disease are the pest or pathogen, the host (the coffee trees), and the environmental conditions.

6. Attack by which pest of coffee is mostly confined to new growth, seedlings and young coffee trees?

   Answer = B. Green scale

   Section 5.4: Young seedlings, new shoots and suckers are preferred by green scale as they can easily access the sap through the softer tissue.

7. Attack by which pest of coffee is mostly confined to the berries?

   Answer = A. CBB

   Section 5.4: All life stages of CBB develop inside the coffee berries. Adult females bore holes in developing berries, reproduce inside the berries and then the immature CBB feed on the developing coffee beans.

8. The key to control of CBB is:

   Answer = D. Removal of all potential breeding sites for the pest

   Section 5.4: The key to control of CBB is removal of every potential breeding site for the pest in order to break its life cycle

9. Which disease of coffee is characterised by the following symptoms: Circular brown spots with grey centres surrounded by yellow halos?

   Answer = D. Brown eye leaf spot

   Section 5.5: Brown eye leaf spot appears as small brown spots on the leaves. The spots usually have a light brown or grey centre surrounded by a wide reddish-brown ring and a yellow halo.

10. Which disease of coffee is characterised by the following symptoms: Yellow spots powdered with yellow-orange spores on the underside of leaves?

    Answer = A. Coffee leaf rust (CLR)

    Section 5.5: The first symptoms of CLR are small pale-yellow spots on the underside of the leaves. As the spots increase in size, they become powdered with yellow-orange spores. The spots may merge to form irregular shapes on the underside of the leaves with pale green patches on the upper leaf surfaces.

11. The majority of plant diseases are caused by fungi. The most common mechanisms of dispersal of coffee fungal diseases are:

    Answer = C. Wind and rain splash

    Section 5.5: Fungi are spread most commonly by wind and water splash and through the movement of contaminated soil, animals, humans, tools, seedlings and other plant material.

12. Which of the following crops should not be intercropped with coffee trees as it is also a host of coffee ring borer?

    Answer = B. Kaukau

    Section 5.4: The main host of the coffee ring borer is kaukau, but it also attacks coffee, therefore, kaukau should not be intercropped with coffee.

13. Which of the following measures will not help to prevent attack by pests and diseases in a coffee garden?

    Answer = C. Spraying coffee trees with chemicals

    Section 5.2: Chemicals are used mostly for the control of pests and diseases, not prevention. It is better to use preventative measures such as good coffee garden establishment and maintenance to prevent attack by a pest or disease, or at least minimise its impact if attack does occur.

14. Which of the following are natural enemies of a coffee pest?

Answer = E. All the above

Section 5.6: There are many natural enemies of coffee pests including certain: parasites, such as parasitic wasps; pathogens, such as fungi; and predators such as beetles, birds and ants.

15. True or False

a. To avoid infestation by pests, coffee seedlings should not be planted in old kaukau gardens for at least 12 months after kaukau was last grown.
Answer = TRUE

b. Coffee trees planted at high densities are less likely to be attacked by pests and diseases.
Answer = FALSE

c. Heavy shade is favourable for the survival of many pests and diseases of coffee.
Answer = TRUE

d. Growing cover crops increases the diversity of pests and diseases of coffee.
Answer = FALSE

e. The coffee berry borer only attacks mature red cherries.
Answer = FALSE

f. It is better to implement measures that prevent attack by pests and diseases of coffee than implement control measures after attack has occurred.
Answer = TRUE

5.9 SOURCES OF FURTHER INFORMATION

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