Farmer's Manual

Good Agronomic Practices in the Production of Organic Coffee

Java, Indonesia

NESPRESSO

Constance Dorise

Constance Dorise

Farmer's Manual

Good Agronomic Practices in the Production of Organic Coffee

Java, Indonesia

2020

Contents

Contents

1.

Organic Agriculture: What Is It?

Organic agriculture follows the principles and logic of a living organism, in which all elements are closely linked together: the soil, plants, animals, farmers and local conditions. This is accomplished through agronomic, biological and mechanical methods.

Definition

Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It is based on ecological processes, biodiversity and cycles adapted to local conditions rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation, and science to benefit the shared environment and promote fair relationships and good quality of life for all involved. (IFOAM)

Success Factors

There are several factors that contribute to the success of organic coffee production, some of them are highlighted below:

Climate, Soil and Coffee Varieties

Respecting favourable climatic conditions for coffee production is fundamental to achieving high productivity and a low incidence of pests and diseases, reducing production costs and ensuring good cup quality.
The soil must provide an adequate environment for the development of the roots of the coffee tree. It is necessary to build up the chemical, physical and biological fertility of the soil through proper management over the years.
The coffee varieties selected by the farmer should present desirable characteristics in terms of resistance and production.

Labour

The availability of the workforce is crucial as organic production demands more labour than conventional production.

Inputs

The availability and accessibility of commercial organic fertilizers in local shops or that can be made with raw materials available at the farm and its surrounding areas are essential, as this directly affects production costs.

Farm Administration

Controlling production costs is key to controlling primary costs and opportunities for investment.

Knowledge of Agronomic and Processing Practices

The production of organic coffee demands a great deal of technical knowledge on farm management, the preparation of organic fertilizers and pesticides, certification, etc. Training farmers and their workforce is essential.

This booklet will develop some key aspects of organic farming and will propose sustainable, regenerative practices that can be implemented in the field by agronomists and farmers. At the end of this guide, there are technifical specifications on the preparation of compost, liquid fertilizers, biopesticides, etc.

2.0

Establishing Nurseries

Location

Nursery Must

- Be close to a water source, protected from wind, of easy accessibility and located close to the coffee beds.
- Have a slight slope for proper drainage.
- Not be located on old beds.

Nursery Layout Must

- Take into consideration the area needed for germination beds and lines of polybags.
- Include a transversal vegetation barrier above the nursery to reduce wind strength.

Figure 1. Nursery at Olam facilities.

Shade

Basic Practice

- Build a shaded roof made of banana leaves or any other appropriate materials. It should be 2-2.5 m high (human size) and provide 50% shade.

Good Practice

- Shade with an artificial roof (black or red mesh).

Advanced Practice

- The sides of the nursery should be fenced in with artificial shading as well.

Germination Beds

Germination Beds Must

- Be installed one month before sowing on clear, clean ground in February-March.
- Be between 1.2 and 1.4 m wide, separated by a 0.5-0.6 m circulation path and raised approximately 25 cm above ground level using bamboo, wooden boards, concrete or raised soil.

Figure 2. Germination bed at Olam nursery.

Germination Substrate

- The substrate is made of a sterile mixture.
- The germination beds should be inoculated with *Trichoderma* spp. (10 g/L of water/m²) six days before planting.

Advanced Practice

- The substrate can be reused for new batches if no disease affected the existing batch, and provided that the substrate is sifted and inoculated again.
- The bottom of the bed can be made of a 5 cm layer of large-grand sand (1 mm in diameter) for better drainage.

Sowing the Beds

- Sowing must be done on a previously moistened substrate in July- August.
- Seeds must be certified organic or come from the farmer's own organic farm.
- Seeds should be sown in a 2 cm x 2 cm grid and then covered with a 0.5-0.7 cm layer of sand.
- Germination beds must be irrigated.
- The beds must be covered with disinfected jute bags or banana leaves to keep in moisture.
- Each bed must be labelled with the variety of coffee.
- There is no need to fertilize the beds during the germination process.

Advanced Practice

- Cover the bed with a microtunnel.

Pest and Disease Control

- Weekly applications of *Trichoderma* spp.

Nursery Management

Layout of Bags in the Nursery in August-September

- Bags should be filled with a handmade mixture of worm compost and soil (4:3).
- The soil should be inoculated with *Trichoderma* spp.
- There should be lines of 10 polybags per rack.
- There should be at least 30 cm between each rack.

Transplanting the Seedlings

- Transplanting is done when the seeds have reached the soldier stage.
- The soldiers must be healthy plantlets with no trace of disease, straight stems and long, straight taproots and secondary roots.
- Transplanting should be done early in the morning. The seedlings must not be exposed to direct sunlight.
- Transplant the seedling into the polybag (14 cm x 28 cm) by opening a hole approximatively 10 cm deep. The plantlet is inserted deep into the hole and then pulled back up. The seedling's collar should be at soil level. The earth is then pressed laterally around the root.
- Each rack of polybags must be labelled with the variety and planting date.

Figure 3. Olam nursery.

Organic Fertilizer and Pesticide Applications at the Nursery

- Fertilization starts when the plantlets have at least one pair of new leaves.
- Organic fertilizer is to be applied weekly, using manure or a mixture of manure, tephrosia, mucilage water and microorganisms.
- Organic pesticide made of tephrosia should be applied when necessary.
- Conduct regular weed control in and around the nursery.

Figure 4. Manure and tephrosia biofertilizer (left) and manure biofertilizer (right).

Good Practice

- Collect rainwater for irrigation in the nursery and the preparation of biofertilizers and biopesticides.

Figure 5. Rain water collection at the nursery.

Transferring to the Field

- Plantlets are transferred to the field after eight months in the nursery.

3.

Establishing Plots

Plots

- Have the boundaries of the farm well defined (title, map, demarcations, etc.).
- Establish buffer zones to avoid contamination with prohibited substances by creating vegetation barriers and a 3-5 m wide transition zone.
- The vegetation barrier can utilize mulberry (*Morus alba*), mimosoid trees (such as *Leucaena glauca*), *Thitonia* sp., etc.

Figure 6. Vegetation barriers.

- Identify the farm and the type of production with a sign.

Coffee Varieties

- Choose vigorous, productive varieties that offer as much resistance as possible to local pests and diseases and that are adapted to local conditions.

Table 1. Recommended varieties according to altitude.

Altitude (m)	Coffee Varieties
700-900	S795, Gayo 1
1000	S795, Andung Sari 1, Sigarar Utang, Gayo 1, Gayo 2, Komasti, Ateng Super
1200	S795, Andung Sari 1, Sigarar Utang, Gayo 1, Gayo 2, Komasti, Ateng Super

Considerations:
- If plantlets or seeds are purchased, they must be organic.
- When no organic plantlets or seeds are available, conventional seeds or plantlets can be bought only if they were treated with permitted products.

Preparing Land for Planting Coffee Trees

Soil Conservation

Basic Practice

- Use bench terracing when there's a significant slope percentage.

Figure 7. Terracing.

Planting Layout

The choice of farming practices (pruning, coffee varieties), as well as other choices such as intercropping or anti-erosion practices, will determine the density of coffee trees.

Basic Practice

- The recommended coffee spacing is:
  - A 2.5 m x 2.5 m square grid for the Gayo variety.
  - A 1.5 m x 2 m rectangular arrangement for Ateng Super.
  - 3 m x 3 m when vegetables are planted between rows.

Good Practice

- A triangular arrangement is recommended for a high slope percentage, which also optimizes ground use.
- The recommended coffee planting density is:
  - 1.7 m in a triangular arrangement.

Digging and Refilling

- Recommended dimensions for planting holes: 60 cm x 60 cm x 60 cm.
- These holes should be dug a few weeks before planting.
- Use topsoil to refill the hole, complemented with soil.
- Compost, manure or well-decayed coffee pulp can be added. For example, 4.5 kg of compost or 2.5 kg of cow manure.

Planting

- Plant at the beginning of the rainy season (December-January).
- Plant only vigorous, well-developed plants.
- Plantlets should have between 6 and 10 pairs of leaves.
- From the planting hole, remove the amount of soil that corresponds to the volume of the polybag.
- Cut off the last 2 cm of the bag to prevent the formation of twisted roots.
- Remove the polybag and insert the plant into the hole vertically. Fill with topsoil.
- Compact the soil around the plants to avoid air pockets and ensure root contact.
- One month after planting, plants that did not recover well should be removed and replanted.

Cover Crops

The purpose of the cover crop is to avoid erosion, leaching or heating, as well as to generate additional organic matter. Cover crops can be native or introduced to the local environment. Different cover crops perform better under different conditions.

Basic Practice

- Maintain natural cover crops at 15 cm high, by allowing vegetation to grow spontaneously.
- Keep the 30 cm around the coffee tree's trunk clean.

Good Practice

- Plant introduced cover crops, such as the leguminous species *Arachis pintoi*.
- Cover crop growth can be enhanced by applying phosphorous-based organic fertilizers and dolomite.

4.

Nutritional Management

The application of organic fertilizers occurs in October and November. They improve soil chemical, physical and biological fertility. On top of increasing the availability of nutrients and reducing erosion, their incorporation into the system allows us to foster the soil's biological communities, improving its structure and its water retention and infiltration capacities.

Each organic fertilizer, on its own or as part of a blend, has a distinct percentage of fresh or dry organic matter, which influences the carbon/nitrogen ratio and the decomposition process. Additional materials (microorganisms, mineral complements, etc.) can be added to improve the physicochemical composition of the blend or to accelerate the decomposition of organic matter. The final quality of the organic fertilizer depends on the quality of the initial ingredients and the production process, as well as other variables such as temperature, humidity, ventilation, etc.

Compost

Compost is prepared in May-September with materials found on the farm and its surrounding areas (manure, crop residue, soil). This mixture of materials is prepared based on cultivation needs (in accordance with a soil analysis, if possible). The volume to be applied is defined in accordance with the number of applications to be performed that year.

Why Apply Compost?

Compost is an excellent organic fertilizer that is applied directly to the soil and principally benefits the secondary roots of the coffee plant. It feeds plants through the decomposition of organic matter collected on the farm.

Composting Techniques

There is one composting technique used in Java: pile composting.

Type of Compost	Type of Practice	Technique	Advantages	Disadvantages & Risks	Cost (IDR)
Pile compost	Good	Piling up layers of fresh and dry raw materials	For producing low volumes Low labour intensity Rapid preparation	A bad smell is produced if not managed correctly Must be fenced in to prevent animal infestations	80,000

Pile Compost

Pile compost is the preparation of a pile made of a single ingredient or multiple ingredients.

Basic Practice

- The compost pile is made of coffee pulp and husk, manure, green matters, EM4 or rested mucilage water respecting an initial C/N ratio of 25:1 - 40:1.
- It must decompose for at least three months.
- Apply 6 kg of compost twice a year in a hole or at the surface.

Figure 8. Individual composting site and compost house from a farmer group.

Good Practice

- Compost applied in a compost hole. The compost hole can be a trench for the hole coffee line or single holes for each tree.

Figure 9. Compost trench and individual hole.

Advanced Practice

- A compost pile made of coffee pulp and other ingredients found on the farm and its surroundings (manure, green matter, topsoil, minerals, etc.). Alternate layers of fresh and dry matter, respecting an initial C/N ratio of 25:1 - 40:1.

Considerations:
- Do not apply fresh coffee pulp directly to the soil.
- Externally sourced manure must come from organic-certified or extensive farms.
- Record data on pile's temperature along the process.

Controls

- If bad smells, excess water or dryness are detected, the mixture can be controlled in the following manner

Table 2. Controls for following up on issues detected in the composting process.

Indicator	Reason	Controls
Bad smells	Excess moisture	Add dry matter Increase the number of turns
	Compacted substrate	Add coarser materials Increase the number of turns
	An excess of certain components	Balance the ingredients of the compost pile
Water leaking from the mixture	Excess moisture	Add dry matter Increase the number of turns (this increases air and water flows)
Dry mixture	Lack of moisture Excessively large particles	Add water to the mixture and turn the compost Reduce the size of the particles

Liquid Biofertilizers

Why Apply Liquid Biofertilizers?

Liquid biofertilizers are organic fertilizers that are fermented with or without water. Unlike compost, liquid fertilizers contain hormonal precursors that stimulate the plant's resistance to pests and diseases.

Liquid Biofertilizer Preparation Techniques

Type of Liquid Biofertilizer	Type of Practice	Technique	Advantages	Disadvantages & Risks	Cost (IDR)
Homemade liquid fertilizer	Good	Fermenting several fresh ingredients in a drum	Multi-recipe Rapid preparation Low labour intensity Ideal for applying during the dry season	Soil acidification can occur if processed improperly Risk of explosion if a gas extraction system is not used	80,000
Processed mucilage water	Good	Rested mucilage water	No cost	Burns the plants when applied fresh	0
Biol	Good	Fermenting fresh ingredients	Multi-recipe Rapid preparation Low labour intensity Ideal for applying during the dry season	Soil acidification due to bad fermentation process	150,000/ 200 L
Supermagro	Advanced	Fermenting fresh and mineral ingredients in a drum	Easy to prepare Complete fertilizer	More investment needed Time consuming Availibility of minerals	TBD
Liquid worm humus	Good	Immertion of worm humus in water	Rapid preparation Low labour intensity Ideal for applying during the dry season	-	0

Homemade Liquid Biofertilizer

Basic Practice

- In a drum with a gas extraction system, add cow or goat manure, mucilage water, green leaves, EM4 and water.
- Apply at drench, diluted to 1%.
- Apply 0.5-1 L per tree, 30 cm from the trunk or in a hole, every three months during the dry season.

Good Practice

- Other ingredients, such as milk, molasses or brown sugar, animal urine, rice water, etc., can be added.

Figure 10. Preparation of liquid fertilizer in Java.

Processed Mucilage Water

Processed mucilage water can be obtained, free of charge, from a local processing plant.

Basic Practice

- Apply processed mucilage water at drench.

Good Practice

- Add mucilage water as an ingredient to compost or a biofertilizer.

Biol

- In a drum with a gas extraction system, add manure, water, milk, molasses, ashes, green matter.
- Ferment for 30 to 40 days and mature the mixture for 2 to 3 months.
- Apply to the leaves or at drench (dilution at 1%).

Supermagro

- In a drum with a gas extraction system, add manure, water, milk, molasses and the minerals according to the calendar.
- Apply to the leaves (diluted to 5%) or at drench (diluted at 20%).

Good Practice

- Aditional organic ingredients can be added such as worm humus, top soil, green matter, blood, fish silage, bone meal.
- Aditional mineral ingredients can be added such as phosphate rock, manganese sulfate, cobalt sulfate, etc.

Bokashi

Selection of the Site

The site must be of easy access, flat, shaded, protected from the weather and far from any source of water.

Materials and Tools

- Dry leaves
- Soil
- Fresh manure
- Ashes/ vegetal carbon
- Molasses
- Yeast
- Water
- A hoe, a shovel, a machete
- Bags for storing
- A black nylon
- A metallic bucket

Preparation of the Mixture

- Mix in a bucket 100 g of yeast, 0.5 L of molasses and warm water.
- Add the following materials in layers, humidifying each layer with the anterior mixture:

  - 100 kg of fresh manure
  - 50 kg of ashes
  - 100 kg of soil
  - 100 kg of dry leaves
  - 2 kg of yeast
  - 100 kg of vegetal carbon

Consideration:

- Do not use green matter as part of the ingredients.

Use

- Compost is applied directly to the soil or in a compost hole.

Storage

- The mixture can be stored up to two months.

Liquid Worm Humus

- Add in a 20 L container worm humus, water and rest for 48 h.
- Add 2.5 mL of liquid humus per L of water.

5. Soil Cover Management

Why Manage Soil Cover?

The space between lines of coffee trees is usually occupied by weeds. The proper management of this space can protect the soil against erosion and overheating, produce additional organic matter and promote biological activity and diversity. With proper management such as cutting, the nutrients absorbed by these weeds return to the soil through their decomposition, making them available to the coffee trees. Weed management is performed in February-March and September-October.

How to Manage Vegetation?

Below the Coffee Trees

- The farmer must remove weeds below the coffee trees, maintaining a weed-free area 30 cm around the trunks in order to reduce competition for light, water and nutrients.

Between Lines

- Farmers must maintain weeds at 10-15 cm high between coffee lines to protect the soil and maintain humidity.

Table 3. Vegetation management techniques.

Type of Management	Type of Practice	Technique	Advantages	Disadvantages & Risks
Manual regulation	Basic	Machete, knife	Low budget	Labour intensive, low efficiency
Mechanical regulation	Basic	Weeding machine	Efficient	-
Integrated regulation	Good	Combining techniques	Minimizes the effects of using only one regulation technique	-
Intercropping	Good	Planting vegetables	Increases the farmer's income and the biodiversity of their farm	More labour needed
Companion plants	Advanced	Planting companion plants	Increases diversity	More labour needed

Manual Regulation

- Use a machete 3-5 times per year.
- Hoes can be used sporadically.

Mechanical Regulation

- Use a weeding machine 3-5 times per year.
- Weeding machines do not have negative effects on the soil.

Integrated Regulation

- The combination of several techniques, such as:
  - Hoeing below the coffee trees + using a weeding machine between lines.
  - Hoeing below the coffee trees + dead cover (mulch) between lines.

Intercropping

- Intercropping allows for diversified production and distributes risks between several crops. For more information, refer to the chapter 3 "**Establishing Plots**".

Companion Plants

- A companion plant is a plant that is useful on the farm. It can attract useful insects or repel harmful insects, inhibit the growth of a certain plant, generate a more productive association with another specific plant, fertilize the soil or generate the raw materials needed for organic processes.
- They can be planted between rows or at the border of the farm.

Table 4. Examples of the beneficial effects of families of companion plants.

Family	Examples	Properties	Comments
Apiaceae	Carrots, dill, coriander, etc.	Host plants for helpful insects, repulsive effects, allopathic effects	Culinary plants They increase the population of insects from the *Syrphidae* and *Cecidomyiidae* families
Asteraceae	German chamomile, aster, Mexican marigold, etc.	Host plants for helpful insects, allopathic effects	Ornamental and aromatic plants They increase the population of insects from the *Syrphidae* and *Cecidomyiidae* families
Brassicaceae	Cabbage, mustard, etc.	Repulsive and insecticidal effects	They contain sulphur
Fabaceae	Peas, beans, etc.	Fertilizer, host plants for helpful insects	They provide nitrogen
Lamiacea	Lavender, thyme, rosemary, etc.	Repellent, allopathic effects	-

Reference: Lefrançois et al., 2010

Some Examples

Insecticidal Properties

- Chilli
- Ginger
- Neem
- Tobacco
- Lemongrass
- Garlic

Nematicidal Properties

- Garlic
- Mexican marigold (*Tagetes patula*)

Considerations:

- The importance of rotation: some plants are autotoxic (for example, the *Brassicaceae* family).
- By mixing plant varieties, diversity increases.
- These beneficial plants can be used on the farm or along its border.

Figure 11. Lemon grass barrier.

6.

Pest and Disease Management

Pest and disease management is an important part of organic production, to be performed in January-February. The incidence of pests and diseases decreases considerably with proper administration of the production unit: shade management, the application of fertilizers, the use of resistant coffee varieties, etc. The agroecosystem has many natural enemies, but their strength can be limited.

Coffee Berry Borer *(Hypothenemus hampei)*

What Is It?

The berry borer is an insect that attacks coffee beans.

Symptoms

The insect bores holes in green and red cherries to lay its eggs.

Figure 12. Coffee berry borer.

Causes of Development and Spread

- Excess humidity.
- Beans left on the plant or on the ground.
- Poor pulp management during the composting process.
- Abandoned plantations and lack of renovation.
- Inadecuate plant density.
- Lack of weed management.

Impact of the Coffee Berry Borer

- Bean weight loss.
- Affects physical quality and therefore the final price.

Techniques to Prevent Coffee Berry Borer

Type of Control	Type of Practice	Technique	Advantages	Disadvantages & Risks	Cost (IDR)
Cultural	Basic	Sanitation and harvesting Pruning	Highly effective	Labour intensive	Time
Biological	Good	*Beauveria bassiana*	Easy to use Also helps reduce white stem borers	Application in the wrong period	137,000/kg
Mechanical	Good	Traps	Highly effective Mainly for monitoring in the field	-	45,000/trap

Cultural Control

- Regular picking of the coffee during the harvest season.
- Pick all ripe or dry berries left on the ground or on the trees. All infected berries should be burned.
- Carry out formative and maintenance pruning to facilitate access to plants during the harvest and to have an open canopy that encourages the presence of the insect's natural enemies.

Biological Control

- Spray *Beauveria bassiana* on the coffee farm during the first four months after flowering (50 g of product per L of water; apply 1 L of the mixture per 19 L of water in two to three applications during the harvest season).

Mechanical Control

- Install 20 traps per hectare and place them on the coffee trees, 1 m above ground level.

Considerations:
- The monitoring of coffee berry borer flights is carried out by means of alcohol traps located within the lot.
- They do not serve to control the coffee berry borer since they would capture maximum 10% of the population that flies a meter away, however, they are useful for recognize the moment of the insect's flight.
- It is advisable to set traps around coffee wet processing facilities.
- Coffee berry borer's greatest catches occur during the first rains after prolonged dry periods.

White Stem Borer *(Xylotrechus quadripes)*

What Is It?

The white stem borer is a small beetle that lays its eggs in the crevices of the bark on the main stems and thick primary branches of coffee trees. The larvae bore and tunnel into the bark.

Symptoms

- Yellowing branches, defoliation and wilting.
- Evidence of wood dust residue.
- Branches are easily broken off.
- Ridges on the bark.
- Exit tunnel holes.

Causes of Development and Spread

- Low shade.
- Low altitude.
- Planting trees with twisted main roots.

Impact of the White Stem Borer

- Death of the tree.

Figure 13. White stem borer.

Techniques to Prevent the White Stem Borer

Type of Control	Type of Practice	Technique	Advantages	Disadvantages & Risks	Cost (IDR)
Cultural	Basic	Sanitation Shade management	Highly effective	Loss of the tree	Time
Mechanical	Advanced	Scrubbing	Highly effective	Labour intensive	Time
Chemical	Advanced	Lime application	Highly effective	Labour intensive	Time

Cultural Control

- Identify, uproot and destroy infected plants by burning before the beetle emerges.
- Coffee trees should not be exposed to too much sunlight, as beetles are very active in hot, bright environments. Proper shade should be maintained.

Mechanical Control

- Scrub the bark of the main stem and thick primary branches with a brush or a thick pair of gloves to reduce the crevices in which eggs are deposited.
- Smooth surfaces discourage the beetle from laying eggs.
- This should be performed on young trees 2-3 years of age and then 6-8 years later.

Chemical Control

- Apply a 10% lime mixture (20 kg per 200 L of water) on main stems and thick primary branches so that lime fills the crevices.

Common Diseases

Coffee Leaf Rust *(Hemileia vastatrix)*

What Is It?

Coffee leaf rust is a fungus that attacks the leaves of the coffee tree.

Symptoms

- Initial stages: small discoloured spots that develop on the underside of the leaves.
- Advanced stages: leaves of variable diameters powdered with spores of the pathogen, ranging in colour from yellowish to bright orange.

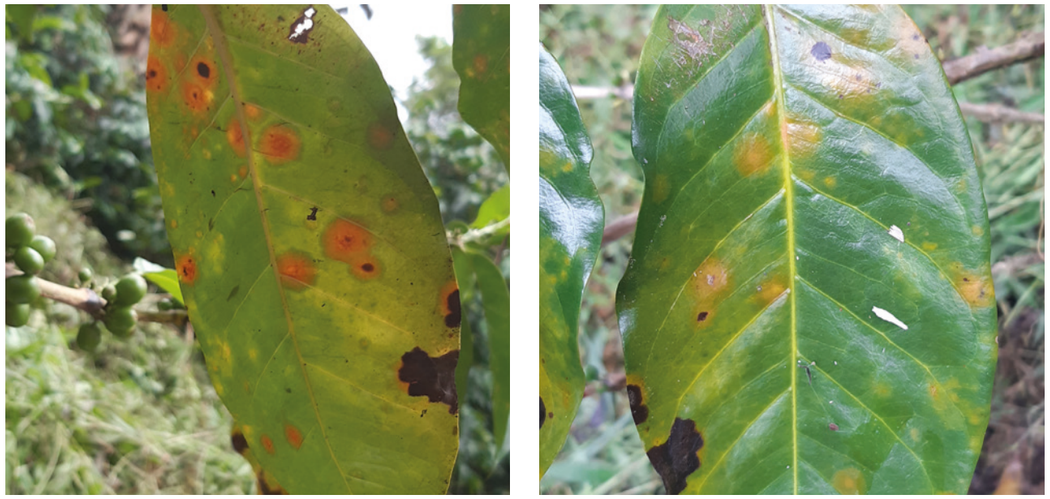

Figure 14. Coffee leaf rust.

Causes of Development and Spread

- Excess shade and humidity.
- Inappropriate coffee varieties.
- Improper plot management.

Impact of Coffee Leaf Rust

- Complete or partial defoliation.
- Death of the tree.

Techniques to Prevent Coffee Leaf Rust

Type of Control	Type of Practice	Technique	Advantages	Disadvantages & Risks	Cost (IDR)
Cultural	Basic	Pruning Balanced nutrition	Regulates the plot's climatic conditions	Time-consuming	Time
Genetic	Good	Resistant varieties Diversity of resistant varieties	Safe production	-	-
Chemical	Application of fungicide	Copper-based fungicides Bordeaux mixture Visosa mixture	Easy to prepare	Useful life of three days	110,000/kg

Cultural & Genetic Control

- Regular pruning of shade and coffee trees to ensure proper air circulation and sunlight penetration on the coffee plot. Maintain shade between 20-45%, in accordance with local conditions.
- Maintain balanced nutrition and pH.
- Use resistant plant varieties, such as Ateng Super, Gayo 1, Gayo 2.

Chemical Control

- Application of copper-based fungicides (oxychloride, hydroxide).
- Spray Bordeaux mixture, diluted at 1%, every month during the rainy season.
- Spray Visosa mixture (a mix of copper sulphate, lime and micronutrients) every month during rainy season.

Diseases in the Nursery

Damping Off *(Rhizoctonia solani, R. bataticola)*

What Is It?

A fungus present in the soil that attacks the root collar, rotting in rings around the bark of the seedling's stem, preventing sap from circulating correctly.

Symptoms

- Wilting.
- Necrosis of the taproot.

Causes of Development and Spread

- Stagnant water and high humidity.
- High seedling density.
- Excess shade.

Impact of Damping Off

- Death of the seedling.

Techniques to Prevent Damping Off

Type of Control	Type of Practice	Technique	Advantages	Disadvantages & Risks	Cost (IDR)
Biological	Advanced	Application of *Trichoderma harzianum* to the seedbed	Significantly reduces seed mortality	Not easy to buy	35,000/ 500 g
Cultural	Good	Appropriate seedling density A well-drained nursery	Significantly reduces seed mortality	Must be complemented by sand disinfection	Time

Biological Control

- Spray *Trichoderma harzianum* on seedbeds six days before planting seeds.

Cultural Control

- Burn the affected seedlings.
- Construct elevated germination beds.
- Maintain appropriate seedling density (4,000 seedlings/1-1.5 m² of seedbed).
- Maintain a carefully drained nursery to avoid stagnant water and high humidity.

Besides these widespread pests and diseases, other species can be found on coffee farms, such as ants, aphids or green scale. As they are not common, they do not represent a major risk for the farm or the farmer, but it is sometimes necessary to treat them with plant-based biopesticides.

7.

Pruning

Pruning is a practice that consists of partially or totally eliminating leaves and vegetative tissues whose productive capacities have declined or ceased. Pruning should be done in June-September.

Why Prune Coffee Trees?

Pruning stimulates the development of new stems by eliminating dry, unproductive or diseased trunks and branches. This increases yields, facilitates the harvest, improves bean quality, increases plot life expectancy and maintains proper sunlight and air circulation.

Types of Pruning

Formative Pruning

Formative pruning is the process of shaping the tree at a young age. It is performed by establishing proper trunk height and pruning young growth back to encourage the tree to grow in the right direction and develop thick branches.

Capping

- The vertical single stem is capped at a height of 160-180 cm above ground level. This encourages the formation of horizontal branches and increase shoot thickness.
- After a few years, the upper primary branches remain and the lower primary branches die off, resulting in the formation of an umbrella-shaped tree.

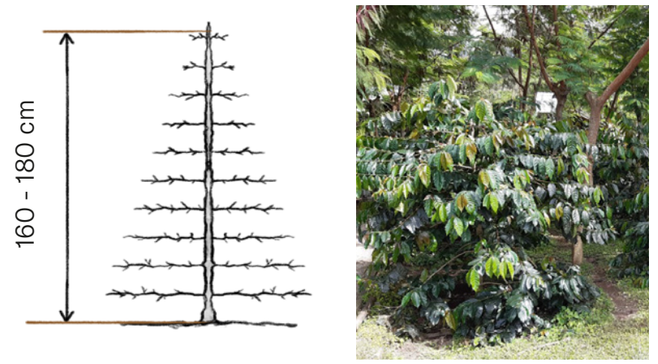

Figure 15. Single stem capping (Wintgens et al.,2004).

Maintenance Pruning

Maintenance pruning maintains the general shape of the tree, promotes fruit production and new stem growth and allows for air circulation and sunlight penetration. It consists of cutting away unproductive, damaged, unhealthy or unnecessary branches.

Basic Practice

- Remove dry, unproductive and diseased plagiotropic branches after the harvest.
- Maintain the plant's height.

Good Practice

- Remove dry, unproductive and diseased plagiotropic branches all year long.
- Remove suckers from the main stem every two to four weeks, all year round.

Rejuvenation Pruning

Rejuvenation consists of removing a large part of the trunk and its stems. It is performed when trees are old (10-15 years), infested or have drastically decreased production. This practice should be applied in sections equal to at least 10% of the plot, allowing for the maintenance of a regular annual yield. Rejuvenation should not be done during a severe dry season in order to not accentuate the stress on coffee trees.

Basic Practice

- Stumping at 40-60 cm above ground.

Good Practice

- Systematically remove all unneeded suckers growing on the trunk.
- When possible, keep several primary inferior branches to optimize sap circulation in the plant.

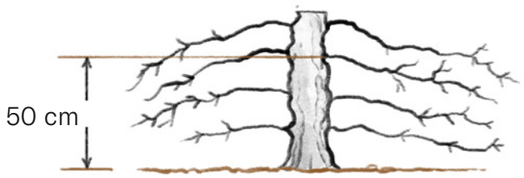

Figure 16. a) Rejuvenation.

b) Stumped single stem with a breather stem left.

Reference: Wintgens et al., 2004

Advanced Practice

- Combine the rejuvenation of coffee trees with severe pruning of the shade trees and rejuvenation of groundcover, maintaining a balance between aerial growth and root development.

Methods and Tools for Pruning

- Pruning must be performed with perfectly sharpened tools.
- Cutting must start from the exterior and progress towards the interior of the tree.
- The cut should be at an angle of 30° to avoid water accumulation.
- Tools must be disinfected regularly.

The following pruning tools can be used as needed

- Secateurs
- Pruning saws
- Machetes
- Knives

8.

Shade Management

Why Maintain Shade?

Shade and shade trees contribute to improved conditions on the coffee farm by limiting extreme soil and atmospheric temperatures, protecting the soil against erosion and weed growth, fixing atmospheric nitrogen into the soil and enriching the soil with organic materials such as falling leaves and twigs. Shade pruning should take place in September-October.

Types of Shade Trees

Temporary Shade

In unfavourable conditions such as excessive wind or sunlight, it may be necessary to protect young trees in the early stage of their development by planting fast-growing plants in coffee inter rows. It will be removed as the coffee trees and permanent shade plants grow.

- Plant prior to the coffee trees to ensure shade and soil protection.
- Space in a 4 m x 4 m grid.

Permanent Shade

Establish diversified, multi-layered shade cover that intercepts between 20% to 45% of the total sunlight on the coffee farm.

Basic Practice

- Keep and maintain existing trees (rosamala, pines, eucalyptus, puspa, etc.)

Figure 17. Rosamala tree.

Good Practice

- Plant fruit trees such as durians, jackfruits, bananas, avocados, mangoes, guavas and oranges. They should be planted in a limited density as they compete directly with coffee trees and usually offer inadequate shade but are important for diversity and food safety.
- Ensure diversity among nitrogen-fixing trees with gamal or acacia, for example.

Figure 18. Jackfruit.

Advanced Practice

- Plant hardwood trees around the farm for reforestation, such as sengon (*Paraserianthes falcataria*).
- Plant trees with medicinal and organic pesticide uses, such as the neem (*Azadirachta indica*), tephrosia (*Tephrosia vogelii*) and surian trees (*Toona sureni*).
- Shade trees can be used to grow other crops, such as vanilla or pepper.

Figure 19. a) Neem tree.

b) Surian tree.

Figure 20. a) Pepper.

b) Vanilla.

Shade Management

Fertilization

- Shade trees are fertilized for the first two or three years after planting.
- They can be fertilized with the same doses as the coffee trees.

Pruning

Pruning shade trees allows us to maintain their shape and uniform height, allowing for better illumination and ventilation of the coffee plantation. It should be performed in September-October.

Formative Pruning

Done when trees are young (less than five years old) to structure them so they have a single, clean trunk 5 m high, with the primary branches above.

Figure 21. Shade regulation.

Maintenance Pruning

- 40% of the primary branches of shade trees are pruned every two years. Either 100% of the population is pruned or 50% one year and the other 50% the following year.
- Maintain between 20-45% shade cover, depending on local conditions.

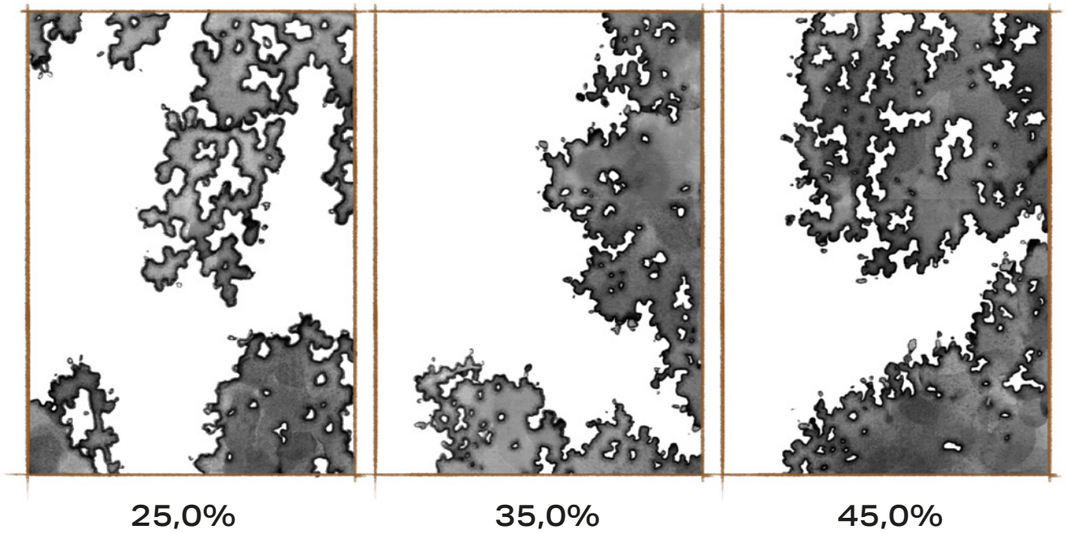

Figure 22. Percentage of shade cover.

9.

Certification

The organic certification is granted to individual farmers and groups of farmers, allowing them to use the “organic” label. Organic farmers must take care not to use prohibited products and to keep detailed records and documentation on the cultivation process for at least five years.

Permitted and Prohibited Products

There are some differences between the organic regulations from the European Union, the United States, Japan, etc. in terms of permitted and prohibited products. It is essential to be in close contact with the certifiers in order to stay up-to-date on this topic.
The main prohibited substances according to the Indonesian organic regulation are as follows:

Domestic Market Requirements

Preparation of Organic Fertilizers

Materials	Use
Synthetic chemical fertilizers	Prohibited
Synthetic plant growth regulators	Prohibited
All products containing GMOs	Prohibited

Preparation of Organic Pesticides

Materials	Use
All synthetic chemical pesticides	Prohibited
Materials derived from GMO products	Prohibited
Fresh manure	Prohibited
Nicotine isolated from tobacco	Prohibited

Weed Control

Materials	Use
Synthetic chemicals	Prohibited
Burning	Prohibited

International market requirements

For the EU and US markets, please refer to the following annexes and sections of their corresponding regulations:

European Union Requirements

- Refer to the authorized products listed in the regulation (EC) No. 889/2008:
  - Fertilizers: Annex I
  - Pesticides: Annex II

United States Requirements:

- Refer to the lists of authorized and prohibited substances in the NOP regulation:
  - Authorized synthetic substances: § 205.601
  - Prohibited non-synthetic substances: § 205.602

Process Requirements

EU Regulation

Fertilization:

- The quantity of manure to be applied on the farm must not exceed 170 kg of N per hectare per year.
- Animal excrements added to the compost (manure, urine, etc.) must come from a certified organic farm or a local extensive farm (factory farming origin forbiden).

Pest, Disease and Weed Management:

- The list states the products that can be used by farmers. If the product is not listed, it cannot be used.

US NOP Regulation

Fertilization:

- If fresh manure is applied on the farm, it should not be applied on the ground less than 120 days before the harvest.
- Composted manure must respect a C/N ratio between 25:1 - 40:1.
- When using the pile composting method, the compost must reach a temperature between 55-77 °C for three days.
- When using the windrow composting method, the compost must reach a temperature between 55-77 °C for 15 days and the farmer must turn the compost at least five time during the process.

Pest, Disease and Weed Management:

- The list states that synthetic products are prohibited, except for the authorized synthetic substances.
- The list states that natural products are permitted, except for the prohibited non-synthetic substances.

Records

Farmers must have traceability for all activities involved with their farm. This includes records on production, processing, the buying and selling of coffee, organic fertilizers and any other harvested products.

Traceability in Production

- Records on general activities concerning land management, seeds, seedling stock, plant rotation, pest control, the harvesting of wild plants and materials used as input substances.
- Records on fertilizer and pesticide application: types of input, doses, application dates, identification of the plot and justification.

- Records on yields: identification of the harvested batch, dates, quantities, types of coffee.
- Map of the farm.

Traceability in Processing

- Control sheet to register relevant information concerning coffee processing, such as the number of processed batches; the date, time and identification of the stage of the process in progress; the volume/weight of the batch before and after processing; etc.

Traceability in Storage (If Applicable)

- Records of the coffee's introduction and removal from storage (dates, types of coffee, quantities).
- Records of pests and diseases.
- Physical identification of batches.
- Control of workers (number of workers, dates, schedules).

Traceability in Buying

- Keep notes and invoices for organic fertilizers, pesticides, etc. purchased with dates, types and quantities.

Traceability in Selling

- Records of sales of coffee or other products.
- Records of sales of organic inputs with dates, types and quantities.

Documentation

- Documentation on the buffer zone between organic production and conventional production.
- Documentation on the segregation between the buffer zone and organic production if the buffer zone is harvested.
- Agreements with neighbouring conventional farms for the non-application of certain chemical products.
- Documentation on the location of stored products.

Appendices: Technical Specifications

Trichoderma spp.

Materials

- *Trichoderma* spp.
- Water
- Bucket
- Wooden stick for stirring

Preparation

- Concentration: 10 g of product per L of water
- Spraying volume: 1 L of mixture per m²

Use

- Prevention of soil-borne diseases such as damping off and root rots.
- To be applied six days before planting.
- Applied in a trench in the field or in the nursery.

Cost

35,000 IDR/500 g

Nutritional Composition of Organic Materials Used as Fertilizers

Table 5. C/N ratio, humidity and nutritional composition of organic fertilizers (dry matter).

Organic fertilizer	C/N	Humidity	C	N	P_2O_5	K_2O	Ca
		%	%				
Cattle manure	16	62	26	1.6	1.6	1.8	0.5
Cured cattle manure	21	34	48	2.3	4.1	3.2	3.0
Chicken manure	11	54	34	3,0	4.8	2.4	5.1
Pig manure	10	78	27	2.8	4.1	2.9	3.5
Horse manure	25	61	35	1.4	1.3	1.7	1.1
Coffee parchment	28	11	50	1.8	0.3	3.6	0.4
Coffee pulp	25	12	43	1.7	0.5	3	0.4
Compost	10	30	-	2.5	3.5	2	6
Bone meal	4	6	16	4.1	27.3	4.3	23.2
Hoof and horn meal	3	6	44	14.4	0.9	4.2	0.3
Fish silage	5	10	35	7.3	6.4	0.8	10.0
Mucuna sp.	20	87	46	2.3	1.1	3.1	1.5
Crotalaria juncea	25	86	50	2.0	0.6	2.9	1.4
Corn	46	88	50	1.1	0.4	3.3	0.4

Organic fertilizer	Mg	S	B	Cu	Fe	Mn	Zn
	%		mg kg^{-1}				
Cattle manure	0.3	0.3	15	16	2100	276	87
Cured cattle manure	0.9	0.3	24	38	3512	335	329
Chicken manure	1.1	0.4	27	230	3200	547	494
Pig manure	1.3	0.6	16	937	3700	484	673
Horse manure	0.5	0.2	10	22	2732	226	85
Coffee parchment	0.1	0.1	33	18	150	30	70
Coffee pulp	0.1	0.2	11	21	77	46	11
Compost	1.5	2	-	-	-	-	-
Bone meal	0.4	-	0.4	2	11	2	18
Hoof and horn meal	0.1	2.4	0.9	12	731	23	115
Fish silage	0.2	-	-	45	552	400	51
Mucuna sp.	0.3	0.3	30	23	370	103	66
Crotalaria juncea	0.3	0.2	20	7	281	60	14
Corn	0.2	0.2	16	10	120	110	25

References: Trani & Trani, 2011; Agüero et al., 2014 and Fierro-Cabrales. et al., 2018

Development Stage

Table 6. Recommendations for fertilizing coffee trees during the growing stage without soil analysis.

Nutrient (g/tree)	Symbol	Months After Planting					
		2	6	10	14	18	Total
Nitrogen	N	7	9	12	14	16	58
Phosphorus	P_2O_5	4	-	5	-	6	15
Potassium	K_2O	-	-	5	-	10	15
Magnesium	MgO	-	-	2	-	3	5

Reference: Cenicafé, 2012

Table 7. Adjustment of fertilizer according to the farm's shade density.

Shade Density (%)	Plant Density (plants/ha)	
	5,000-7,500	< 5,000
Direct Sunlight / Shade < 35%	95%	85%
Shade 35-45%	85%	75%
Shade 45-55%	-	50%
Shade > 55%	-	0%

Reference: Cenicafé, 2012
Note: Should be read as, for example, that for a plant density inferior to 5,000 plants/ha and a shade cover of 47%, 50% of the maximum amount of fertilizer should be applied.

Production Stage

Table 8. Recommendations for fertilizing coffee trees during the production stage without soil analysis according to shade cover and plant density.

Nutrient		N (kg/ha/year)		K_2O (kg/ha/year)		P_2O_5, MgO, S (kg/ha/year)	
Plant Density		5,000-7,000	< 5,000	5,000-7,000	< 5,000	5,000-7,000	< 5,000
Shade Cover (%)	< 35	285	255	250	220	48	43
	35-45	255	225	220	195	43	38
	45-55		165		145		28

Reference: Cenicafé, 2012

Scales for Compost Preparation in Java

- Small Scale: Individual farmer composting site.
- Intermediate Scale: Compost house shared by farmers from the same village.
- Large Scale: The Olam processing plant.

Small Scale

Selection of the Site

The composting site must be of easy access, flat, shaded, protected from the weather and far from any source of water and from coffee trees in order to avoid contamination (with water and the coffee borer, respectively).

Materials and Tools

All or some of these ingredients can be used in composting:

- Manure (from cows, goats, chickens, buffalo, etc.)
- Coffee pulp
- Green matter
- Dry matter
- Soil
- Topsoil
- Mucilage water or EM4
- A screen for sifting
- A hose or watering can
- A spade or machete
- A thermometer
- A compost house
- Personal safety equipment

Consideration:
- Consider the 20% average reduction of the volume of the original mixture.

Preparation of the Mixture and Pile

- Grind the organic matter.
- Prepare alternating layers, 20 cm in height, of fresh and dry matter with a initial ratio of 25:1 - 40:1.
- Moisten each layer with water, mucilage water or EM4.
- Cover the mixture with dry leaves, banana leaves or soil in order to limit insect infestation.

Considerations:

- Get the manure on the day the pile is to be made.

- The ideal size of the particles at the beginning of the process is between 5-30 cm.

Figure 23. Individual compost house in Java where chickens are present at the composting site.

Turnover

- Ventilate the mixture by mean of weekly turns during the first month.
- After the first month, turn the mixture every two months until the maturation phase.
- In the maturation phase, do not turn the pile.

Considerations:

- Follow these parameters for the decomposition process for organic matter in order to ensure quality:

Table 9. Parameters to follow during the decomposition process for organic matter.

Monitoring Parameters	Start of the Process (0 - 2 Weeks)	Mid-Process (2 - 5 Weeks)	Maturation (5 Weeks - 6 Months)
Humidity (%)	50-60%	45-55%	30-40%
Particle size (cm)	< 25 cm	15 cm	< 1.6 cm
Temperature (°C)	45-60 °C	45 °C	Ambient temperature
Smell of the mixture	Fruit, green matter	Slightly acidic	Humid soil
Colour of the mixture	Initial colour	Brown	Black

Reference: FAO, 2013

- Record quality indicators throughout the process.

Sifting

- Sift the compost manually, mechanically or using animals (chickens, for example).
- The organic matter that does not go through the sieve is to be incorporated into the following compost batch.

Storage

- Store the compost in closed bags in a shady area.

Application

- Compost is applied directly to the soil or in a compost hole.

Consideration:

- A homemade mixture that does not contain manure is not considered to be compost, but as a soil improver.

Intermediate Scale

A shared compost house for groups of farmers.
The method of preparation is identical to that for small-scale compost production.
Please refer to the above section.

Figure 24. A compost house in Java.

Figure 25. Manure and urine from animal husbandry can be used in preparing compost.

Large Scale

Materials and Tools

- Coffee pulp
- Mucilage water
- Manure
- Tanks
- Tubes
- Bags
- Compost house
- Shovels

Preparation Process

- Pulp is collected from the processing plant and transferred to the composting site.
- The first batch of water from coffee fermentation is collected and stored in a tank.
- It is sprinkled on the fresh coffee pulp at the compost site at a 1:1 ratio.
- The material sits for one month and is turned every week.
- After one month, manure is added at a 1:3 ratio (1 kg of manure:3 kg of compost).
- The substrate is then bagged.

Figure 26. Process for preparing compost at the Olam processing plant.

Preparation of Worm Compost for the Nursery

Worm compost is made with pre-composted materials, which can come from the compost itself or from fresh materials pre-composted in piles. Worm composting is a decomposition process that takes at least three months, depending on weather conditions.

Selection of the Site

The composting site must be of easy access, flat, shady, protected from the weather and isolated from any source of water (rivers, lakes, etc.) in order to avoid contamination.

Figure 27. Worm compost house at Olam facility.

Figure 28. Homemade worm compost.

Materials and Tools

- Coffee pulp or compost
- Red Californian earthworms
- Personal safety equipment
- A worm compost house or beds

Consideration:
- Apply *Beauberia bassiana* to the pulp beforehand to avoid the spread of coffee borer.

Preparation of Worm Compost

- Pre-decompose the pulp for three months.
- Transfer the decomposed pulp into worm beds and add the worms (1 kg/m²).
- Let sit for four months and gently turn the mixture every 15 days.
- Cover the bed with a jute bag to keep humidity in.
- Water weekly if necessary.
- The finished product should be black and humid, smell like fresh soil, look homogeneous and feel light. Worms should be seen on top of the mixture.

Considerations:
- Before adding the worms, perform a trial with the substrate.
- Maintain the following conditions in the mixture:

Table 10. Conditions to maintain in the worm bed.

Variables	Ideal Conditions
Temperature	25 °C
Humidity	80%
pH	6.5-7.5
Light	Reduced

- Keep a record of the conditions observed during this process.

Figure 29. Pulp being composted by worms.

Harvesting Worm Compost

- Add fresh coffee pulp to the bed.
- Worms will migrate on their own to the new feeding site.
- Harvest the worm-free compost.

Figure 30. Worm compost.

Sifting

- Mechanically or manually sift the worm compost with a 1-2 cm mesh.
- Material that did not make it through the mesh is to be reincorporated into the next cycle.

Storage

- Store in closed bags in a shady area to maintain the substrate's humidity.

Figure 31. Finished worm compost.

Application

- Use part of the mixture for the substrate in the nursery.

Controls

Table 11. Controls for worm compost.

Indicator	Reason	Controls
Thin worms	Lack of organic matter	Add organic matter
Worms escape	Lack of organic matter	Add organic matter
	Worm compost is ready	Harvest the compost
	Increased humidity or temperature	
Water leaking from the mixture	Excess humidity	Gently turn the mixture
Dry mixture	Lack of humidity	Moisten the mixture to reach 80% humidity again
Presence of pests (birds, chickens)	Natural predators	Protect the worm composting site
Presence of red ants	Lack of humidity	Moisten the mixture to reach 80% humidity again

Preparation of Organic Biofertilizers

Compost Leachate

Recipe

- Ferment fresh mucilage water in the coffee pulp at the compost site for one month.
- The leachate from the composting process is collected and stored in a tank.

Use

- Apply at drench.

Cost

- None.

Figure 32. Liquid organic fertilizer.

Organic Fertilizer Made of Goat Manure and Tephrosia

Materials and Ingredients

- 20 kg of goat manure
- 5 kg of tephrosia
- 60 L of water
- A hermetic drum with a gas extraction system

Preparation

- Ferment all ingredients for one week.
- Label the drum identifying the organic fertilizer, along with the preparation date.

Use

- Apply every two weeks.
- Use at drench.

Cost

- Average cost: 4,000 IDR/100 L

Figure 33. Organic fertilizer made of goat manure and tephrosia.

Organic Fertilizer Made of Goat Manure

Materials and Ingredients

- 40 kg of goat manure
- 60 L of water
- A hermetic drum with a gas extraction system

Preparation

- Add the ingredients to the drum.
- Ferment for two weeks.
- Label the drum identifying the organic fertilizer, along with the preparation date.

Use

- Apply every two weeks.
- Use at drench.

Cost

- Average cost: 24,000 IDR/100 L

Figure 34. Organic fertilizer made of goat manure.

Organic Fertilizer Made of Mucilage Water and EM4

Materials and Ingredients

- 2 L of EM4
- 100 L of mucilage water
- A hermetic drum with a gas extraction system

Preparation

- Add the ingredients to the drum.
- Ferment for one week.
- Label the drum identifying the organic fertilizer, along with the preparation date.

Use

- Apply every two weeks.
- Use at drench.

Cost

- Average cost: 60,000 IDR/100 L

Figure 35. Organic fertilizer made of mucilage water and EM4.

Biol

Materials and Tools

- 40 kg of manure
- 70 L of water
- 3.5 L of molasses
- 3 L of milk
- 4 kg of ashes
- 5 kg of green matter
- 200 L drum with gas extraccion system
- A wooden stick for stiring
- PPE

Preparation of the Mixture

- In a drum add all the ingredients.
- Ferment for 30 to 40 days and mature the mixture for 2 to 3 months.
- Label the drum identifying the organic fertilizer, along with the preparation date.

Consideration:

- The absence of bubbles in the gas extraction system is an indicator that the mixture is ready.

Use

- Foliar application (diluted at 30-50%).

Storage

- The biopreparation can be stored for four months.

Supermagro

Materials and Tools

- 40 kg of manure
- 100 L of water
- 9 L of mollasses
- 9 L of milk
- 3 kg of zinc sulfate
- 0.3 kg of iron sulfate
- 2 kg of calcium chlorate
- 1 kg of magnesium sulfate
- 0.3 kg of copper sulfate
- 1 kg of borax
- A drum of 200L
- PPE

Preparation of the Mixture

- In the drum with gas extraction system add: 40 kg of manure, 100 L of water, 1 L of milk, 1 L of molasses, mix it and leave it to ferment for 3 to 5 days.
- Add every five days one of the minerals with 2 L of water, 1 L of molasses, and 1 L of milk until 180 L is reached.
- Ferment for 30 days.

Use

- Once ready, stir the mixture, filter it and apply it foliar (diluted to 5%) or at drench (diluted at 20%). Application must be early moring.

Storage

- Store the supermagro in a container or in a drum in a shady area. It can be stored up to one year.
- Label the drum identifying the organic fertilizer, along with the preparation date.

Liquid Worm Humus

Materials and Tools

- 0.5 kg of worm humus
- 2.5 L of water
- 20 L container
- Stick to stir
- Filter

Preparation of the Mixture

- In a 20 L container mix 0.5 kg of worm humus with 2.5 L of water.
- Rest the mixture for 48 h.
- Filter.
- Mix 2 L of liquid humus.
- Filtrate.

Use

- Apply 2.5 mL of worm humus for each L of water.

Plant-Based Fertilizers

Plant	Scientific name	Use	Extraction technique	Main nutrient contents
Greater burdock	*Arctium lappa*	Fertilizer	Fermented extract	K
Comfrey	*Symphytum* spp	Fertilizer & stimulant	Decoction, fermented extract	P, K
Eagle Fern	*Pteridium aquilinum*	Fertilizer	Fermented extract	P
Common dandelion	*Taxacum denta-leonis*	Stimulant	Fermented extract	K
Neetle	*Urtica dioica*	Fertilizer & stimulant	Fermented extract	N, mineral salts, oligoelements
Elder	*Sambucus nigra*	Stimulant	Fermented extract	-

Plant-Based Organic Pesticides

There are endless recipes for the preparation of plant-based organic materials. The plants used must be healthy, in a good phytosanitary state and located in a safe environment (away from sources of contamination). In order to maximize the nutrient content, plants must be harvested according to the development phase needed:

- Fruits: at maturation.
- Roots: at the end of the growth period.
- Flowers: before they open completely.
- Leaves: before flowers open completely.

There are different ways of extracting components from plants:

Extraction Method	Technique	Aim	Use	Shelf Life
Oil-based maceration	Quick fermentation in oil	Fungicide, insecticide	Diluted	3 weeks
Water-based maceration	Quick fermentation in cold water	Fungicide, insecticide	Diluted	24 hours
Alcoholic extractions	Maceration in alcohol	Insecticide	Diluted	6 months
Infusion	Infusion in hot water	Strengthens the natural defences of plants, insecticide	Pure or diluted	24 hours
Decoction	Extraction of active ingredients from plants with hot water	Strengthens the natural defences of plants	Pure or diluted	72 hours
Purine / fermented extract	Lengthy fermentation in cold water	Bloom stimulator, growth stimulator, fungicide, insecticide	Diluted	1 year

Recipes differ according to the plant, the part of the plant used and the extraction technique.

Table 12. Identification of useful plants and their organic uses.

Plant common name	Sientific name	Part Used	Use	Technique	Dilution
Neem tree	*Azadirachta indica*	Kernel	Insecticide	Maceration	Pure
German chamomile	*Matricaria chamomilla*	Flowers	Insecticide	Infusion	Pure
Marigold	*Tagetes* spp.	Roots	Nematicide	Cover crop	-
Chrysanth	*Chrysanthemum*	Flowers	Insecticide	Infusion	Pure
Tobacco	*Nicotiana tabacum*	Leaves	Insecticide	Infusion	Dilution at 5%
Tobacco	*Nicotiana tabacum*	Leaves	Insecticide	Oil based maceration	Pure
Nettle	*Urtica dioica*	Leaves, stem	Insecticide	Fermented extract	Dilution at 10%
Nettle	*Urtica dioica*	Roots	Fungicide	Decoction	Dilution at 10%
Nettle	*Urtica dioica*	Leaves	Reppellent	Maceration	Dilution at 10%
Elderberry	*Sambucus nigra*	Leaves	Reppellent	Decoction	Pure
Chilli	*Capsicum annuum*	Entire chilli	Insecticide	Oil based maceration	Pure
Mint	*Mentha spicata L.*	Leaves	Repellent	Infusion	Pure
Pepper	*Piper nigrum*	Fruits	Insecticide	Oil based maceration	Pure
Lavander	*Lavandula latifolia*	Flowers, stems	Insecticide	Fermented extract	Dilution at 10%
Lavander	*Lavandula latifolia*	Flowers, stems	Insecticide	Infusion	Pure
Rhubarb	*Rheum* spp.	Leaves	Reppellent	Maceration	Pure
Horseradish	*Armoracia rusticana*	Leaves	Fungicide	Maceration	Pure
Onion	*Allium cepa*	Bulb	Fungicide	Maceration	Pure
Onion	*Allium cepa*	Bulb	Insecticide	Maceration	Pure
Comfrey	*Symphytum* spp.	Leaves	Insecticide	Decoction	Pure
Garlic	*Allium sativum*	Bulb	Fungicide	Decoction	Dilution at 10%
Garlic	*Allium sativum*	Bulb	Insecticide	Decoction	Dilution at 20%
Garlic	*Allium sativum*	Bulb	Insecticide	Oil based maceration	Pure
Tephrosia	*Tephrosia vogelii*	Leaves	Insecticide	Fermented extract	Dilution at 5%
Surian	*Toona sureni*	Leaves	Insecticide	Fermented extract	Dilution at 5%
Chinaberry tree	*Melia azedarach*	Fruits	Insecticide	Fermented extract	Pure
Tansy	*Tanacetum vulgare*	Flowers	Insecticide	Decoction	Pure
Tansy	*Tanacetum vulgare*	Flowers	Insecticide	Infusion	Pure
Tansy	*Tanacetum vulgare*	Flowers	Fungicide	Infusion	Dilution at 20%
Tansy	*Tanacetum vulgare*	Flowers	insecticide	Decoction	Pure
Tansy	*Tanacetum vulgare*	Flowers, leaves	Reppellent	Fermented extract	Dilution at 10%
Clary	*Salvia sclarea*	Leaves	reppellent	Maceration	Pure
Wild Sweet William	*Saponaria officinalis*	Entire plant	insecticide	Infusion	Pure
Eagle Fern	*Pteridium aquilinum*	Leaves	Insecticide	Decoction	Pure
Eagle Fern	*Pteridium aquilinum*	Leaves	Insecticide	Fermented extract	Dilution at 5%

Below are common recipes for each extraction method, which will probably need to be adjusted in accordance with the plant used.

Water-Based Maceration

Plants That Can Be Used

- Nettles, onions, surian, tephrosia, tobacco, marigolds, chamomile, chrysanthemum, neem.

Parts of the Plant

- Fruit with the skin, roots, leaves, stems, flowers.

Materials and Ingredients

- 100 g of fresh vegetal material
- 1 L of water
- A bucket
- A wooden stick for stirring
- A sieve

Preparation

- Clean the vegetal material.
- Cut it into small pieces.
- Immerse it in water for 24 hours (48 hours for nettles).
- Filter it.

Use

- Apply it undiluted.

Cost: N/A

Oil-Based Maceration

Plants That Can Be Used

- Garlic, pepper, tobacco.

Parts of the Plant

- Fruit with the skin, leaves (for tobacco).

Materials and Ingredients

- 100 g of vegetal material
- Oil
- Liquid black soap
- 1 L of water
- A bucket
- A wooden stick for stirring
- A sieve

Preparation

- Clean the vegetal material.
- Pound 100 g of vegetal material with its skin.
- Add three spoons of oil.
- Let sit for 24 hours.
- Filter and pound the pulp to maximize extraction.
- Add 1 teaspoon of liquid black soap and mix.
- Add 1 L of water and let sit for three days.
- Stir the mixture.
- Filter.

Use

- As an insecticide or fungicide.
- Dilute to 5% - 10% and spray at night.

Cost: N/A

Alcoholic Maceration

Plants That Can Be Used

- Garlic and pepper together.

Parts of the Plant

- Leaves.

Materials and Ingredients

- Materials and Ingredients:
- 50 g of garlic
- 50 g of pepper
- 1 L of ethyl alcohol at 90°
- A jar with hermetic lid
- A mortar
- A sieve

Preparation

- Grind the garlic and the pepper.
- Macerate the mixture in 1 L of alcohol for seven days.
- Filtrate.
- Store in a jar.

Use

- Apply 5-7 mL of the mixture in 1 L of water.

Cost: N/A

Infusion

Plants That Can Be Used

- Mint, spearmint, chamomile, tephrosia, surian.

Parts of the Plant

- Leaves and flowers.

Materials and Ingredients

- 100 g of fresh vegetal material
- 1 L of water
- A knife
- A bucket
- A cover
- A filter
- A wooden stick for stirring
- Heat source: fire

Preparation

- Clean the vegetal material to be processed with clean water.
- Cut it into small pieces.
- Add the vegetal material to a bucket with 1 L of water and heat (not to boiling).
- Stir the mixture.
- Remove the bucket from the heat, cover and let sit for 24 hours.
- Filter and store.

Use

- Spray undiluted or diluted to 50%.
- Prevents insect attacks and the spread of fungi.
- Can be conserved for 24 hours.

Cost: N/A

Decoction

Plants That Can Be Used

- Garlic, nettles.

Parts of the Plant

- Thick leaves, roots, seeds.

Materials and Ingredients

- 100 g of vegetal material
- 1 L of water
- A knife
- A cover
- A bucket
- A sieve
- A wooden stick for stirring

Preparation

- Clean the vegetal material with clean water.
- Cut it into small pieces.
- Soak for 24 hours in cold water.
- Add the vegetal material to 1 L of water and boil it for 10-30 minutes, depending on the consistency of the plants.
- Remove from heat and let the mixture sit for 15 minutes.
- Filter and store.

Use

- Apply to foliage.

Cost: N/A

Purine / Fermented Extract

Plants That Can Be Used

- Nettles, tephrosia, surian, chinaberry tree

Parts of the Plant

- Leaves and stems.

Materials and Ingredients

- 1 kg of vegetal material
- 10 L of water
- A knife
- Gloves
- A cover
- A drum
- A wooden stick for stirring
- A sieve

Preparation

- Cut the vegetal material into small pieces.
- Add the ingredients to a drum, cover it and place it in a shady area.
- Stir it every day.
- After three days, bubbles will appear.
- Once there are no more bubbles, the process is finished and the product is ready to use (this takes eight-10 days).
- Filter.

Use

- Apply every 15 days at drench or on leaves:
    - As a stimulant: dilute to 5%.
    - As a fertilizer: dilute to 10%.
    - As insecticide: dilute to 10%.

Cost: N/A

Considerations:

- Each ingredient must be processed independently and then mixed, if desired.
- Do not add aromatic plants to cover the smell, as this will alter the product's properties.
- Manure can be added to the mixture.
- Purine can be added to a compost pile to speed up the decomposition process.

Black Soap

Properties

- Insecticide, bactericide, moisturizer, emulsifier.
- Solution for mealybugs, aphids, red spiders.

Recipe

- Mix 3 teaspoons of liquid black soap with 1-5 L of hot water.
- Wait for the mixture to cool down.
- Apply to leaves in the morning or late afternoon.

Frequency of Application

- Weekly, if the problem is serious.

Application

- For bacteria (sooty mould): 3 teaspoons in 5 L of hot water.
- For insects: 3 teaspoons in 1 L of hot water.
- As an adjuvant: 1-2 teaspoons in 1 L of water.

Cost

55,000 IDR/L of black soap

Materials and Ingredients

- Soap
- 1 L of water
- A cheese grater
- A bucket for heating water

Preparation

- Grate the soap with the cheese grater.
- Mix a handful of soap chips in 1 L of hot water.
- Mix until the soap completely dissolves.

Use

- Insect repellent (mainly aphids).
- Apply in a trench.

Cost

30,000 IDR / soap

Considerations:

- A few drops of lavender or mint essential oil can be added to act as a repellent.

- 1 teaspoon of rapeseed oil can be added to help remove the most resistant aphids.

Materials and Ingredients

- EM4
- A drum

Preparation

- Follow the instructions on the bottle.

Use

- EM4 can be added to the compost pile, to any biofertilizer recipe or applied directly to the farm's soil.

Cost

- 20,000 IDR/L

Bordeaux mixture acts as a fungicide and helps reduce coffee rust.

Materials and Ingredients

- 100 L of clean water
- 1 kg of copper sulphate
- 1 kg of lime
- A 200 L drum
- A 20 L bucket
- A wooden stick for stirring
- A machete
- Personal safety equipment

Preparation of the Mixture

- Dissolve the copper sulphate in 10 L of water.
- Dissolve the lime in 90 L of water.
- Add the diluted copper sulphate to the diluted lime.
- Stir until a homogeneous mixture is obtained.
- Identify the contents of the drum with the preparation date.
- Use the mixture within the following three days.

Figure 36. Bordeaux mixture.

Use

- Apply on leaves every month during the rainy season.
- Apply with a plastic, not metallic, spout.
- Use 200 L per hectare.

Considerations:

- Apply in the morning before 9 a.m. or in the afternoon after 5 p.m.

- Apply only to the plant's leaves.

- Do not apply to blooming or young plants.

- This mixture can be used in nursery.

Controls

- Acidity Test: Immerse a knife or machete in the mixture for one minute. If the machete oxidizes in contact with the mixture, it is not ready, and more lime should be added. If it does not oxidize, the mixture is ready.

Figure 37. Acidity test.

References:

Aubert, C. 2015. *J'associe mes cultures... et ça marche!* Ed. Terre Vivante, Mens.

Castro Toro., A.M, Rivillas Osorio, C.A, Serna Giraldo, C.A, Mejia, C.G., 2008. *Germinadores de café construcción, manejo de Rhizoctonia solani y costos.* Available at: https://www.cenicafe.org/es/publications/avt0368.pdf.

Castro Toro., A.M, and Rivillas Osorio, C.A, 2018. *Trichoderma spp. Modos de acción y eficacia en el cultivo de café.* Available at: https://issuu.com/revistaelcafetalero/docs/trichoderma.

Cenicafe. 2018. *Trichoderma acción y eficacia en el cultivo de café por Cenicafe.* Available at: https://issuu.com/revistaelcafetalero/docs/trichoderma.

Cenicafé. 2012. *Fertilizacion de cafetales sin analisis de suelo.* Available at: https://www.slideshare.net/AGROROYERCITO/fertilizacion-de-cafetales-sn-analisis-de-suelos.

FAO., 2013. *Los biopreparados para la producción de hortalizas en la agricultura urbana y periurbana.* Available at: http://www.fao.org/3/a-i3360s.pdf.

Fierro-Cabrales, N., Contreras-Oliva, A., González-Ríos, O., Rosas-Mendoza, E.S., Morales-Ramos,V., 2018. *Caracterización química y nutrimental de la pulpa de café (Coffea arabica L.)* . Agroproductividad. Vol. 11, Núm. 4. pp. 9-13.

Gomez, I., L. Thivant, L., 2017. *Training Manual for Organic Agriculture.* Available at: https://books.google.com.mx/books?id=cFaMDwAAQBAJ&lpg=PP1&dq=training%20manual%20for%20organic%20agriculture&pg=PP1#v=onepage&q=training%20manual%20for%20organic%20agriculture&f=false

IFOAM, *Definition of Organic Agriculture.* Available at: https://www.ifoam.bio/en/organic-landmarks/definition-organic-agriculture.

Jackson, Doug Skillman, Jane Vandermeer, John, 2012. *Indirect biological control of the coffee leaf rust, Hemileia vastatrix, by the entomogenous fungus Lecanicillium lecanii in a complex coffee agroecosystem.* Available at: http://agris.fao.org/agris-search/search.do?recordID=US201400177114.

Lapouge-dejean., Lapouge,S., 2013. *Je prepare mes potions pour le jardin.* Purins, badigeons, traitemants. Ed : Terre vivante, Mens.

Lefrancois, S., 2017. *Jardiner sans engrais ni pesticides chimiques.* Ed. Massin.

Lefrancois,S., Thorez, J.F. 2010. *Plantes compagnes au potager bio, le guide des cultures associees.* Ed. Terre Vivante, Mens.

Ministry of Agriculture of the Republic of Indonesia, Regulation of the Minister of Agriculture, 2013. *Organic Agriculture System.* Available at: https://www.usdaindonesia.org/wp-content/uploads/2013/11/Permentan-No-64-2013.pdf.

Rivera, J.R., 2007. *Biofertilizantes preparados y fermentados a base de mierda de vaca.* Available at: http://agroecologa.org/wp-content/uploads/2016/12/ABC-de-la-Agricultura-organica-Abonos-organicos.pdf.

SCOPI., 2016. Pelatihan Budi Daya Berkelanjutan dan Pascapanen kopi arabika.

Teguh Wahyudi, pujiyanto, dan Misnawi. 2016. *Kopi sejarah, botani, proses produksi, pengolahan, produk hilir, dan system kemitraan.* Gadjah Mada University Press.

Wintgens, J.N. (ed.), 2004. *Coffee: Growing, Processing, Sustainable Production: A Guidebook for Growers, Processors, Traders, and Researchers.*

World Coffee Research, 2019. *Good Practice Guide: Coffee Nursery Management.* Available at: https://worldcoffeeresearch.org/work/good-practice-guides-gu%C3%AD-de-buenas-practicas/.

World Coffee Research, 2019. *Good Practice Guide: Coffee Seed Production.* Available at: https://worldcoffeeresearch.org/work/good-practice-guides-gu%C3%AD-de-buenas-practicas/.

Constance Dorise

Farmer's Manual
Good Agronomic Practices in the Production of Organic Coffee
Java, Indonesia

1st edition
-
Editorial Project: **Lasca Studio**
Support: **Nespresso**

NESPRESSO®