Farmer's Manual

Good Agronomic Practices in the Production of Organic Coffee

Aceh, Indonesia

NESPRESSO

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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.

2.1

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.
- 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 March-April

- 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.
- Organic pesticide should be applied when necessary.
- Conduct regular weed control in and around the nursery.

Good Practice

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

Figure 4. 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 5. 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 6. Terracing.

Good Practice

- Place anti-erosion strips between rows of coffee trees with deeply rooted perennials, such as lemongrass (*Cymbopogon citratus*), rattlepods (*Crotalaria* spp.) or Mexican sunflower (*Tithonia diversifolia*).
- These plants can also provide mulching or composting materials.

Figure 7. Crotalaria spp.

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 varieties.
    - 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.

Advanced Practice

- The “Pagar Ganda Segiriga” arrangement (double triangle border method) is recommended for optimizing intercropping.

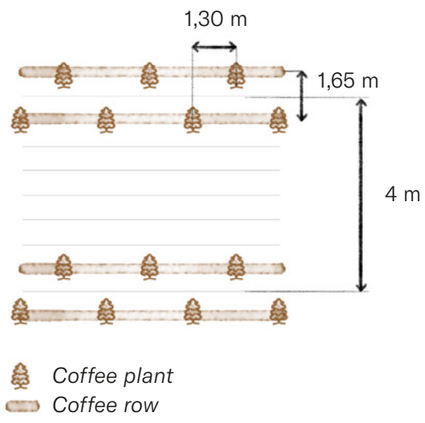

Figure 8. “Pagar Ganda Segiriga” arrangement.

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 (September-October).
- 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 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.

Intercropping

Intercropping allows for diversified production and distributes risk between several different crops.

Figure 9. Intercropping.

Basic Practice

- Associate plants that are not from the same botanical family.
- Associate plants that have complementary root systems (deep roots with shallow roots).
- Respect spacing.

Table 2. Examples of successful associations.

Favourable Associations		Unfavourable Associations
Association: Garlic +	Carrots Tomatoes Lettuce	Beans Onions Leeks Peas
Association: Fava Beans +	Almost all vegetables	Onions Garlic Other legumes
Association: Peas and Beans +	Corn Potatoes	Leeks Garlic Onions
Association: Onions +	Carrots Lettuce	Peas, beans Garlic, leeks Corn
Association: Chilli +	Cabbage French marigold Mexican marigold	Tomatoes Potatoes Eggplant

Note: This should to be read as, for example, garlic having a favourable association with tomatoes but an unfavourable association with beans.

Reference: Aubert, 2015

Good Practice

- Plant vegetables that require low levels of fertilizer, such as garlic or onions.
- Rotate vegetable associations yearly.
- Alternate line of vegetables having the same cycles or mix vegetables and aromatic plants on the same line.
- Fertilize vegetable with an average amount of 3 kg of compost per year per m².

Table 3. Demand for compost or manure of some vegetables.

Major (30 kg/10 m²)	Moderate (< 30 kg/10 m²)	None
Potatoes Cabbage Cucumbers Corn Chilli Tomatoes	Beetroot Carrots Beans Lettuce	Garlic Onions Shallots

Reference: Aubert, 2015

Advanced Practice

- If there is a need to use plants with a high fertilizer consumption, associate them with leguminous species (*Fabaceae* family).
- Use RCW (Ramial Chipped Wood) mulch to reduce the weed population and keep in moisture.

Consideration:
- Be careful with plants with autotoxic properties (for example, the *Brassicaceae* family).

4.

Nutritional Management

The application of organic fertilizers occurs in March-April and September-October. 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.

The quantity of fertilizer to be used will depend on production objectives and the results of a soil analysis.

Compost

Compost is prepared in January-February 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 Aceh: pile composting. Some farmers tend to leave their coffee pulp on the farm and wait for it to decompose. We will not discuss this practice as we do not consider it beneficial.

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 solely of coffee pulp.
- It must decompose for at least three months.
- Apply 6 kg of compost twice a year in a hole or at the surface.
- Fertilize with an average amount of 3 kg of compost/year/m².

Figure 10. Fresh and decomposing coffee pulp (left) and decomposed coffee pulp (right).

Good Practice

- A compost pile made of coffee pulp complemented by a mixture of mucilage residue and water (or EM4) to both speed up the decomposition process and increase the nutritional value of the compost.

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.

Figure 11. Compost station.

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 4. 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

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 5. 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 6. 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.

6.

Pest and Disease Management

Pest and disease management is an important part of organic production, to be performed in January-February and July-August. 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.

Common Pests

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 litre of water; apply one litre of the mixture per 19 L of water in two to three applications during the harvest).

Mechanical Control

- Install 20 traps per hectare and place them on the coffee trees, one meter 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 12. 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 farm'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 farm. 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.

Root Rot Diseases *(Rosellinia bunodes, R. pepo, Leptoporus lignosus, Phellinus lamoensis, etc)*

What Are They?

Fungi present in the soil that infect coffee and shade trees.

Figure 15. Dead lamtoro.

Symptoms

- Yellowing leaves and necrosis.
- Star-shaped white mycelia below the cut.
- Withered leaves.
- Branch decay.

Causes of Development and Spread

- High humidity and temperature.
- Spread by tools (hoes).
- Practices that injure the tree's stems or roots.
- Immediate replanting after the eradication of contaminated trees.
- High organic matter content in the soil.

Impact of Root Rot Diseases

- Plant weaken and die.

Techniques to Prevent Coffee Leaf Rust

Type of Control	Type of Practice	Technique	Advantages	Disadvantages & Risks	Cost (IDR)
Biological	Advanced	*Trichoderma koningii*	Reduces incidence	Not easy to buy	35,000/500 g
Cultural	Good	Cut, dig and burn Isolate the area	Eradication of the disease	Loss of the tree	Time
Chemical	Good	Apply sulfur	Good results	-	20,000/kg

Cultural Control

- Immediately remove affected and neighboring shade and/or coffee trees.
- Dig a hole to remove root residue.
- Burn all residue.
- If the problem is serious, dig a trench aroud the affected area to isolate the infestation.
- Expose the infected site to direct sunlight for at least three months, keeping it free of weeds, before replanting.
- Apply Bordeaux paste after pruning and disinfecting tools with a copper-based fungicide.

Biological Control

- Apply *Trichoderma koningii* to the affected and surrounding areas (50 g/hole).

Chemical Control

- Apply sulfur to the hole and surrounding areas.

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, many 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 biofungicides or 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 January-February and July-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.

Bad pruning

Good pruning

Figure 16. Illustration of bad and good prunings.

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 17. Single stem capping (Wintgens, et al.,2004).

Young Growth Removal

Remove young growth on horizontal branches, from the trunk to 30 cm away, to allow sunlight to penetrate and air to circulate.

Figure 18. Clearing the first 30 cm.

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.
- Desucker the main stem every two to four weeks, all year round.

Advanced Practice

- Remove plagiotropic branches to maximize light penetration and air circulation:
  - Year 1: first pair
  - Year 2: third pair
  - Year 3: second pair
  - Year 4: fourth pair
  - Year 5: first pair

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

- The Matalima system: put one new plant in between four old plants.
- This should be done every 5-6 years.

Good Practice

- Among the many suckers, select one to start a new tree. The old trunk is stumped later on.
- Systematically remove all unneeded suckers growing on the trunk.
- When possible, keep several primary inferior branches to optimize sap circulation in the plant.

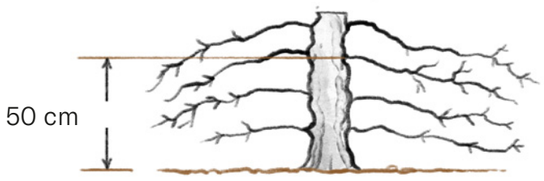

Figure 19. a) Rejuvenation.

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.
- Stumps should be perfectly cleaned to encourage the growth of new shoots.

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 in 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

- Plant lamtoro (*Leucaena leucocephala*), a fast-growing leguminous tree that produces high-quality firewood and has leaves with a high protein content, which can be used for feeding animals (except for equines).
- Plant the trees in a 4 m x 4 m grid.

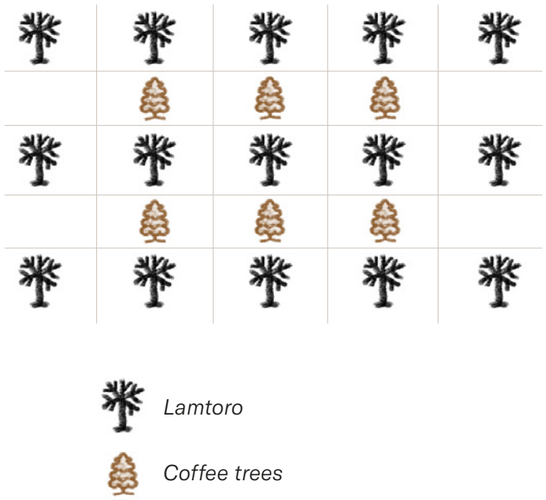

Figure 20. a) Planting design for shade trees.

Good Practice

- Plant fruit trees such as durians, jackfruits, bananas, avocadoes, 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 21. 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.
- Install a beehive.

Figure 22. Neem tree.

Figure 23. a) Pepper. *b) Vanilla.* *c) Beehive.*

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 January-February and July-August.

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.

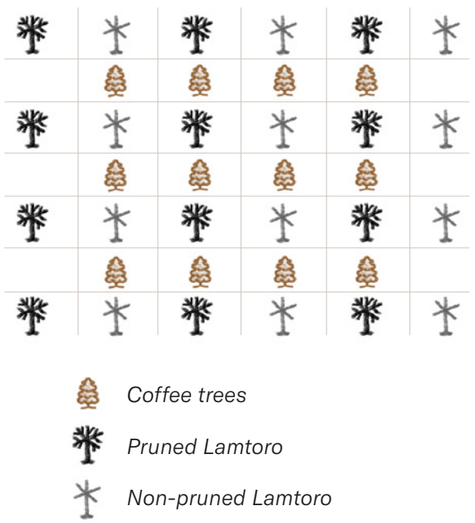

Figure 24. Pruned Lamtoro.

Maintenance Pruning

- Shade trees must be pruned every year. Either 100% of the population is pruned or 50% one year and the other 50% the following year.
- Maintain primary branches more than 5 m above ground level and prune the ones below.
- Maintain between 20-45% shade cover, depending on local conditions.

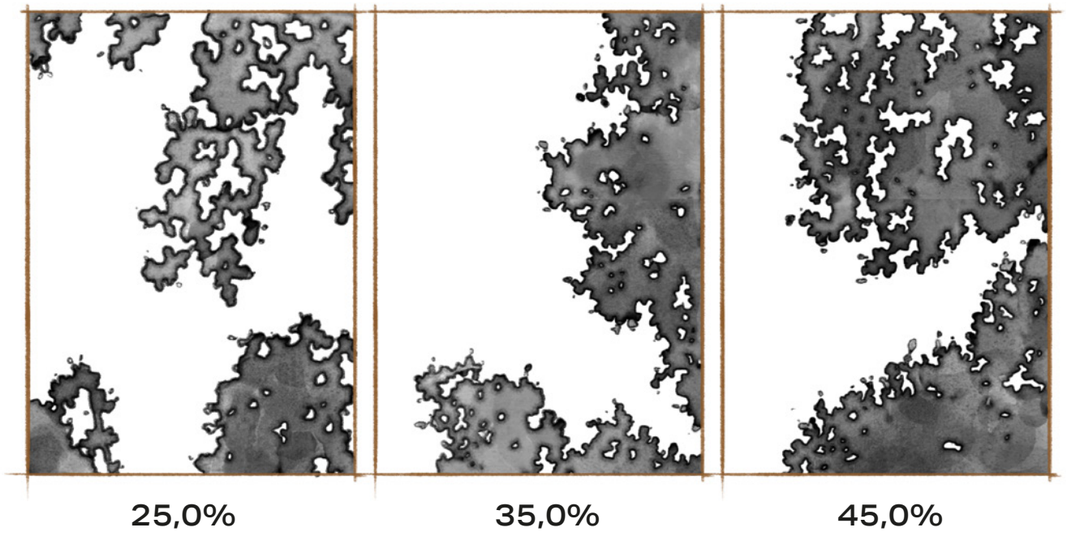

Figure 25. Percentage of shade cover.

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

This regulation applies to coffee as well as any other crops cultivated on the farm.

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 7. 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

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

Development Stage

Table 8. 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 9. 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 10. 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 Aceh

- 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:

- Coffee pulp
- 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

- Let the coffee pulp decompose in bags for two weeks.
- Transfer the pre-decomposed pulp to the compost house.

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 11. 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.

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

Traditional Soap (No Additives)

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

Tips:
- 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 26. 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 27. Acidity test.

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