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SMALLHOLDER COFFEE PRODUCTION IN PAPUA NEW GUINEA – FARMER TRAINING GUIDE

UNIT 2: MANAGING YOUR COFFEE GARDEN

# MODULE 6:
## COFFEE BERRY BORER MANAGEMENT

*Hypothenemus hampei*
The Coffee Berry Borer

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

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# MODULE 6:

## COFFEE BERRY BORER MANAGEMENT

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

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

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

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

## ACIAR Resource

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

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

## CARE Resources

Organisational Strengthening Training
CARE Family Money Management Training

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

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

## Extension Officer Training Program

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

## Farmer Training Program

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

# CONTENTS



## MODULE TOPICS

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# ACKNOWLEDGEMENTS

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Improving Livelihoods of Smallholder Coffee Communities in Papua New Guinea (ASEM/2016/100)

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# INTRODUCTION

**Aim of Module:**

The aim of this module is to inform smallholder farmers about CBB: why it is a pest; how it reproduces and spreads; and the best management practices for control.

Coffee Berry Borer (CBB) is the most damaging pest of coffee worldwide. The pest reduces coffee bean yield and quality and therefore farmer incomes. It is difficult to control as it completes its entire life cycle in the coffee berry. Smallholder incomes from coffee can be maintained or even improved if simple management practices are adopted to manage the pest.

## LEARNING OUTCOMES:

- Why CBB is a pest and how to identify it in your coffee garden
- The life cycle of CBB and how it reproduces and spreads
- The best and most labour-efficient practices to adopt for control of CBB

## LESSON PLAN:

The module has two parts:

Sections 6.1 to 6.2 Understanding CBB: why it is a pest; how it reproduces and spreads

Sections 6.3 to 6.6 Methods of CBB control

## TIME REQUIRED TO COMPLETE THIS MODULE: 3 DAYS

## LIST OF SYMBOLS:

Farmer notes, brochures & factsheets

Information for farmers that must be taken very seriously

For the extension officer

Danger - Poison

## TEACHING AIDS:

- Farmer notes, CBB brochures and factsheets
- The coffee calendar and stickers
- Coloured white board markers and white board eraser
- Posters
- See the Pre-Training Activities below for what is required for each demonstration and exercise

## PRE-TRAINING ACTIVITIES:

- Source sufficient copies of farmer notes, CBB brochures and factsheets for training participants
- Demonstration 1. Collect a small quantity of CBB-infested coffee berries at different stages of maturity, from immature (green) to overripe (black-raisin). Treat the berries to destroy all life stages of CBB by dropping in boiling water or leaving in a plastic bag in the full sun for at least 48 hours
- Demonstration 2. Source single copies of Farmer Training Modules on coffee garden establishment and management, and coffee harvesting and processing
- Demonstration 3. Collect 'clean' coffee berries at different stages of maturity from immature (green) to overripe (black-raisin)
- Exercise 1. Collect cherries with symptoms of CBB attack and cherries with symptoms of weevil attack. Treat the cherries to kill any living CBB or weevils. If undertaking the further activities, organise a visit to a coffee garden to identify the presence of CBB
- Exercise 2. Source Farmer Notes with key activities from all other modules that minimise the impact of CBB
- Exercises 3-5. Organise access to a coffee garden where harvesting is currently taking place. Source 3-4 harvesting bags, large bucket (minimum 20L), shovel, large dark-coloured/black bucket with sealable lid, tarpaulin, and rocks or timber for securing the tarpaulin. If there is no water source at the coffee garden, take water for the float test

# 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 berry 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

    - Working with the farmer group, attach stickers to complete each row of the coffee calendar
    - Begin by attaching the progressive stages of coffee berry development from flowering through to high-value bright red cherry, 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 CBB management listed below

**CBB management**

In an established coffee garden, and depending on the time of year and the stage of coffee crop development

1. Maintain coffee trees to keep them strong and healthy
2. When harvesting, pick **every 1 to 2 weeks** and pick all coloured berries (red, purple and black), keeping CBB-infested berries separate from ‘clean’ berries
3. After the final harvest of the season, strip pick all berries from the trees

    Alternatively, farmers wanting to harvest year round, or for extended seasons, can leave the green berries on the trees and pick all other berries

4. Before commencing cherry processing, float test the cherries and separate all floaters from ‘clean’ cherries because floaters are likely to contain CBB

## Quiz

- Refer to the Quiz located at the end of this module and have farmers complete the questions. This will give the extension officer an idea of the level of knowledge the training participants have of CBB control

- Repeat the Quiz on completion of the module topics

# 6.1 COFFEE BERRY BORER AND ITS IMPACT ON COFFEE PRODUCTION

## What is the coffee berry borer (CBB)?

The **coffee berry borer** (CBB), *Hypothenemus hampei*, is a small species of beetle that lives, feeds and breeds inside coffee berries. The beetles consume the seed or bean which is the marketable portion of the coffee cherry.

## Why is CBB a pest?

The coffee berry borer:

- Is the most devastating pest of coffee worldwide
- Causes serious economic losses through cherry fall, decreased **yield** and reduced **bean quality**
- Can infest up to 95% of cherries in unmanaged coffee gardens and infestations can spread relatively quickly
- Is endemic to Central Africa and has spread throughout most coffee-producing countries of the world
- Was first detected in PNG in Banz, Jiwaka, in February 2017 and since then has spread to other highland provinces where coffee is primarily grown
- Since its arrival in PNG, coffee growers have experienced a reduction in coffee quality and price, and an increase in production costs

## The purpose of this module

- CBB will eventually become established in most coffee producing areas in PNG, so people will have to learn to live with this pest
- This module has not been developed to provide recommendations to farmers on how to eradicate the pest from their coffee gardens as this has not proved possible in other coffee growing countries
- Instead, the module has been developed to provide recommendations for farmers on how to minimise the impact of CBB on coffee production so that famers can continue to produce quality coffee (and potentially even improve coffee quality)

## How can you tell if CBB is present in your coffee garden?

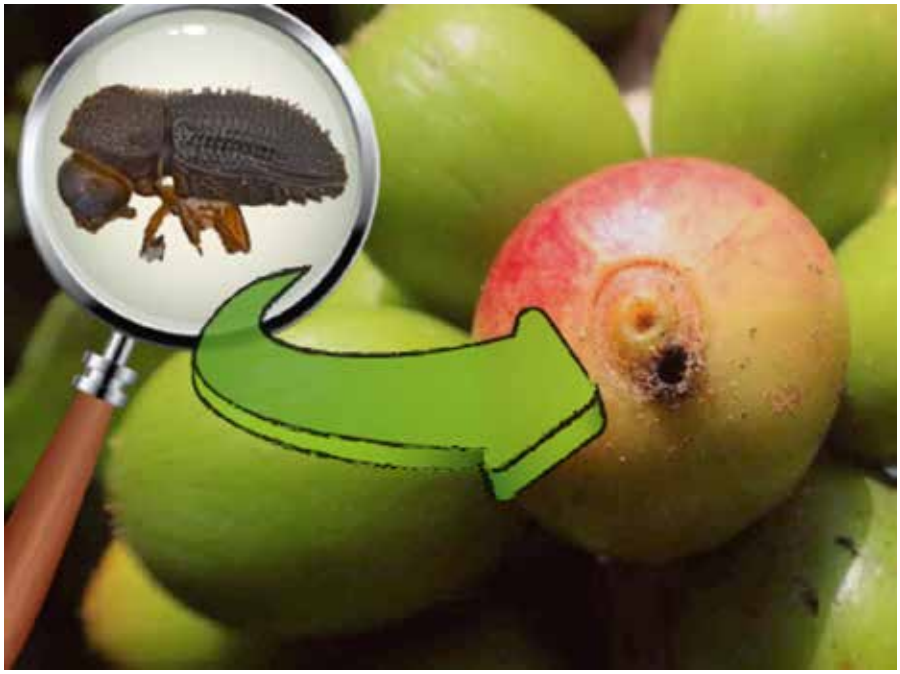
- CBB is a type of bark beetle. Many bark beetles feed on the inner bark of trees but some feed on the fruit or seeds. CBB feeds on the seeds (or beans) of coffee
- The adults are black and are 1.4-1.8 mm in length. The head and body are uniform in colour


The coffee berry borer (a) Side view and (b) Top view
*(Source: https://edis.ifas.ufl.edu/publication/FR447)*
*Credit: Andrew Johnson, UF/IFAS*

- Many beetles can often be found in a single coffee berry
- Immature stages (eggs and larvae) occur within berries and remain there until adults
- There are many similar and mostly harmless bark beetles present in PNG which can be misidentified as CBB

- Holes bored in the end of the berry opposite the stalk are an indicator of the presence of CBB
- If you think you have found CBB in your coffee garden, and it is not known to be in the area, it is important to report it to your local CIC extension officer and have its identity confirmed

CBB on a split green berry

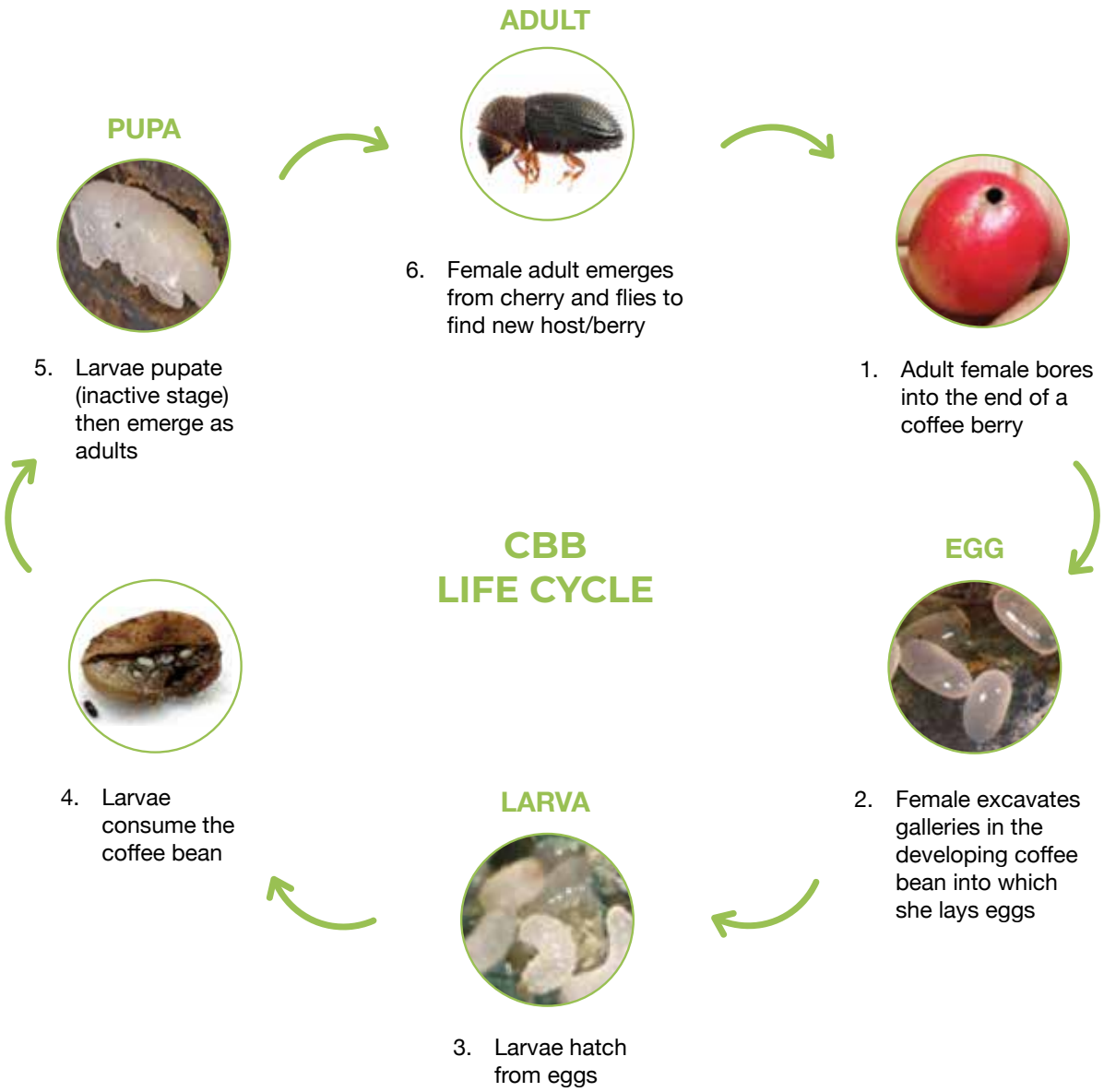


Holes bored in the end of the berry opposite the stalk are an indicator of the presence of CBB
*(Source: Comunicaffe International and http://onebugaday.blogspot.com/2014/11/coffee-berry-borer.html)*

# 6.2 CBB LIFE CYCLE, DISPERSAL AND DISTRIBUTION

## Life Cycle of CBB

- The entire life cycle of CBB is completed within the coffee berry
- CBB has 4 life stages — egg, larva, pupa and adult




Life cycle of CBB (3.5 to 9 weeks)

*Sources of images: (1) CIC; (2, 3, & 5) Ishakh Pulakkatu Thodi & Mark Wright, UH/CTAHR; (4) Jiri Hulcr, UF/IFAS; (6) Andrew Johnson, UF/IFAS.*

- The length of the life cycle from egg to adult depends on temperature, altitude and the maturity of the bean, and can range from 3.5 to 9 weeks (shorter life cycle in warmer climate)
- The female will be ready to reproduce 2-5 days after reaching the adult stage
- Females will mate before leaving the original berry, meaning they are immediately ready to lay fertile eggs
- Once mated, females either lay eggs in the same berry or leave the berry in search of another one to colonise
- When infestations are heavy more than one female may colonise a berry and a single berry can support several generations of CBB
- Males do not leave the berry and do not fly
- Females can live for up to 5 months. Some have been found to survive for up to 8 months in dried or overripe berries
- Depending on the climate and availability of coffee berries, up to 9 generations of CBB can be produced in one year

## How does CBB damage coffee berries?

- CBB is only a pest of the coffee berries. It does not damage any other part of the coffee tree (only very rare occurrences when infestations are severe)
- The female CBB bores a single hole into the floral disc of the coffee berry (the tip at the opposite end to the stalk). The entrance hole is circular and less than 1mm in diameter

Holes bored by CBB in green and red berries

- The female excavates galleries in the berry into which it lays its eggs
- The eggs hatch and the larvae (immature stage) feed on the developing coffee bean, that is, the part that is marketed
- Infestation results in premature berry drop or reduced bean weight, poor bean quality and therefore a lower price
- Infested berries may also become infected by diseases and infested by other pests

Coffee berries infested with CBB

Demonstration 1:
CBB Life cycle

Using infested coffee berries, show the farmers examples of the different life stages of CBB (eggs, larvae, pupae & adults)

Point out the hole bored by the female and the galleries excavated inside the berries containing immature stages of CBB

Note: Ensure all life stages of CBB in the infested berries are dead to prevent further spread

Parchment coffee with CBB damage

## At what stages of development is a coffee berry susceptible to attack by CBB?

- Infestation by CBB can occur anytime during development of the berry up until it is fully ripe (bright red/maroon)
- CBB may begin to attack when the bean begins to form inside the immature green berry at around 100-150 days (3.5-5 months) after flowering
- If the berry is too young (the bean has not yet started developing inside), the female will either abandon the berry or wait in the bored tunnel until the coffee bean (endosperm) has developed and the moisture content has decreased
- Overripe cherries or raisins can be heavily infested with CBB

Green berries infested with CBB

CBB-infested overripe and raisin berries

## Development of coffee cherry from flowering to harvest and the stages of berry development susceptible to infestation by CBB

Flower buds form in the leaf axils. A dry period followed by rain and pruning of shade trees stimulates the tree to flower

**1-5 weeks Flowers open**

The fertilised flower bud that looks like a pinhead sits inside the flower. There is little change in size or weight during this stage


**+ 7 weeks Pinhead dormancy**

Tissue inside the berry expands

The amount by which the berry expands is dependent on the environmental conditions. Adequate moisture, sunlight and nutrients are required for large beans to develop


**+ 10 weeks Rapid berry development**

The tissue inside the berry is consumed by the developing beans

**+ 6 weeks Bean formation**

From when the beans begin to form, the berry becomes susceptible to CBB. CBB will attack from the first 6-9 weeks of bean development if there is no red cherry available. Red cherry is the preferred food source for CBB.

At the end of bean formation the remaining tissue inside the berry becomes the silver skin around each bean

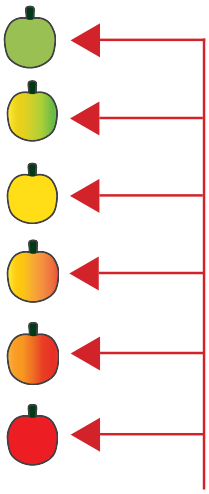
The beans gain weight using a large amount of energy produced by the tree. The tree will not grow during this phase as it is using all of its energy and nutrients to produce berries


**+ 12 weeks Bean weight gain**

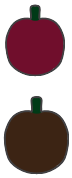
The berry ripens changing from green to yellow-orange, then to bright red cherry


**+ 6 weeks Final ripening**

**CBB re-infests other berries**



As the cherry over-ripens it will turn purple and eventually brown. Overripe cherry is often heavily infested with CBB and must be removed from the coffee tree to prevent further infestation of other berries in the coffee garden.




**Cherry over-ripens**

**CBB exits**

As the cherry over-ripens most adult CBB will exit and re-infest other berries.

## Other hosts

- Arabica and Robusta coffee are the primary hosts of CBB
- Although CBB has been found feeding and seeking shelter on other plant species when coffee berries are unavailable, there is no firm evidence that it can complete its life cycle in any other plants

## Dispersal

- Dispersal mechanisms include long and short distance flight, hitchhiking on animals, humans, vehicles and air currents
- Females can fly up to a distance of half a kilometre. Flight activity is generally confined to mid-afternoon
- Flight activity is influenced by maturity of berries and environmental conditions (e.g. CBB prefers berries with >20% dry matter and increased temperature and humidity)
- CBB boring activity is highest between 12:00 midday and 5:00 pm, so CBB females may be observed on the berries at this time
- Movement of infested cherries and parchment coffee are also modes of dispersal of CBB
- Movement of cherries or undried parchment is one of the main methods of long-distance dispersal to uninfected regions
- Females will remain in berries left on the plant or ground following harvesting until conditions are suitable for dispersal. These old coffee berries (raisins) become reservoirs of the pest to seed new infestations of CBB
- As berries over-ripen most adult CBB will exit and re-infest other berries in the coffee garden
- Sources of subsequent dispersal and new infestations of newly formed berries include:

  1. Berries left on trees after harvest
  2. Berries that have fallen on the ground or dropped during harvesting
  3. Berries on pruned branches

- Passive dispersal can occur when materials contaminated with CBB are moved from one place to another. These materials include:

  1. Coffee bags used during harvesting
  2. Harvesting equipment
  3. Vehicles
  4. Clothing
  5. Infested beans

## Distribution

High risk areas for infestations are:

- Areas close to processing facilities
- Areas where there are infested neighbouring coffee gardens
- Neglected or abandoned coffee gardens and wild coffee plants
- Areas of elevated shade or humidity (Note: these conditions also favour soil and water conservation and nutrient availability, and support a diversity of natural enemies of CBB)

**Objective:**

**How to find out if you have CBB in your coffee garden**

**You will need:**

**White board marker and marker pen**

**Coffee berries with symptoms of CBB attack**

**Coffee berries with symptoms of weevil attack**

**(Note: Ensure the berries have been treated to kill the pests)**

# EXERCISE 1

## Identifying CBB

If there is a large number of participants, divide them into smaller groups of 4-5

**Part one: Recognising the presence of CBB in your coffee garden**

Ask the group/s to discuss some of the methods of identifying the presence of CBB in a coffee garden. Things they should consider include:

I. Are berries beginning to develop on the coffee trees (4-5 months after flowering)?

II. Monitor for CBB activity on the berries, particularly in the afternoons

III. If activity is observed, are the beetles CBB or another type of beetle (adult CBB are black all over and 1.4-1.8 mm long)? It is most likely CBB if it is known to be in the area

IV. Check berries for any sign of boring activity. Do any berries have holes in the end opposite the stalk?

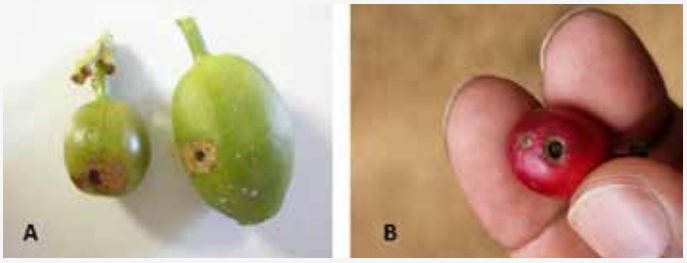
V. If CBB is present, what do you think its source may have been (e.g. old raisins on trees, infested berries left on the ground, neighbouring coffee gardens)?

**Part Two: Differentiating CBB symptoms from those of other pests**

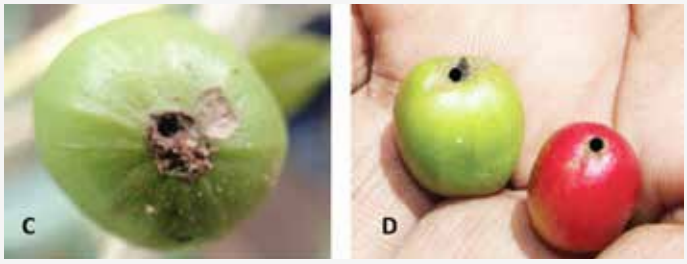
CBB damage is often confused with damage caused by other pests.

I. Show the groups the photos of CBB damage and weevil damage

Damage caused by weevils




Damage caused by CBB




II. CBB always bores into the end of the berry. How does the damage differ from that caused by weevils?

III. Show the groups some berries that have been attacked by either CBB or weevils and note the differences

After completing the activities in Parts One and Two ask the groups to contribute to a whole group discussion on identifying CBB. List the methods of identification of CBB on the white board.

**Further activities if in a CBB affected area**

Visit a coffee garden

IV. Observe coffee berries on the coffee trees and look for any signs of infestation by CBB

V. Dissect some berries to determine if CBB is present

VI. Look for raisins on the ground. Dissect the raisins to determine if CBB is present

**These activities can only be undertaken pending strict quarantine measures**

# 6.3 MEASURES TO MINIMISE THE IMPACT OF CBB

CBB is a very difficult pest to control even in well-resourced plantation settings. To continue coffee production in the presence of CBB, it is important for farmers to adopt measures in their production system that minimise its impact.

## Why is CBB so difficult to control?

- Because the entire life cycle of the coffee berry borer is completed within the coffee berry it is extremely difficult to control. The berry provides it with protection from potential predators, diseases and pesticides

- Characteristics that make it a successful pest:

  1. Very small
  2. Produces a lot of offspring
  3. Produces several generations per season
  4. Hides inside coffee berries giving it protection from the environment, natural enemies and pesticides

## What is the the most effective CBB control method for smallholders?

- Many methods of CBB control have been trialled including the use of synthetic chemicals and biological control agents. However, these are costly, not always effective and synthetic chemicals can be toxic to the environment and to those applying them

- The only way to effectively control CBB is by **interrupting its life cycle** so that it cannot continue reproducing

- The most widely recommended and effective method used to interrupt the pest's life cycle is through **cultural control**

- Cultural control uses techniques in the coffee garden to change the coffee tree environment and discourage the establishment and build-up of CBB

## Start with a healthy and productive coffee garden

Having clean, healthy and productive coffee gardens is an important strategy in minimising the impact of CBB.

Refer to modules in Unit 1 and Unit 2 in the **Farmer Training Guides** for further information on measures to establish your coffee garden and keep it clean, healthy and productive.

**Coffee nursery development**

**Establishing a new coffee garden**

**Weed control**

**Maintenance pruning and rehabilitation**

**Shade management**

**Drainage**

**Pest and disease management**

**Soil fertility and nutrient maintenance**

**Coffee harvesting and processing**

Many of the Farmer Training Guides give recommendations on how to best establish and manage your coffee garden in order to keep the trees healthy and productive. These cover important management practices in:

- Establishment of healthy trees in a new coffee garden
- Minimising weed growth
- Pruning of coffee trees
- Shade management
- Soil conservation
- Maximising nutrient supply and availability
- Methods to minimise the impacts of pests and diseases of coffee and encourage their natural enemies

If coffee trees are healthy and productive and the coffee garden is well maintained using simple management practices, the establishment and impact of pests like CBB can be minimised.

If you plan to become a certified coffee grower many of the requirements for certification will assist in the management of CBB.

Demonstration 2: Farmer Training Guides

Not all farmers may have undertaken training from the suite of Farmer Training Modules.

Show the farmers the Farmer Training Modules covering:

- Coffee garden establishment and management (Unit 1 and Unit 2)
- Coffee harvesting and processing (Unit 3)

Point out sections in each module that are specific to CBB management highlighted by the image of a CBB.

Explain the importance of undertaking training to develop skills in good coffee management that will improve productivity and minimise the impact of CBB.

## Remove or improve management of poorly managed or abandoned coffee trees

- Poorly managed and abandoned coffee trees provide habitat for CBB and enable the pest to continue breeding and disperse to healthy coffee trees
- These trees should be removed or managed in order to reduce populations of CBB and their ability to disperse and infest healthy trees

## Implement good sanitation control practices

The most effective cultural practice to use for control of CBB is sanitation.

### What is sanitation control?

- Sanitation control is the **complete removal** of all CBB-infested berries from the coffee garden and processing area to reduce CBB populations
- All coffee berries infested with CBB must be removed to prevent spread of the pest to other berries in the coffee garden or processing area, or to your own or neighbouring CBB-free coffee gardens
- Old coffee berries (raisins) are reservoirs of CBB, harbouring several generations at once. Tree raisins in particular can carry a high abundance of CBB so it is important they are removed

Raisin berries containing CBB at all stages of development.

- Heavily infested berries must be destroyed *(see Section 6.4)*
- Lightly damaged berries can still be processed and sold as low grade coffee

## Marketing CBB-damaged parchment

- If CBB damaged berries are separated and processed separately from healthy berries they can be sold as low grade parchment
- The parchment must be dried to less than **12% moisture** prior to being moved to areas not infested with CBB
- Before transporting to market, all damaged berries or parchment must be **securely contained** or enclosed
- Buyers and processors **must be informed** that the coffee has CBB damage

**Why must infested berries be removed from coffee gardens?**

- CBB can escape and fly back to the coffee trees
- CBB must be killed to stop them attacking healthy berries
- Removing CBB-infested berries from coffee gardens will interrupt the life cycle of the pest

CBB ready to fly back into the field from an uncovered bucket full of raisins/dried berries
*(Source: hawaiicoffeeed.com)*

**Sanitation control strategies**

- There are several management strategies *(discussed in further detail in Sections 6.4. and 6.5)* that can be implemented during both harvesting and post-harvest processing which facilitate effective sanitation control:

  Harvesting strategies — frequent and efficient harvesting, separating healthy and infested berries while harvesting, destroying heavily infested berries and maintaining good harvest hygiene

  Post-harvest strategies — keeping CBB-infested berries contained; processing harvested cherry promptly; separating healthy and infested berries using the float method, and destroying heavily infested berries

- Sanitation control can be labour intensive and is required throughout the whole of the coffee fruiting (berry production) period

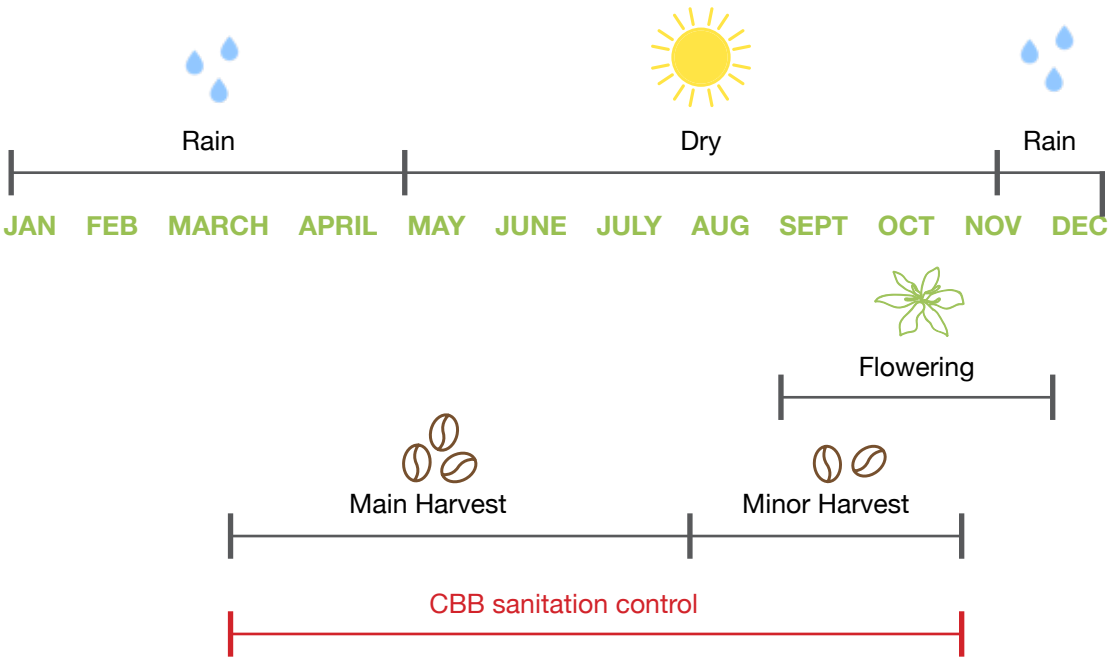
- There are measures, discussed below, that can be used in the coffee garden to minimise the demands on labour for sanitation control

## Shorten the coffee flowering period

**The coffee cycle**

The coffee production cycle in PNG follows the seasons. Towards the end of the dry months the coffee trees begin to flower and berries develop from the flowers. The main harvest occurs towards the end of the wet season and continues into the dry season. Some minor harvesting may be required in the off-season, after the main harvesting period.

## Coffee Flowering and Harvesting Cycle




**Synchronised flowering**

- Synchronised flowering is when all trees in the coffee garden flower at the same time
- In some coffee gardens the coffee trees flower at differing times, so flowering occurs over a very long period
- Many farmers are reporting more off-season coffee production. Climate change may be exacerbating non-synchronised flowering and extended flowering times
- Long periods of flowering and subsequent fruiting not only provides a continual feeding and breeding habitat for CBB but also puts heavy demands on household labour for harvesting and CBB control
- If the coffee trees all flower at around the same time the result is:
  - » More uniform berry development
  - » Better quality cherries
  - » More efficient and effective harvesting with less labour required
- Although it is impossible to have all trees flowering at the same time there are measures that can be applied in the coffee garden that encourage the trees to flower at around the same time
- A shorter flowering period minimises the time when there are high demands placed on household labour for harvesting and CBB control

## Manage shade cover

Optimum shade cover provides many benefits to coffee trees as detailed in the module on shade management. It also encourages the coffee trees to flower at around the same time:

- In coffee gardens with low shade cover, coffee trees tend to flower over very long periods. This not only extends the fruit development and harvesting periods but also places high nutrient demands on the coffee trees
- If shade levels in coffee gardens are optimal the coffee trees are more likely to flower at the same time
- However, too much shade creates high humidity which is ideal for survival of CBB, so it is important that shade is managed appropriately

*See the 'Shade management' module for further information on how to optimise shade.*

## Prune correctly and frequently

Pruning encourages growth of the coffee trees and boosts yields. It also assists in controlling CBB in the following ways:

1. Harvesting is easier and more efficient if coffee trees are correctly and frequently pruned as both ripe healthy cherries and CBB-infested berries are more accessible
2. Pruning reduces habitat for CBB
3. Pruning allows more airflow and reduces humidity. This creates an environment less favourable for CBB
4. Pruning can also assist in encouraging the coffee trees to flower at a similar time

The following **pruning** practices are recommended to minimise the spread of CBB:

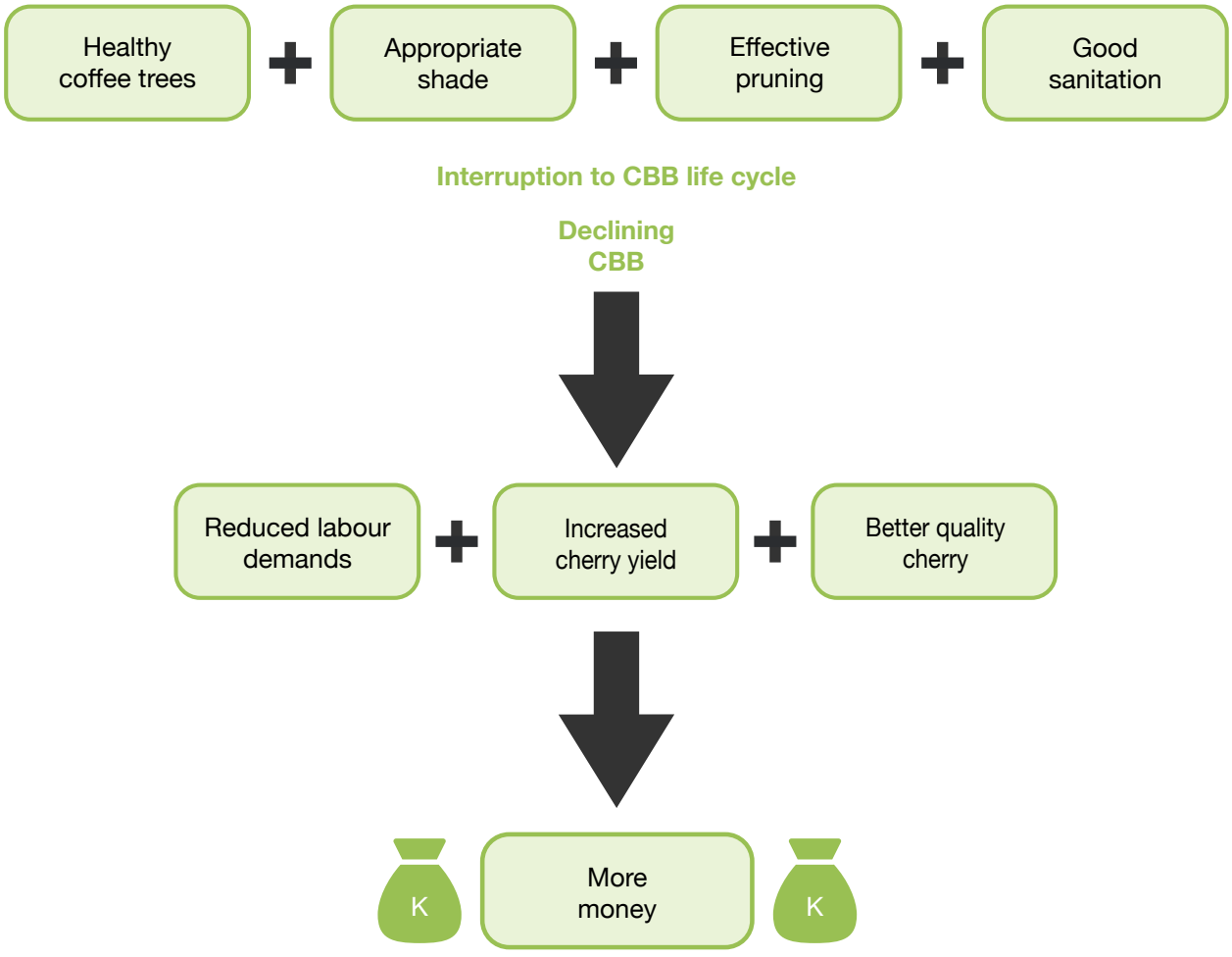
- All berries should be removed from the coffee trees prior to pruning to prevent spread of CBB
- It is recommended that coffee trees be pruned after the end of the coffee season. The final harvest is a strip pick where all berries are removed *(see Section 6.4)*
- Remove excess and older vertical branches
- For heavy infestations or neglected/abandoned coffee trees, consider stump pruning or tree removal

*See Unit 2, Module 2 'Maintenance pruning and rehabilitation' for further information*

## Will farmers be rewarded for implementing CBB cultural control measures?

If farmers implement recommended cultural practices including growing **healthy trees**, providing appropriate **shade**, **pruning** effectively, and practising good **sanitation**, the population of CBB should decline over the second and third coffee seasons as will the amount of labour required to control it. Cherry **yield** and **quality** will also improve so farmers will have **more coffee to sell** and receive a **better price**, resulting in **improved returns to labour**.

### Cultural control practices




Levels of CBB infestation can be monitored when using the post-harvest float method to separate healthy and infested berries *(see Section 6.5)*. Farmers can see that their CBB management practices are effective and paying off if the proportion of floaters declines over time.

**In summary,** crop sanitation is the most effective tool for controlling CBB. Using management practices that produce a heathy and productive coffee garden will not only minimise the establishment of CBB and enable more efficient control of the pest through sanitation but also improve the yield, quality and value of coffee cherries.

The next section of this module details the measures involved in effective sanitation control of CBB.

**Objective:**

**To identify key coffee garden activities that will help minimise the impact of CBB.**

**You will need:**

**Farmer Notes (with key activities from all modules that minimise the impact of CBB)**

# EXERCISE 2

## Minimising the impact of CBB

Using the Farmer Notes, ask the group/s to discuss the key coffee garden activities that will assist in minimising the impact of CBB, that is, activities that will produce healthy and productive coffee trees (e.g. good seedling establishment, weed control and pruning methods; optimising shade cover, nutrient supply and availability).

Ask the farmers to contribute any other ideas they may have that will minimise the impact of CBB.

After the groups have discussed the activities join in a whole group discussion and share ideas on how best to minimise the impact of CBB.

# 6.4 HARVESTING STRATEGIES FOR SANITATION CONTROL

There are certain harvesting strategies that should be implemented during the coffee season to limit the reproductive capacity of CBB.

## Harvesting during the coffee season

**Frequent harvesting**

- Harvesting frequently is an important component of CBB control
- Regular harvesting will prevent CBB populations from building up and will interrupt the life cycle of the pest
- Multiple harvests will also improve quality and yield of coffee cherry
- Cherries should be picked **every 1 to 2 weeks** during the harvest period


*(Source: Sweet Marias)*

**Efficient harvesting**

**(a) Berries that must be picked**

- During each harvest round in the coffee season, it is important that all red (ripe), black (overripe) and raisin (old) berries are picked from the trees
- Only green, yellow and orange berries should be left on the coffee trees
- Tree raisins in particular can carry a high abundance of CBB, so it is important they are removed. Old coffee berries (raisins) are reservoirs of CBB, harbouring several generations at once. These berries are also likely to fall off the trees and onto the ground during harvesting

Farmers **must** harvest **every 1 to 2 weeks**. Overripe berries must be removed during every harvesting round and kept separate to 'clean' berries

All berries other than green, yellow and orange must be picked during every harvesting round *(Source: Big Island Coffee Roasters)*

Pick all coloured berries and raisins. Leave green, yellow and orange berries on the tree to ripen.

**(b) Testing harvesting efficiency**

- To test the efficiency and effectiveness of harvesters, assess a sample of five trees after a harvest round is completed
  - » Good and efficient harvesting is indicated by no more than 5 coloured (excluding green, yellow and orange) berries left on any one tree
  - » Poor and inefficient harvesting is indicated by more than 10 coloured (excluding green, yellow and orange) berries left on any one tree

## Harvesting standard

- The goal is to pick all coloured (not green, yellow and orange) berries from the trees
- The harvesting standard is measured by the number of **coloured** berries remaining per tree after a harvesting round
- Coloured berries include all red, purple, black and raisin berries

| Standard | Number of coloured berries remaining on tree |
|---|---|
| Excellent | Less than 5 |
| Good | 5-10 |
| Bad | More than 10 |

Demonstration 3: How to identify which berries should be picked during regular fortnightly harvesting

Using a collection of coffee berries, group them by their different stages of development:

1. Green (immature)
2. Yellow (very early ripening)
3. Orange (ripening)
4. Red (mature, ripe)
5. Black (overripe)
6. Raisin (dark coloured, very old)

Show which berries must be picked

Show which berries should be picked into a separate harvesting bag

## Training

- Training of those helping with harvesting improves their harvesting effectiveness and significantly increases control of CBB
- It is recommended that harvesting techniques be checked intermittently to ensure ongoing harvesting effectiveness

## Separate healthy and infested berries

When harvesting, immature berries and ripe cherries obviously infested with CBB, and all old berries must be kept separate from healthy, ripe cherries intended for processing.

- Use two bags when harvesting:
  1. Bag 1 for ripe, healthy cherry **(clean berries)**
  2. Bag 2 for CBB-infested berries and old, overripe and raisin berries **(reject berries)**
- The bag for reject CBB-infested berries, overripe and raisin berries should be **plastic** or lined with plastic to prevent the escape of CBB
- If infested berries are accidentally put in the 'clean berries' bag they can be separated from the healthy cherries using the float method during post-harvest processing *(see Section 6.5)*
- **Tie off** each bag **immediately after it is filled**. The purpose of this is to prevent healthy cherries becoming infested or prevent CBB escaping from bags containing CBB-infested berries

*Cherries infested with CBB*
*(Source: https://konacoffeefarmers.org/topics-of-interest/farming/pests/coffee-borer-beetle/coffee-berry-borer-photos)*

## Effective harvesting for CBB control

1. Pick cherries **every 1 to 2 weeks**
2. Pick all red, purple, black (overripe) and raisin (old) berries. Farmers should leave green, yellow and orange berries on the trees to ripen
3. Keep healthy cherries separate from CBB-infested berries

## Removal of raisin berries

All raisin berries must be removed from coffee trees

They must be removed as soon as they are spotted to prevent spread of CBB onto new cherries or to other coffee gardens

Tightly tie off any bags containing raisin or other CBB-infested berries before moving them out of the coffee garden

Destroy the raisin berries as soon as possible

Do not reuse harvesting bags that have contained raisin or other infested berries unless they have been thoroughly washed and left to dry in **full sun** for a few days

**Do not drop berries**

- Berries should be prevented from falling to the ground as dropped berries become store houses of CBB
- If possible, pick up any berries that have fallen on the ground

## Fallen berries (ground raisins)

- Ground raisins that have fallen from the coffee trees often contain CBB
- While it is preferable to remove and destroy these raisins it can be very labour intensive
- CBB survival in ground raisins is lower than those in tree raisins as they often succumb to natural enemies such as diseases and nematodes, and/or weather conditions e.g., rain/flooding and direct sun exposure

- Fallen berries will become less of a problem through time if farmers practise regular and full harvesting including the removal of all CBB-infested berries

**Limit movement in the coffee garden**

- Avoid carrying infested berries through clean areas of your coffee garden, areas that have already been harvested or near neighbours' gardens that are not infested with CBB

**Kill any CBB in picking bags**

- CBB may become lodged in the fabric of canvas bags used for picking cherry. The bags should be thoroughly washed and dried in the full sun for a few days prior to reuse

- If plastic bags are used for picking berries the bags can be tied closed and left in the **full sun** for at least 48 hours to kill any CBB remaining in the bag

## Destroying infested berries

Berries in all 'reject' harvesting bags should be destroyed without delay to prevent spread of CBB.

Destroy infested berries using one of the following methods:

1. **Seal:** Seal the infested berries in dark-coloured, black or painted black buckets, drums or containers, or **heavy-duty** black garbage bags. Leave them in the direct sunlight for at least 2 weeks

Container must be sealed

2. **Cover:** Dump the infested berries in a pile on a large canvas or a tarpaulin. Wrap the pile in the canvas or tarpaulin and **secure the edges** to stop CBB from escaping. Leave the pile to compost for many weeks

3. **Bury:** Dig a hole to the depth of the blade of a spade (no less). Place the berries in the hole then cover with soil. **Compact** the soil so CBB cannot escape. If the hole is too shallow and/or the covering soil is not heavily compacted, CBB can escape

4. **Burn:** Build a hot fire and burn the infested berries straight after harvesting

Burning infested berries

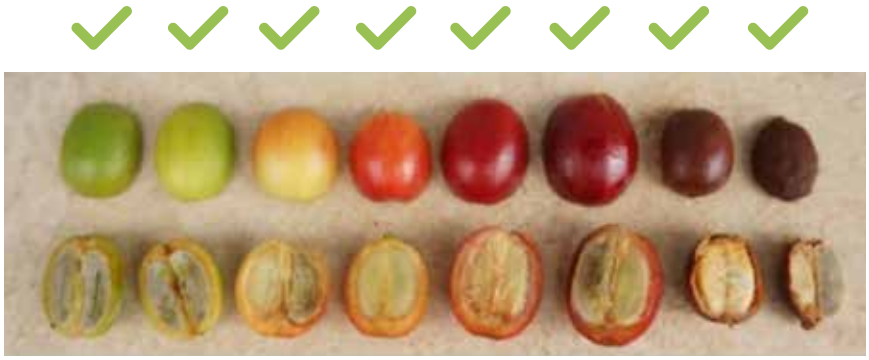
### Seal all containers when destroying CBB

- CBB can chew through many types of plastic and can fly
- Ensure buckets, bags and canvases are well **sealed**

## Final harvest 'strip pick'

**Pick all berries**

- The final harvest at the end of the coffee season is a sanitation pick or strip pick. This involves total removal of **all berries**
- This is important for breaking the life cycle of the pest and preventing it from carrying over to the next coffee season
- Farmers that have multiple flowering periods and/or multiple off-season harvests can choose to leave the green and orange berries on the trees, but they must pick all other berries and continue with regular harvesting once the first berries ripen
- The strip pick must be completed **before the coffee trees are pruned**. If berries are not picked prior to pruning they may dislodge during pruning and fall to the ground or be left in the coffee garden on pruning debris. This will leave a reservoir of CBB to re-infest the next season's coffee crop



Green | Green Cane 1 | Green Cane 2 | Cherry 1 | Cherry 2 | Ripe Cherry | Overripe Cherry | Raisin

At the final harvest pick **ALL** berries of **every colour**
*(Source: Big Island Coffee Roasters)*


## Final harvest strip pick

**HOW?**

- At the final harvest, do a strip pick of all coffee trees
- Pick **ALL** berries off the trees – green, yellow, orange, red, black and raisin

**WHY?**

- Breaks the CBB breeding cycle
- Good farm sanitation practice
- CBB will decline over time

# 6.5 POST-HARVEST SANITATION

Further controls can be put in place after harvesting to prevent infestation of healthy, harvested cherry as well as further spread of CBB

## Keeping CBB-infested berries contained

- It is important that any CBB in harvested berries is contained and prevented from escaping and infesting healthy berries or neighbouring coffee gardens
- Ensure all harvesting bags are **sealed** and have been carefully **tied off**
- When transporting cherry to the processing site, it is best if the cherry is kept in **sealed** bags or containers

## Prompt processing of harvested cherry

- Cherry should be processed as soon as possible after harvesting
- CBB in infested cherry can spread to healthy cherries very quickly and thus reduce its value
- The first stage of processing can begin in the coffee garden

## Separating healthy and infested berries using the float method

- Any CBB-infested berries that are in the 'clean' harvesting bags should be separated from the healthy cherries as soon as possible to minimise contamination of the healthy cherries
- Berries in the 'clean' harvesting bags should **all** be put through the float test to separate healthy and unhealthy berries
- If possible, do the float test at the coffee garden where the cherry was picked
- Fill a large tub or bucket with water and place the cherries in the water
- Cherry that has been damaged badly by CBB will float (as will under-developed berries, dry raisins and other rubbish like sticks and leaves). Healthy and lightly damaged cherry will sink
- Scoop off the rejects and bag up the healthy cherry
- Repeat this process until all harvested cherries have been put through the float test

- Firmly tie-off all bags
- Badly damaged cherry or 'floaters' can be processed but must be kept separated from healthy cherry

Floating coffee after harvesting
*(Source: Pr. Albert Ukaia)*

Unhealthy floating cherries
*(Source: https://sites.miis.edu/amandabensel/2012/08/07/the-coffee-process-from-field-to-roastery)*

CBB-infested cherry can still be processed because lightly damaged coffee beans are still marketable and can fetch a reasonable price. Badly damaged beans are also marketable but will be of low value.

**Monitor the proportion of bad cherry**

With good sanitation control practices the levels of infestation of CBB should decline over time. Farmers could monitor levels of infestation by doing a float test each harvesting round on samples of 'clean' harvested cherry.

1. Take half a shovel full of cherries from a harvesting bag containing 'clean' cherry
2. Place the cherries in a large bucket (20 L) three-quarters full of water (healthy cherries will sink; rejects will float)
3. Remove and count the number of 'floaters'
4. Count the cherries remaining in the bucket
5. Calculate the ratio of floaters (bad cherry) to good cherry and write this in a notebook with the date of the harvest round
6. Do this for each harvesting round to determine if the CBB management practices are effective. If effective, the proportion of bad to good cherry should gradually decline over time

## Drying parchment

- One of the main methods of long-distance dispersal of CBB to uninfected regions is through movement of undried parchment
- To achieve the **best quality**, it is recommended that parchment coffee be dried down to **10-12% moisture**
- Ensure parchment is sufficiently dried to obtain the best price and to also prevent the spread of CBB to uninfected areas

## Post-harvest hygiene

- Thoroughly clean harvesting bags, baskets, buckets or other harvesting equipment prior to it being returned to the coffee garden
- Clean the processing area and equipment to ensure all CBB-infested berries have been removed

**Objective:**

**To understand the process involved in sanitation control of CBB in a coffee garden**

**You will need:**

- **Access to a coffee garden during harvesting**
- **Three harvesting bags**

# EXERCISE 3

## Coffee garden sanitation

**Activity 1: Assessing coffee garden health**

I. Discuss the condition of the coffee garden

II. Do the trees appear to be healthy?

III. Are there any signs of the presence of CBB (or other pests and diseases)? What are these signs?

IV. Are there weeds present? How well have they been managed? Is there easy access for harvesting?

V. How well were the trees pruned? How has pruning affected access to the coffee trees for harvesting?

VI. What is the condition of shade trees and how much shade do they provide? Is the level of shade cover optimal?

VII. Ask farmers to contribute any ideas they may have on how CBB could be better managed in this coffee garden. Pay special attention to factors that may make CBB harder or easier to manage

VIII. Ask farmers how they would manage labour for CBB control

IX. Discuss sanitation and harvesting practices

**Activity 2: Select 2 coffee trees for harvesting**

I. Tree 1: Pick all berries that should be picked during each harvesting round in the coffee season (all coloured berries, except green, yellow and orange berries). Separate 'clean' berries and 'rejects' into two separate harvesting bags

II. Tree 2: Pick all berries that should be picked during the final harvest (strip pick all berries)

**Objective:**

**To understand how to do the float method to separate healthy and CBB-infested berries**

**You will need:**

- **Berries harvested during Exercise 3 from Tree 1 in the 'clean' berries bag**
- **A three-quarters full large bucket of water (at least a 20 litre bucket)**
- **Shovel**

# EXERCISE 4

## Separating healthy and infested cherries during processing

**Float method**

I. Place half a shovel of 'clean' berries in the bucket of water

II. Scoop off the berries that float (and any other debris)

III. Pour the water out of the bucket into another bucket leaving behind the healthy sunken berries

IV. What is the difference between the berries that float and those that sink?

V. Count the number of 'floaters' and the total number of berries placed in the bucket

VI. Calculate the ratio of floaters (bad cherry) to good cherry

**Objective:**

**To understand how best to destroy CBB-infested berries**

**You will need:**

- **Large dark coloured/black bucket with sealable lid**
- **Tarpaulin (with no holes) and rocks or timber for securing the tarpaulin**
- **Shovel**

# EXERCISE 5

## Destroying CBB

**Activity 1: Sealing berries in a bucket**

I. Take the harvesting bags containing the 'reject' berries

II. Place the berries in the empty bucket and seal the bucket with the lid

III. Point out the dark colour of the bucket, how it is well sealed and the importance of placing it in direct sunlight. Explain that the dark colour absorbs the sun's heat and so will heat up more quickly

IV. To destroy CBB, how long should the berries be left in the sealed bucket in the sun?

**Activity 2: Composting berries**

I. Place the 'reject' berries in a pile on the tarpaulin

II. Wrap the pile in the tarpaulin

III. Secure the tarpaulin with the rocks or timber

IV. Point out the condition of the tarp (no holes) and how it is well secured

V. To destroy CBB, for how long should the berries be left to compost?

**Activity 3: Burying berries**

I. How deep should the hole be?

II. Dig a hole to just over the depth of a blade of a spade

III. Place some 'reject' berries in the hole

IV. Cover with soil and stamp it down, while emphasising that it must be well compacted

The most important question to ask the farmers is: What is the outcome if infested berries are not destroyed?

# 6.6 OTHER METHODS OF CONTROL OF CBB

While there are other methods of CBB control available to farmers, none alone is as effective as sanitation control and would need to be used as part of an Integrated Pest Management (IPM) program. An IPM program combines the use of several different control measures including chemical, biological and cultural control.

## Area Wide Management

**Working together with neighbours**

- CBB fly short distances (between neighbouring coffee gardens)
- If one coffee garden is not kept CBB-clean it will infest the neighbouring coffee garden
- Neighbours must work together to stop CBB circulating and re-infesting each other's coffee gardens
- It is also important to manage or remove abandoned coffee trees

### Collective action

To be successful, CBB management strategies must be undertaken in an area wide approach. This requires collective action among neighbouring coffee growers.

**Moving unprocessed cherry**

- It is illegal to move unprocessed cherry into areas free of CBB

**Moving parchment**

- The moisture content of parchment must be below 12% if moving it into new areas or passing through provinces that are CBB-free
- It is recommended that parchment not be moved until the moisture content has been reduced to 12%

## Trapping

- Traps are used for monitoring the dispersal and flight patterns of CBB, not control
- Traps can be expensive but can be a useful management strategy to inform the farmer if and where CBB is present in the coffee garden

- Traps can be made from a large red or white plastic bottle with some soapy water in the bottom. A smaller bottle is placed inside the larger bottle. The smaller bottle has a small opening and contains a ratio of 3:1 methanol and ethanol which may be sourced from a pharmacy

DANGER - POISON

The methanol-ethanol mix attracts CBB

It is poisonous to humans if consumed or inhaled. Do not get it on your skin or in your eyes. Wash hands well after use.

Simple home-made CBB traps *(For more information visit: https://www.ctahr.hawaii.edu/site/cbbtrap.aspx)*

**Identification of CBB using a trap**

- This needs to be done by a CIC trained officer or an expert who can differentiate CBB from other bark beetles collected in the trap using a microscope or magnifying lens
- Have an extension officer demonstrate how to set up an ethanol trap
- Set up a few traps throughout the coffee garden
- Collect beetles in the traps. Place them in individual tubes/jars
- Label the tubes/jars with the date, location, district and province
- Send the tube/jar to the nearest CIC office for identification

## Natural enemies

- Encouraging natural enemies of CBB in the coffee garden will assist in control of the pest
- Natural enemies of CBB include ants, thrips, beetles, birds and fungi

- Having optimum shade cover and managing surrounding habitats will affect the diversity and abundance of these natural enemies. Avoid heavy shade as this increases humidity and may create a CBB 'hotspot'
- Healthy soils will also enhance the diversity and abundance of natural enemies

## Other forms of biological control

- Biocontrol methods using parasitic wasps, nematodes and fungi (such as *Beauveria bassiana*) have been used as methods of CBB control
- These methods have had varying success, and they can be costly and require labour and equipment for application

### Vigilance

- To be able to manage CBB effectively it is important to remain vigilant
- It is recommended that farmers continually monitor for the presence of CBB in their coffee gardens as soon as coffee berries begin to develop on the coffee trees after flowering

Discussion: Farmer management strategies

Farmers often use management strategies based on local knowledge. These strategies may be very effective, yet extension officers may not be aware of them.

Discuss and consider the strategies that farmers may use in managing CBB and determine how they can be incorporated with the CBB management strategies recommended in this module.

# 6.7 KEY MESSAGES

The important messages for farmers are:

- CBB is a major pest of coffee as it causes serious economic losses for farmers and is difficult to control because it can spend its entire life cycle inside the coffee berry
- CBB can be controlled with effective management and farmers can still achieve high yields of quality coffee
- Dispersal of CBB and subsequent infestation of healthy berries occurs when old infested berries are left on trees or on the ground, or through movement of harvested cherries infested with CBB
- Several measures can be adopted in the coffee garden and during harvesting and processing to minimise the impact of CBB
- Cultural methods of control are the cheapest and most effective for smallholders
- Sanitation is the most effective form of cultural control and involves the complete removal of all CBB-infested berries from the coffee garden. Removal of infested berries is required during every harvesting round throughout the coffee season
- At the final harvest of the season all berries should be strip picked from the coffee trees to prevent reinfestation of the next season's coffee crop. Green berries can be left on the trees if farmers are harvesting for extended seasons
- Cultural control practices such as shade management can be used to encourage coffee trees to flower at around the same time. Reducing the flowering interval will also reduce the period of high demand for labour for sanitation control of CBB
- Berries heavily infested with CBB, overripe berries and black raisins must be destroyed and/or removed from the coffee garden to prevent further infestation of healthy berries

# 6.8 QUIZ

**Place a '✓' in the correct box.**

## 1. CBB may begin to attack berries:

- A Immediately after flowering
- B During the pinhead stage
- C When the beans begin to form
- D When they are overripe

## 2. When are coffee berries susceptible to infestation by CBB?

- A Only when green
- B Only when ripening
- C Only when ripe and overripe
- D Anytime during development

## 3. At which stage of development are berries likely to have the highest level of infestation of CBB?

- A Green (immature)
- B Colour change (when ripening)
- C Red (ripe)
- D Brown-black (overripe and raisin)

## 4. CBB reproduction is dependent on the development of which part of the coffee berry?

- A Flower
- B Skin
- C Pulp
- D Seed/bean

## 5. What can result from the infestation of coffee gardens by CBB?

**Tick all that apply**

- A Infection of coffee berries by diseases and infestation by other pests
- B Infestation by CBB of intercropped fruit and vegetable crops
- C Premature coffee berry drop or reduced bean weight
- D Poor coffee bean quality and price

## 6. Which of the following are methods of CBB dispersal?

**Tick all that apply**

- A Water droplets
- B Flight and wind
- C Attachment to people and animals
- D Movement of infested materials/equipment

## 7. What is the most important reason why sanitation is the most effective form of control of CBB?

- A It reduces the amount of food available for the pest
- B It reduces the pest population
- C It breaks the pest's life cycle
- D It eradicates the pest from the coffee garden

## 8. Sanitation control can be labour intensive particularly if required over long periods. What measures can be applied in the coffee garden to shorten the flowering period and therefore the interval for CBB control?

- A Shade cover and pruning
- B Shade cover and weed control
- C Pruning and weed control
- D Strip picking and pruning

## 9. All farmers need to harvest their coffee trees every 1 to 2 weeks during the coffee season. Identify which colour berries they should pick during each harvesting round **(Tick ✓ those to be removed)**

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

## 10. An excellent standard of harvesting for CBB sanitation control is when there are how many berries (other than green, yellow and orange) remaining on average per coffee tree?

- A Less than 5
- B 5-10
- C 10-20
- D 20-30

## 11. For effective sanitation control of CBB, what is the longest period that can be left between harvests during the main harvesting period?

- A 1 week
- B 2 weeks
- C 5 weeks
- D 8 weeks

## 12. What are the key factors in control of CBB?

- A Frequent and efficient harvesting
- B Sanitation and hygiene
- C Strip picking at the final harvest
- D All of the above

## 13. What practices are important when destroying CBB-infested berries? **Tick all that apply**

- A Leave containers in direct sunlight for at least 2 weeks
- B Ensure containers are dark coloured or black
- C Seal all containers
- D Ensure containers don't get wet

## 14. True or false.

| | True | False |
|---|---|---|
| a. CBB can infest coffee berries prior to development of the bean. | ☐ | ☐ |
| b. CBB survives only for a short time in old berries left on coffee trees. | ☐ | ☐ |
| c. Sanitation control of CBB is simply strip picking all berries from the coffee trees after the final harvest. | ☐ | ☐ |
| d. Well managed coffee gardens are not susceptible to attack by CBB. | ☐ | ☐ |
| e. In addition to sanitation control of CBB another method of control suitable for smallholders is encouraging populations of natural enemies of CBB. | ☐ | ☐ |
| f. Control of CBB requires action from all coffee farmers in the community. | ☐ | ☐ |

# 6.9 SOURCES OF FURTHER INFORMATION

Aristizábal L F (2018) *Controlling the coffee berry borer through integrated pest management: A practical manual for coffee growers and field workers in Hawaii*. Kailua-Kona, Hawaii (USA), 79 pp. www.researchgate.net/publication/328688033_Controlling_Coffee_Berry_Borer_Through_Integrated_Pest_Management_A_Practical_Manual_for_Coffee_Growers_and_Field_Workers_in_Hawaii

Aristizábal L F (2020) CBB Notes. *Frequent and Efficient Harvesting Practices to Reduce Coffee Berry Borer Populations*. Kailua-Kona, Hawaii (USA). DOI:10.13140/RG.2.2.12242.91843

Aristizábal L F, Johnson M A, Shriner S and Wall M (2023) Frequent and efficient harvesting as an economically viable strategy to regulate coffee berry borer on commercial farms in Hawaii. *Economic Entomology* 116(2): 513-519. https://doi.org/10.1093/jee/toad041

CIC (2016) *The Papua New Guinea Coffee Handbook* (2nd Edition)

Damon A (2000) A review of the biology and control of the coffee berry borer, *Hypothenemus hampei* (Coleoptera: Scolytidae). *Entomological Research* 90(6): 453-465. DOI:10.1017/S0007485300000584

Vega F E, Infante F, Johnson A J (2015) The genus *Hypothenemus*, with emphasis on *H. hampei*, the coffee berry borer. In: Vega F E and Hofstetter R W (eds.) *Bark Beetles, Biology and Ecology of Native and Invasive Species*. 1st ed. Elsevier; London, UK: 2015. pp. 427–494. Chapter 11. DOI:10.1016/B978-0-12-417156-5.00011-3.

**Watch on YouTube**

Coffee Berry Borer IPM – Main Harvest (University of Hawaii) https://www.youtube.com/watch?v=JZMWPxusOhI&list=PLBpisCn1IX-VFM9G3wtKyegsKOkCOgv4N8&index=3

Coffee Berry Borer – End of Season Strip-Pick (University of Hawaii) https://www.youtube.com/watch?v=-uWqkovPqKg

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