Guide for Good Agricultural Practices for Seed Production and Nurseries in the Philippines







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About this Manual

This manual serves as a guide for good agricultural practices (GAP) in coffee seed production and the establishment of coffee nurseries in Philippine setting.

The Food and Agriculture Organization of the United Nations describes GAP as practices that address environmental, economic and social sustainability for on-farm processes, and result in safe and quality food and non-food agricultural products.

This publication provides a short, but comprehensive history of Philippine coffee, advices on how to track seed origins and traceability, along with instructions on the proper methods of coffee seed production and sound recommendations on the establishment and management of coffee nurseries.

The information presented in this manual are easy-to-follow which are accompanied by images, illustrations, and graphs that help facilitate clear understanding and appreciation of the best practices in coffee production.

The manual is designed as a reference guide and learning tool for Filipino coffee farmers, coffee producer organizations, and key players in the country's coffee value chain to encourage the adoption of GAP. Overall, it aims to impart significant knowledge and skills among its users with the objective of allowing them to produce high-quality coffee seedlings that will mature into productive and profitable trees.

Part 1

Coffee in the Philippines



The Philippines is one of the few countries that produces the four species of commercially viable coffee: Arabica, Liberica (Barako), Excelsa and Robusta. Climatic and soil conditions in the Philippines - from the lowland to mountain regions - make the country suitable for all four species.

According to the Philippine Coffee Board, the first coffee tree introduced to the Philippines was a Liberica tree that was introduced in Lipa, Batangas in 1740 by two Franciscan friars, where two Filipino natives who have been identified as part of the Macasaet family helped plant and propagate the seedlings. From there, coffee growing spread to other parts of Batangas like Ibaan, Lemery, San Jose, Taal, and Tanauan. Batangas owed much of its wealth to the coffee plantations in these areas and Lipa eventually became the coffee capital of the Philippines.

By the 1860s, Batangas was exporting coffee to America through San Francisco. In 1880, the Philippines was the fourth largest exporter of coffee beans, and when the coffee rust hit Brazil, Africa, and Java, it became the only source of coffee beans worldwide.

But in 1889 the Philippine coffee industry was hit by rust. That, coupled with an insect infestation, destroyed virtually all the coffee trees in Batangas. Since Batangas was a major producer of coffee, this greatly affected national coffee production. In two years, coffee production was reduced to 1/6th its original amount. By then, Brazil had regained its position as the world's leading producer of coffee. A few of the surviving coffee seedlings were transferred from Batangas to Cavite, where they flourished. This was not the end of the Philippines' coffee farming, but there was less area allotted to coffee because many farmers had shifted to other crops.

During the 1950s, the Philippine government, with the help of the Americans, brought in more resistant varieties of coffee. It was also then that instant coffee was being produced commercially, thus increasing the demand for beans. Because of favorable market conditions, many farmers went back to growing coffee in the 1960s. But the sudden proliferation of coffee farms resulted in a surplus of beans around the world, and for a while importation of coffee was banned in order to protect local coffee producers.

When Brazil was hit by a frost in the 1970's, world market coffee prices soared. The Philippines became a member of the International Coffee Organization (ICO) in 1980. Today, the Philippines produces 30,000 metric tons of coffee a year, with 70% of which coming from Mindanao.

Source: Philippine Coffee Board

Part 2

Seed Plantations





Seed Origin and Traceability

Traditionally, when coffee growers need seed, they turn to the plants of their own farm to collect it. They would select a plant that represents their ideal and use the cherries to produce seed to later create a nursery and finally plant the new plants in the field.

The problem is, not all of the seeds from the plant will share the same genetic characteristics of the mother plant, especially when the mother plant is planted near other plants of different varieties or characteristics. This is especially due to cross-pollination. The term cross-pollination is used when an individual's pollen pollinates another individual, delivering seed that has characteristics of both parents.

To avoid this kind of variability, coffee growers can turn to local entities that produce certified or verified seed.

This can be national or private organizations that can deliver proof of the traceability of the material, such as:

- Documents indicating the origin of seeds/seedlings
- Certificate of authenticity permits to produce seeds in order to develop seedlings (respect breeders' rights).
- Invoice/purchase order
- Name of variety
- Proof that variety is registered with the Bureau of Plant Industry National Seed Quality Control Services (BPI-NSQCS)
- Seed/seedling import documents (import must be legal)

Importance of pure genetic seed

The definition of "pure" refers to a population of plants with similar characteristics such as plant height, size, or bean shape. These characteristics are specific to one cultivar and distinguish it from another. This population must be homogeneous (minimum variability) and stable (characteristics must be inherited to the seed).

As a matter of fact, at most nurseries in coffee producing countries seeds and plants are marketed without traceability. There is no system to certify the origin and genetic purity of the varieties used. In order to renew plantations or to establish new ones, growers invest heavily to purchase new plants available near their regions. Some growers engage in making their own seedbeds.

As a result, growers often plant adulterated genetic material. It also can lead to increased susceptibility of plants to diseases and to lower yields. It is advisable that seeds from the selected coffee variety are obtained from certified, registered nurseries to make sure the variety comes from a renowned source with the required genetic stability and homogeneity.

Main species and varieties

It is very important to separate and define the terms of species, varieties and hybrids. First, we will discuss the larger unit, which is species. Species is defined as a group of similar individuals capable of exchanging genes or interbreeding with the result of viable offspring.

Coffee plants originated in Africa, in northern Ethiopia. Two major species exist commercially, *Coffea arabica* and *Coffea canephora*, although other such as *Coffea liberica* exist and many dozens of others that are not currently used as commercial coffee. From a business standpoint, *C. arabica* enjoys better reputation and cup quality. It stands for about 62% of world production.

Robusta or *C. canephora* is a bigger shrub with better resistance to pests and diseases than *C.Arabica*. It is used mainly for coffee mix or instant coffee. Its production cost is lower than that for *C. Arabica* due to its vigor and higher productivity. It is a strong shrub growing up to some 10 feet tall, blooming irregularly. Flowers take up to 11 months to mature and result in oval beans. It has better yield (higher productivity per hectare) than *C. arabica*, but with a more bitter taste.

Coffea arabica: Currently, more than 80% of the world production of Arabica coffee comes from Latin America. The genetic basis of Arabica coffee brought into Latin America in the 19th century is limited to two slightly different populations (Bourbon and Typica). Bourbon and Typica compose the most culturally and genetically important groups of C. arabica coffees in the world.



Coffea arabica



Coffea canephora or Robusta

The term varieties is used to refer to mutations from the same species that result in plants that have different characteristics from one another, but can still reproduce and exchange genes with one another. Bourbon and Typica are tall varieties from the same species *Coffea arabica*. These two varieties were the origin of the many arabica plants planted today. Mutations and selection of these tall material eventually lead to the compact stature materials, or short varieties. This process has had several stages:

FIRST STAGE
During the Green Revolution in the 50s, researchers created varieties/lines adapted to crop intensification, with excellent cup quality. These included the Caturra and Catuaí varieties, with compact stature and good organoleptic quality, but susceptible to coffee leaf rust.

SECOND STAGE
In view of coffee leaf rust, the resistance of *C. canephora* was transferred to improved varieties. Natural crossbreeding between *C. arabica* and *C. canephora* resulted in the Timor hybrid, which allowed to launch a program of crossbreeding with current varieties. From there, different groups of varieties called Catimores, Sarchimores or Colombia resulted. This research was conducted by the Centro de Investigacao da Ferrugem do Cafeeiro (CIFC in Oieras, Portugal. Different varieties resistant to several diseases such as coffee leaf rust were obtained, although their cup quality is equal to or lower than the standards developed between 1980 and 2000.

THIRD STAGE
From 1990 on, in view of new market demands and the development of biotechnology, new F1 hybrid varieties were developed. These have been selected for adaptation to "ecological" agriculture based on agroforestry. This program was launched in conjunction with PROMECAFE, CIRAD and CATIE. From a collection of African genetic resources (with good organoleptic quality) and improved varieties (productive and resistant to coffee leaf rust) different instances of crossbreeding took place. According to expert's criteria, after 20 years of experiments in controlled environments or at growers' farms, F1 hybrids are producing in agroforestry systems 30-40% more fruit than the best previous lines, with good organoleptic quality and with good resistance or tolerance to coffee leaf rust.

Hybrids and lines

Currently, growers are encouraged to plant/renew their farms, as much as possible with improved varieties resistant to coffee rust (varieties derived from the Timor hybrids) or with F1 hybrids to ensure their environmental, social, and above all economic sustainability. To understand what a hybrid is, we must understand what a line is.

WHAT IS A VARIETY/LINE?
In genetics/genetic improvement a line is an individual or group of individuals descending from a progeny by self-fertilization, which is homozygous. Homozygosity means that each allele of a given gene encodes the same information. Alleles can be either dominant or recessive. In other words, it is a lineage continuously keeping constant characteristics through generations of sexual reproduction, either by self-fertilization or by cross-fertilization with other plants in the same line.

There are different variants of varieties or lines. These are called:

- Pure: when they come from a progeny by self-fertilization of the same variety.
- Fixed: in the case of a pure line that has passed through several generations of self-fertilization to obtain an F8, with a minimum level of segregation (<1%).
- Composite: if a mixture of lines takes place (e.g., Castillo, Batian).

In plant breeding, it is common for breeders to place the letter "F" to explain the number of crossings in a development of a hybrid. For example, a hybrid that is an F1 will be a first generation crossing, while and F8 means that eight crossings have been made. Usually, the higher the number, the more stable and pure a variety is.

HOW ARE LINES OBTAINED?

Lines are obtained through selection of the best plants in sexual reproduction by eliminating the least interesting individuals from a population as compared to others, and selecting individuals with the characteristics growers wish to perpetuate, such as productivity, organoleptic quality, bean size, and resistance to rust, among others.



The best plants are then reproduced through seeds. Only the most interesting individuals obtained are conserved and reproduced again. The same is done with the new generation, and so on. The process can take about 20 years or 8 - 9 generations. This type of selection results in lower strength due to successive self-fertilizations carried out over time (consanguinity), but it increases homozygosity. From eight generations of self-fertilization, a very low percentage of segregation (heterozygous variants) is obtained, just around 1%.

Several varieties currently seen as lines are mentioned below:

- MARSELLESA
- PARAINEMA
- LEMPIRA
- CR 95
- IAPAR 59
- GEISHA
- T5175
- ANACAFE 14
- OBATA

WHAT IS A HYBRID?

Hybrids are a new generation of coffee varieties resulting from crossbreeding between two genetically different parents. It is not uncommon for growers to be in contact with the term “F1 Hybrids”. F1 refers to any first generation cross, so it is not correct to assume that the term “F1” refers to a variety or type of coffee, it simply states that it is the first generation of a specific cross.

Many of these relatively new crosses were created to combine the best traits of both parents, including high cup quality, high yield, and disease resistance. Hybrids are notable because they tend to have significantly higher yields (30-40%) than traditional varieties.

Seeds taken from hybrid plants will not display the same characteristics as mother plants. This is known as segregation and means that derived plants will not look/perform as the mother plant, with potential loss in terms of yield, resistance to disease, quality, and other agronomical behavior traits.

It is important for coffee growers to know that hybrids must only be purchased in certified nurseries, with totally reliable traceability systems.

HOW ARE HYBRIDS OBTAINED?

To obtain F1 hybrids (first-generation hybrids) two steps are taken:

- First, varieties or lines with desired traits are obtained and selected.
- Next, the two lines selected for the purpose desired are crossbred to obtain the first-generation cross between the two selected varieties.

F1 hybrids obtained by PROMECAFE, CIRAD and CATIE resulted from induced crossbreeding between traditional varieties grown in Central America (such as Caturra, Catimores, and Sarchimores) and wild varieties from Ethiopia such as Rume Sudan, among others.

Several varieties currently seen as hybrid are mentioned below:

- H1 Centroamericano
- EC16 Mundomaya
- H10 Milenio
- Starmaya

If you would like to know more about the different coffee varieties, please refer to WCR's Variety Catalog, available online at:
https://varieties.worldcoffeeresearch.org/varieties

Seedlot Establishment



How to select a plot

There are several aspects to take into consideration when you select a plot to establish a seed plantation. First, it is very important to understand that producing seed is not the same as producing coffee fruit, there are certain aspects that will be different from the typical coffee production farm.

Important aspects in selecting a plot for seed production include:

- Access to water sources nearby
- It is preferable to plant in flat lands or mild slopes
- Protection against floods, strong winds, etc.
- Soil conditions (not compacted, free of nematodes, fertile soils are preferable)
- Separate from other coffee plantations nearby (isolation)

Signs of soil compaction include:

- Water logging occurring in areas which were not susceptible to this previously
- Poor seed germination
- Poor response to fertilizer
- An increased tendency of grass & other crop to be affected by minor drought conditions

Isolation Practices

It is critical to make sure that the lot chosen to plant mother plants or seed plantations is isolated from every type of potential cross-pollination risk (other coffee plantations), to ensure that plants will produce seeds from the variety selected.

Ideally, the seed lot will be isolated by 500 meters away from any other variety or not purified plants. If coffee, is planted nearby then it must be of the same variety chosen to produce seed. In the case that isolation by 500 meters is not possible, then the outside rows of the seed lot are not to be harvested for seed (however, they can be used for fruit).

If the distance is between 200-500 meters then the two outside rows will not be contemplated for seed collection, and if the distance is between 50-200 meters then the first four rows should not be used for seed collection.

Planting seedlings

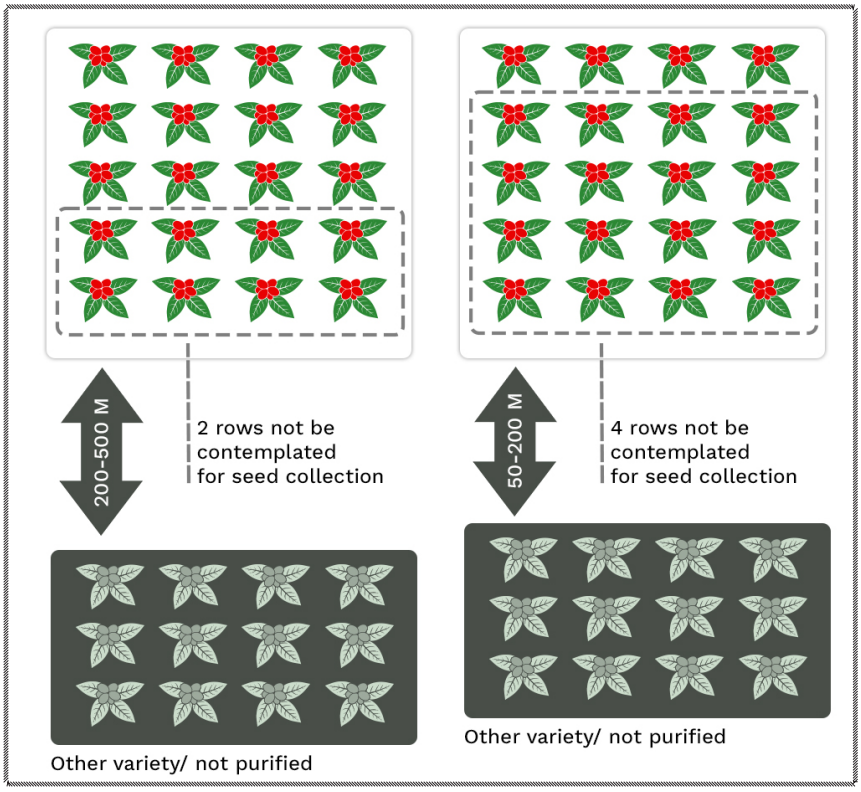
Seedling selection is key to ensure the quality of seeds to reproduce from the very beginning. Growers should look for plants with the following characteristics:

- Genetically pure plants
- Only plants that are vigorous.
- No nutritional deficiencies.
- Pest-free.
- Straight root (not too small, bifurcated, or necrotic).
- Seedling comes in a bag/tube with substrate that allows the root system to grow healthy and strong

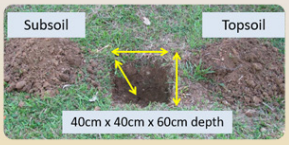
Good Practices for Land Preparation

Proper soil preparation prior to planting mother plants ensures appropriate seed production under the best possible circumstances.

- Terrace for slopes above 40%.
- Use natural contour lines of the property
- If plot is located where coffee was planted previously, allow at least one year before planting (fallow).
- Plot must be clean, control any excessive growth of weeds. Cut them off. If needed, apply herbicide at least two weeks after cutting weeds off and 20-30 days prior to planting.
- Minimize vehicle and equipment traffic through the block
- Cultivate rows across the slope rather than up and down the slope



Stages in Planting



STEP 1

Dig hole 40 cm wide and 60 cm deep. This will be enough to accommodate a ball of earth with roots intact.

NOTE: While digging, make sure to separate the top soil and the subsoil.



STEP 2

Return topsoil into the hole.



STEP 3

Prepare the following fertilizers and mix 2/3 of it with the subsoil:
- 56 g Complete
- 56 g Calcium / Dolomite
- 56 g Extra P (Trebel superphosphate)
- 15 g Micro element mix (Zn, Cu, B)
- 1 kg Wormcastings / Compost



STEP 4

Cut off about 1-2 inches from the bottom of the seedling bag to remove any circling roots. Place the seedling in the hole and remove any remaining plastic.



STEP 5

Fill the planting hole with subsoil and fertilizer mix, pressing it firmly around the seedling.

Seedlot Management

Nutrition for good seed development

Soil conditioning is very important for a plantation intended to produce coffee seed for reproduction. The first step is to analyze the soil prior to planting seed lot; and then apply liming or soil conditioners to improve soil pH if needed.

Nutritional deficiencies are not necessarily the result of nutrient chemical element deficit in the soil. They may be a result from low pH (acid soil), which prevents nutrient absorption. This problem can be corrected through the application of soil conditioners (Calcium carbonate or Dolomitic lime).

Most soils in coffee plantations contain high levels of iron. Also, they tend to be very acid. Acid soil (low pH) can negatively affect yield, resulting in lower amounts of fruit and seeds. In addition, in the case of most fertilizers an acidic reaction occurs, so soil pH tends to decrease over time. Soil conditioning helps mitigate this problem, and provides sulfur (S), calcium (Ca) and magnesium (Mg) depending on individual products.

However, neutral soils also exist and since those do not have low pH, it means they do not require pH correction.

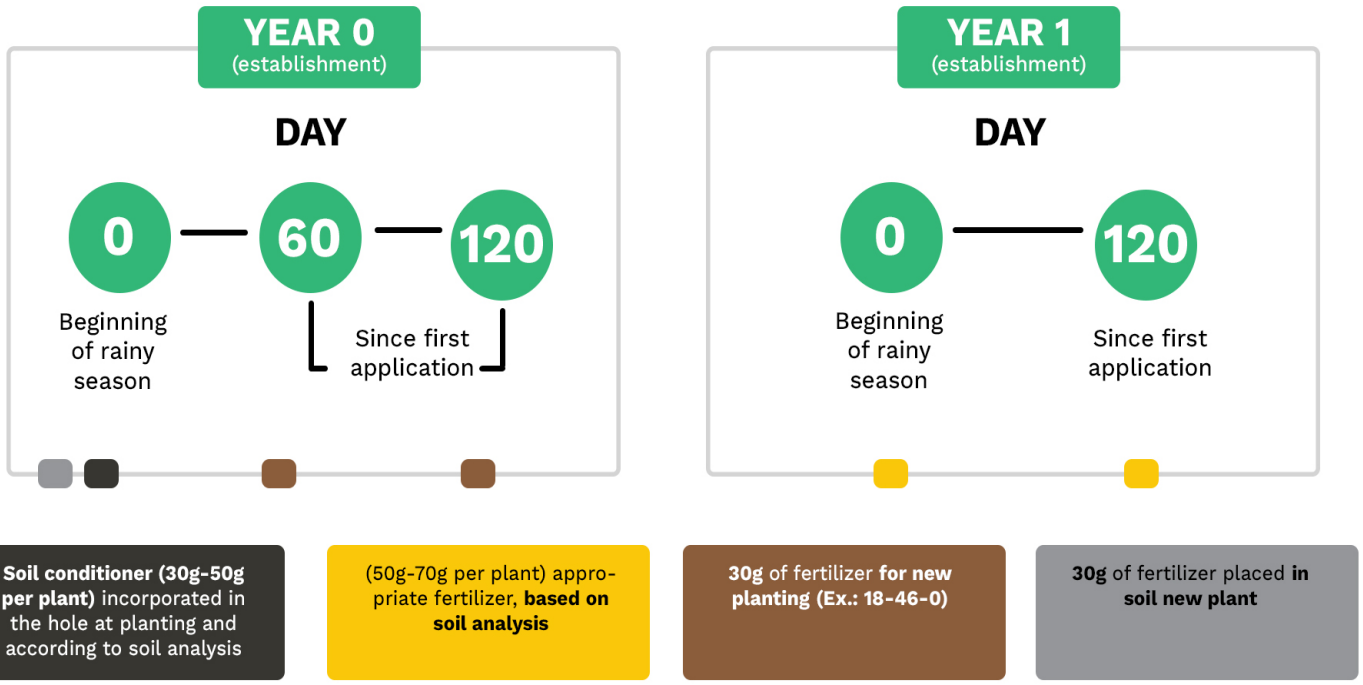
If pH is not corrected, roots will not be able to absorb nutrients. Thus, it will lead to a waste of money.

Fertilization supplies extra nutrients to enhance plant development as soils are not always able to meet plant requirements in terms of nutrients. In addition, it compensates the extraction of nutrient from the soil carried out by the plants. Chemical fertilizers or lime applications should not be performed before an analysis of the soil. This is the only way a grower can know how much product to apply.

Requirements for effective fertilization:

1. Fertilization based on soil and foliar analysis (note: recommended soil and foliar analysis is every 2 years)
2. Purchasing fertilizers from certified suppliers
3. Fertilization in line with individual variety nutritional requirements
4. Applying soil conditioner based on nutritional analysis
5. Applying fertilizer according to harvest estimation

Color code indicates applications depending on day and year.



Soil conditioner (30g-50g per plant) incorporated in the hole at planting and according to soil analysis

(50g-70g per plant) appropriate fertilizer, **based on soil analysis**

30g of fertilizer **for new planting (Ex.: 18-46-0)**

30g of fertilizer placed **in soil new plant**

Organic fertilization

Fertilization either from organic sources (manure, compost, etc.) or inorganic (Phosphate rock, Potassium sulphate) is an important source of nutrients for coffee shrubs. It can serve as the only source of nutrients or combined with traditional fertilization methods.

Organic fertilizers result from decomposition of different organic materials including animal manure, plant remains, food waste and coal performed by micro-oganisms. It improves physical, biological and chemical properties of the soil.



Organic fertilization - Advantages

- Lower economic cost of the material itself, but considered expensive to apply in the field in some countries
- Use of natural resources available in the environment to produce fertilizers
- Environmental balance in plantation that can result in the reduction of pests
- Provides organic matter and helps preserve soils
- Provides hormones contributing to root and plant growth

Organic fertilization - Risks

- Mismanagement of some source of organic material resulting in poisoning of plantation
- Insufficiency of nutrients to meet plant needs
- Pathogens that can infect the soil due to poor management of organic fertilizer

It is key for growers to analyze organic fertilizer or demand an analysis of the fertilizers purchased to know their contribution in detail. Analyze moisture content, pH, electric conductivity, total organic matter, total nitrogen, phosphorus, potassium, calcium, magnesium, iron, copper, manganese, zinc, and sodium.



Organic fertilization – recommended annual cycle:

Applications	Time range/month	Organic Fertilizer
1	Beginning of rainy season	Compost, bokashi, chicken manure, lombricompost
2	50 days after the beginning of the rainy season	Compost, bokashi, chicken manure, vermicompost
3	100 days after the beginning of the rainy season	Compost, bokashi, chicken manure, vermicompost
4	150 days after the beginning of the rainy season	Compost, bokashi, chicken manure, vermicompost

Organic foliar fertilization- recommended annual cycle:

Applications	Time range/month
1	**Pre-blooming:** 0-45 days before blooming
2	**Flowers strengthen, fruit sets, and beans grow:** 0-45 days after blooming
3	**Fruit multiplies:** 60-120 days after blooming
4	**Maturation and preparation of plant:** 150-120 days after blooming

Growers can also manufacture bio inputs from mountain micro-organisms (MM), fermented grass, bio-ferment of dung, phosphorus, and bio-ferment. There are also many also recipes for organic pesticides.

As mentioned previously, inadequate fertilization in conventional or organic farms, results in low yield and increased likelihood of disease. A guide to major deficiencies is shown below. It is important to always check well the plantation.

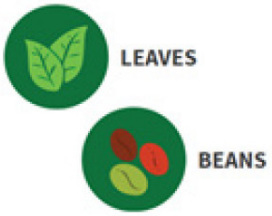
Remember that yellow, deformed, or different leaves do not always indicate nutritional deficiency; a comprehensive assessment of causes must always be made.

NITROGEN DEFICIENCY

Symptoms:

- Chlorosis/yellow mature leaf
- Lower vegetative growth
- Potential defoliation
- Lower chlorophyll content





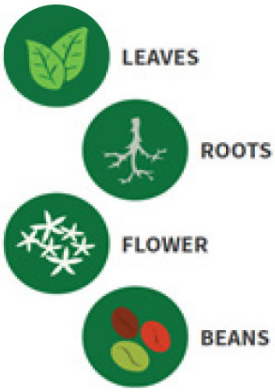
PHOSPHORUS DEFICIENCY

Symptoms:

- Slow plant growth
- Little root
- Small leaves
- Decreased ripening
- Smaller beans
- Reddish mature leaves



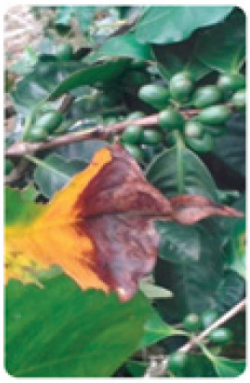
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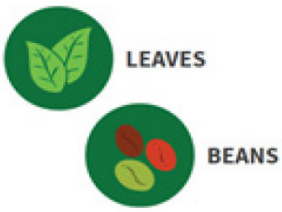
POTASSIUM DEFICIENCY

Symptoms:

- Chlorosis or necrosis of leaf edges and points
- Defoliation
- Small beans with little mucilage
- Less dry weight
- Unequal ripening
- Cup quality loss due to low amount of sugar in beans



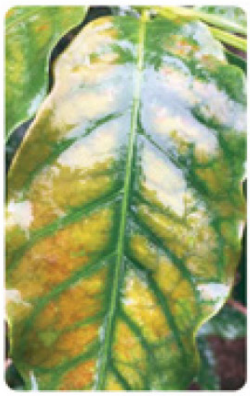
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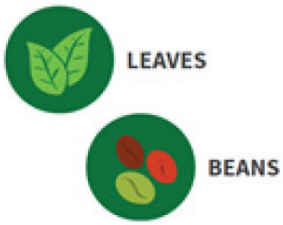


MAGNESIUM DEFICIENCY

Symptoms:

- Lower vegetative growth/fewer beans
- Acceleration of premature ripening
- Fall of fruit during harvest
- Yellow spots between leaf veins
- Small beans and fruit with lower percentage of Brix degree beans



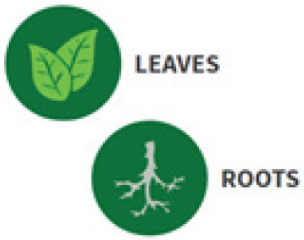


CALCIUM DEFICIENCY

Symptoms:

- Marginal chlorosis at the edges of young leaves
- Corrugated leaves
- Necrosis and deformation of tips
- Generalized pale green color





Pests and diseases that can affect the seed

Integrated pest management ensures quick pest control and safeguards productivity and income to growers. Pest and disease control are needed at every coffee plantation to protect coffee production.

Risks from failing to conduct pest and disease management:

- Low productivity
- Financial loss
- Risk of partial/total loss of plantation
- Non-compliance with the standard results in loss of seed certification
- Risk of impacting surrounding farms due to poor pest management

An Integrated Pest Management (IPM) plan is a strategy created by the producer, containing several control measures that are used together to combat a pest or disease in a crop.

There are different types of control measures:

- Cultural practices: these are agronomic practices that the producer can perform to prevent the introduction or spread of a pest or disease, and mostly have to do with actions on coffee plants or on the system around it. For example, a cultural practice to reduce the incidence of Coffee Berry Borer is the collection of all coffee beans, including those on the ground.
- The physical combat is that the one that physically removes the plague from the plantation, such as the use of traps or physical barriers such as anti-aphid meshes.
- Biological control is combat done using other biological organisms that are natural enemies of the pest (predators, pathogens or parasites). For example, the use of entomopathogenic fungi (like *Beauveria bassiana*) to control insects such as the Coffee Berry Borer.
- Genetic combat is the use of materials that are by their genetics, resistant or tolerant to certain diseases or pests. For example, the planting of coffee varieties that tolerate the presence of rust or nematodes in the soil.

- Chemical combat is done through pesticides that affect pests or diseases. It is not recommended to use only this type of measure as, although it might be effective for a specific time, it does not alone solve incidence problems over time. Additionally, the sustained use of the same chemical molecules on a pest can promote that it generates resistance to the applied product, making it more difficult to control in the future.

Collectively using all of the above types of measures reduces the negative impact pests may have on crop yield over time.

The economic threshold: a pest or disease is said to be needed to be controlled once it crosses the economic threshold. This is defined when the population or incidence of the pest or disease negatively affects the crop to a point in which the losses caused are greater in cost than the expense it represents of controlling the pest or disease. This means, a producer can tolerate small populations of plagues, as long as they do not cause great damage to the plantation. Sampling pest populations or disease incidence provides the information needed to know when this threshold has been crossed and therefore when control of this organism is necessary.

When designing an IPM plan, in addition to the biology of the pathogen, attention should be directed to identifying the pathways of entry of the pathogen to the place of production. Introduction of pests may occur from the incorporation of contaminated planting material, or by the use of contaminated tools (e.g. those used to prune or remove weeds) that are not disinfected properly. Seedlings of coffee plants or shade trees being introduced into the plot, should always be inspected so that they are free of pests or diseases such as nematodes or fungus. Likewise, tools such as shovels, saws, machetes and others should be disinfected regularly to prevent the spread of diseases.

Constant sampling is a basic tool for implementing an IPM plan as they assess the incidence of the negative effects of pests and diseases, and also the performance of the measures used for their control. Sampling and observation should be supported by laboratory sampling and analysis if necessary.





Another important component of a IPM plan is the definition of “pests”. These are organisms or populations of organisms that negatively affect a crop and decrease its yield. They can affect different parts of the plant, such as fruits, foliage or roots. It is sometimes overlooked by producers to think about pests and other pathogens as living organisms just like any other, it is indispensable for them to stay active and reproduce. Unfortunately, this means they affect coffee plantations in order to survive. It is important to note that, being living organisms, having a detailed knowledge of their behavior, habitat or reproductive cycle allows to better control them with a plan that is effective in reducing pest populations or the incidence of diseases, or even avoiding them completely. IPM plans must be constantly updated as well since pest and disease populations, as living organisms, are constantly affected by factors such as temperature, relative humidity, precipitation or wind speed.

These are the most important pests and diseases that may affect the production of seed. Please notice that many pathogens that affect coffee are not listed here, since these are only the most relevant in coffee seed plantations as they affect the cherry directly.

COFFEE BERRY BORER

Coffee berry borer (*Hypothenemus hampei*) is a small insect whose adult female attacks coffee beans between week 8 and week 32 after blooming.

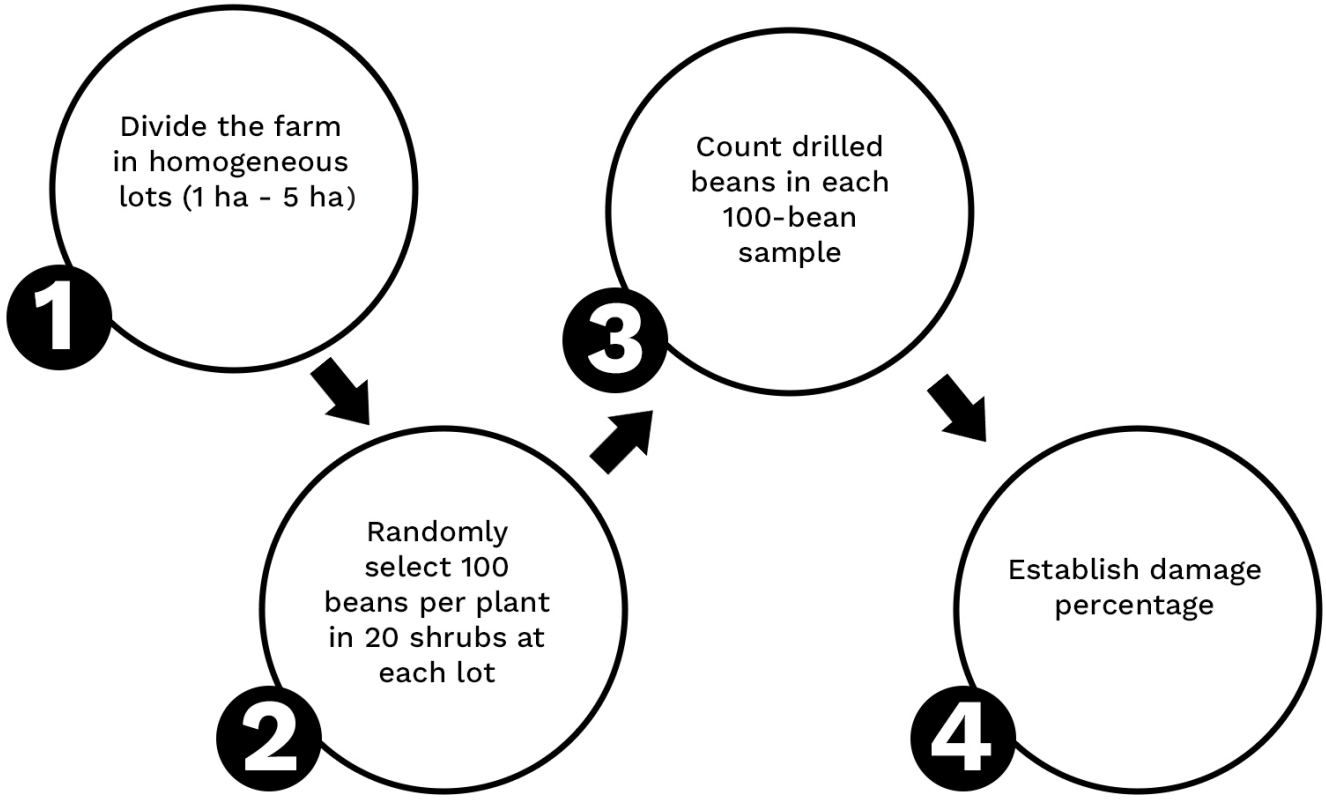


Damage: Female coffee berry borers pierce coffee beans, making tunnels to lay their eggs in green, brown, or grain bunches resulting in damaged beans. Once they hatch, eggs release larvae feeding on the bean and making it useless to plant.

In a IPM plan for coffee berry borer producers can use measures such as:

- The collection of all cherries in the plant, including the ones that may have fallen to the ground.
- Monitoring the insect population through sampling
- The use of traps to physically remove insects from the plantation
- The application of benefitial fungi such as *Beauveria bassiana*
- Apply insecticide as a last resort and only if the beetle is not yet inside the cherry. Once the beetle has penetrated the fruit and is inside it, no application will be effective to control it.

For sampling, producer can use the following method:



To remove the insect physically, traps can be really useful. They are most effective if placed when the population of the beetle is starting.

Create a CBB trap: this can be a homemade device effective in trapping the insect during flight periods.

- Cut open water bottles
- Equip a lure filled with 1:1 ratio of ethyl alcohol and methyl alcohol
- Deploy 20-30 traps per 1 hectare.

BERRY BORER CONTROL PRACTICES

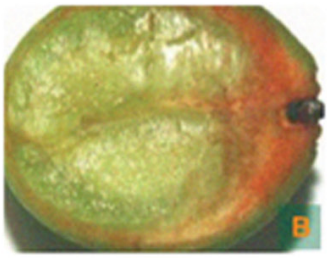
What you can expect to find when monitoring the berry borer



A. Outside the cherry.

Recommended control:

Either biological or chemical control to contact the insect.

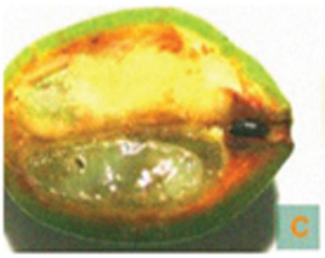


B. Starting to drill, has not reached parchment yet.

Recommended control:

Use either biological or chemical control to contact the insect.

Effectiveness at this stage will be lower than at the previous one.



C. Already reached cherry parchment.

Recommended control:

No chemical control as it will be ineffective.
Conduct health harvest.



D. Within the cherry. Has built tunnel. There are either eggs or larvae.

Recommended control:

No chemical control.

Collect cherry early or late in the harvest process, depending on crop stage.

(ICAFE, 2019)



COFFEE LEAF RUST

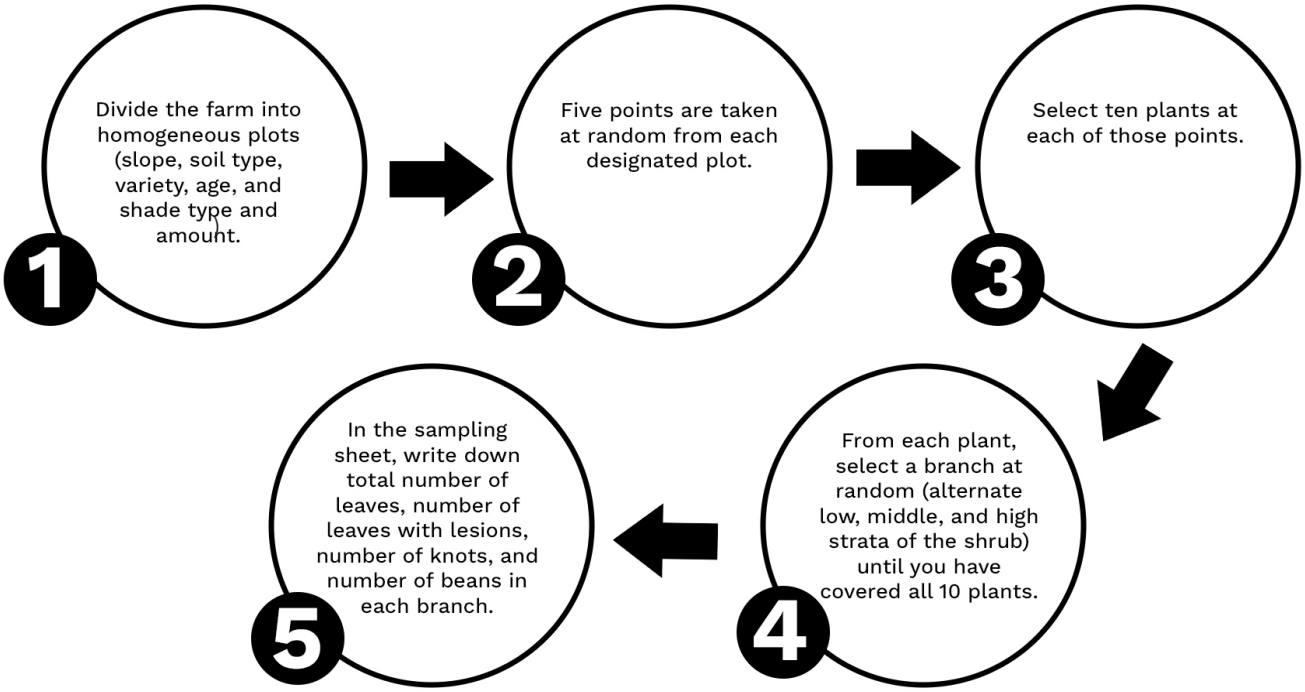
Coffee rust epidemics devastate coffee plantations, since this disease is particularly easy to disseminate. This disease is caused by a fungus (*Hemileia vastatrix*) and is particularly serious in mid- and low-altitude plantations. High temperature, and humid, rainy environment help it thrive. Also, farms whose trees have lots of cherries are particularly vulnerable to rust.

The first symptoms of the disease appear on the underside of leaves, with pale yellow spots growing over time and coming together to form larger yellow-orange spots with the appearance of fine dust. That is where spores are produced.

In case of severe attack, the main damage results from the fall of a large amount of leaves, which weakens the plant, as well as from very irregular ripening of beans, lower yield, and even death of the shrub.

Producers can use several measures to control it:

- Shade management to lower the stress level of plants due to many cherries being produced or climatic reasons. However, avoid excess shade since high humidity levels favor the disease.
- Pay attention to the plant's nutrition, since malnourishment can produce stress which favors the disease.
- Plant varieties that are tolerant or resistant to the disease in your area. However, take into account that this fungus mutates and changes fast, so this tolerance may be reduced over time and eventually any variety can become susceptible to the disease.
- Fungicides can be used, specially from the triazole type but only when incidence is more than 5%.



Formula to measure incidence:

$$\text{Incidence} = \frac{\text{Number of leaves with coffee rust}}{\text{Total number of leaves evaluated}} \times 100$$

ANTHRACNOSE

Anthracnose is caused by the fungus *Colletotrichum coffeanum* and impacts leaves, branches, flowers and fruits of coffee. Damage starts in the tips of the branches and spreads towards the main stem. It occurs in different conditions and at different altitudes and affects coffee plantations with different technology levels -from traditional to technified- as well as different coffee varieties. It occurs in all coffee areas, both low and dry and high and humid.

It infects mainly malnourished plants or plants that suffer from stress resulting from climate factors, management factors, or other pests. Both fruits and leaves dry up.

High incidence results in leaves and fruit fall and the shrub gradually dries up. Yield is reduced, and shrub may even die. To control anthracnose, it is important to prune sick plants or branches to eliminate it, the disease will not affect healthy, vigorous tissue but if the incidence is high contaminated material can be taken out of the plot or fungicides can be applied. It is recommended to prune 4 inches below the point where the disease appears. (Pruning scissors must be disinfected for each plant.) Also, it is important to review the farm's fertilization plan, since the disease appears mainly on weakened plants.

How to control diseases caused by fungus:

- Establish planting density not above 2,000 plants/ha, depending on variety, temperature, altitude, and so on. The distance for intercropping is 2m between plants x 5m between rows to leave space for the companion crops.
- Choose appropriate and resistant varieties.
- Prune plants exhausted or badly hurt by disease
- Thin twice per year; leave two axes per planting point
- Conduct effective weed control
- Regulate shade from trees/plants
- Fertilize appropriately based on soil analysis
- Apply early before sporulation takes place



Shade management

Coffee cultivation can be done under the shade of trees or in full sun, and this component must be planned since the plantation is designed at the very beginning. Each of these types of management (shade or full sun) produces various effects on the plant, which can be enhanced by the climate of the area where it is grown.

In the case of plantations intended for seed production, in the vast majority of cases it is recommended that the coffee trees be under shade, since this condition promotes a lower stress level and extends the life of the plantation. The incorporation of agroforestry systems into coffee farming is generally considered to be a necessity, not only for the benefits to the plantation but for the agroecosystem in general and as a source of added value in farms, since shade tree can provide timber, fruits and pollinators. However, there are climatic zones where the use of shade or inadequate design can affect fruit growth and production. The climatic zone where the plantation is located affects the design: the selected species and the planting density of the trees must be adapted to the weather conditions on the farm.



Shade is important to coffee for various reasons:

- Shade regulates microclimates. Coffee shrubs are sensitive to dramatic temperature changes.
- Shade reduces radiation, improve water balance and increases relative moisture levels.
- Shade improves soil fertility through organic materials. When trees from the Fabaceae or
- Leguminosae family are used, they supply nitrogen to plantations.
- Erosion control. Leaves and branches resulting from pruning protect the soil against runoff and erosion.
- Shade improves ecosystems by providing food and shelter to birds, insects, and reptiles, which results in ecological balance in plantations.

Risks associated to lack of shade:

- Coffee shrub burning from high radiation
- Nutritional issues in case of both low nutritional levels and lack of shade
- Increased risk of anthracnose in beans
- Increased soil erosion
- Production peaks. May provoke bi-annuality
- Soil cracking, leading to root tearing
- Loss of water in soil during the dry season
- Increased incidence of pests and diseases

Shade type depends on different factors including rain, cloudiness, altitude, and wind at the plantation site. Growers must take these factors into account to select the most suitable shade for their plantations.

Generally, between 15% and 40% shade levels are recommended, in line with factors above. Shade trees must be planted between coffee shrubs, not on alleys, so they do not hinder plantation management.

TEMPORARY SHADE/TEMPORARY CULTIVATION

Temporary shade can be used mainly early in plantation life to take advantage of land, bring in additional income, protect the new plantation against pests and solar radiation and to combine coffee with other short-term crops.

Advantages from temporary shade

- Protection against sun and wind
- Addition of organic materials
- Moisture is kept
- Additional income to coffee growers
- Improved soil

Plants mentioned below are recommended: (List will vary depending on region)

- Corn (*Zea mays*)
- Beans (*Phaseolus vulgaris*)
- Bell peppers (*Capsicum annuum*)
- Tomato (*Solanum lycopersicum*)
- String beans (*Phaseolus spp.*)
- Cassava (*Manihot esculenta*)
- Pigeon pea (*Cajanus cajan*)
- Tephrosia (*Tephrosia candida L.*)
- Castor oil plant (*Ricinus communis*)
- *Crotalaria sp.*

PERMANENT SHADE

Trees are commonly used to provide permanent shade. In addition, these can provide fruit or timber, resulting in extra income for coffee growers. Also, they can provide nitrogen sequestration, adding value to coffee plantations.

Fruit trees and plants are recommended to provide shade (The list will vary depending on region):

- Rambutan (*Nephelium lappaceum*)
- Avocado (*Persea americana*)
- Lanzones (*Lansium domesticum*)
- Mangosteen (*Garcinia mangostana*)
- Banana, plantain (*Musa sp.*)
- Citrus "Suha" (*Citrus maxima*)
- Guava (*Psidium guajava*)
- Caimito (*Chrysophyllum cainito*)

Timber trees: (List will vary depending on region)

- Mahogany (*Swietenia mahogany*)
- Falcata (*Falcataria moluccana*)
- Japanese Alnus (*Alnus japonica*)
- Cedar (*Cedrela odorata*)
- Molave (*Vitex parviflora*)
- Lauan (*Shorea contorta)*
- Apitong (*Dipterocarpus grandiflorus*)
- Narra (*Pterocarpus indicus*)

Nitrogen fixers: (List will vary depending on region)

- Kakawate(*Gliricidia sepium*)
- Ipil ipil (*Leucaena leucocephala)*
- Calliandra (*Calliandra colothyrsus*)





SHADE REGULATION

As stated previously, shade management depends on individual plantation circumstances. However, it is advisable to:

- Prune shade trees at least once a year to allow for light. Pruning generally takes place prior to blooming.
- Prune tree center and let horizontal branches grow.
- Allow at least two meters between coffee plants top and the shade canopy.

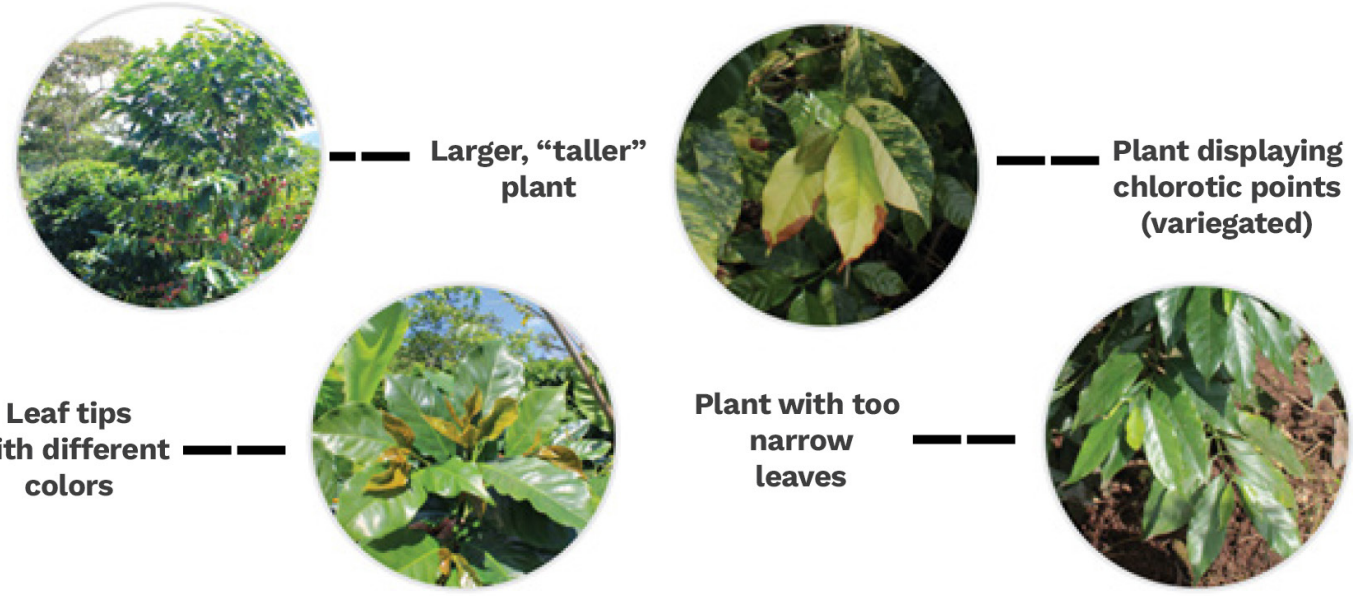
Eliminating atypical plants

Atypical plants must be eliminated as soon as possible from seed plantations, preferably as early as the nursery to avoid setting them in the field, thus incurring expenses and risks due to contamination from pollen.

In case it has not been done before, it is key to do so in the field. It is essential to preserve "genetic purity" at seed lots to replicate desirable characteristics in seeds and future plant generations. Growers should look to eliminate plants that present different characteristics than the rest or differ from what the selected variety should have.

Thus, elimination is advisable in the following cases:

- Genetically non-conforming plants detected through observation of phenotype (coloring of sprouts – apexes – or plant size different from the variety planted)
- Plants with high disease levels (coffee rust, coffee-tree wilting, American leafspot, anthracnose, thread blight)
- Plants suffering from nutritional deficiency or showing yellow/chlorotic leaves
- Low-yield plants



Traceability of seedlings begins when they are received at the farm and includes:

- Assigning a code to each seedling or variety received
- Storing seedlings, separating them according to their variety, to avoid cross contamination
- Inventorying individual lots in written including code, variety, date it was received, storage location, date and place of planting, and quantity, among others
- Designing a map to identify individual lots and their codes
- Regularly updating map and inventory

Seed and Fruit Physiology Basics

The buds that give rise to inflorescence are basically distributed axillary in the lateral branches, at the base of leaves in each node with a potential of 32 - 40 flowers per node. For Arabica, individual flowers are complete, hermaphroditic and self-fertile. This makes Arabica coffee an autogamous plant with a high percentage of self-fertilization (above 85% -90%), note that is not 100% and there is always risk of cross pollination! Before flowers open, some antennae have already released pollen internally. As a result of the union of pollen grains with both ovules (inside the ovary) a fruit normally containing two seeds.

Thirty-two weeks elapse, on average, from flowering to maturation of the fruit. The fruit takes 220 to 280 days on average to develop, depending on the area and the species. When the fruit is ripen, it is ready for collection and extraction of the seed.

Seed Collection

Coffee beans need a careful harvesting process. A good harvesting process ensures optimum quality of the seeds you want to reproduce. It discards imperfect, undesirable beans that may result in weak, sick plants.

Basic good harvest requirements:

1. Harvest ripe cherries only (no green or overripe cherries).
2. Harvest healthy, perfect cherries.

Selection of plants for seed

Coffee growers should only harvest coffee cherries for seed from plants that are:

- Productive coffee bushes, preferably young plants (4 to 10 years).
- Strong plants with healthy leaves, stems, and branches, with well-shaped, firm and healthy roots.
- Plants with size characteristics and the phenotype of the chosen variety.
- Plants with stable productivity.
- Seed lot located within the isolation limits.
- It is advisable to eliminate the plants not meeting the size and phenotype requirements of the selected variety



Traceability practices in collection

Traceability is very important in seed plantations, since it is nearly impossible to tell one bean from another. It is important that practices are performed in the field to avoid confusion, mixing of cherries and thus working with seed that is not pure.

- Clean Baskets: Baskets must be clean to avoid cross contamination with seeds from different varieties.
- Qualified Staff: Staff must be trained and qualified prior to harvesting.
- Optimal berries: Collect ripe cherries only, not half-ripe or overripe cherries
- Collection at peak harvest time: Collect at the peak of harvest season (not before, not later). No beans from the earliest harvest or those collected after harvest are used. These can be sold as cherries, but not as coffee seed.

Seed Processing

After careful harvesting, coffee cherries are processed to serve as seed for reproduction. To do so, a rigorous process consisting of depulping, fermenting, demucilaginating, washing and drying is carried out to preserve seed quality.

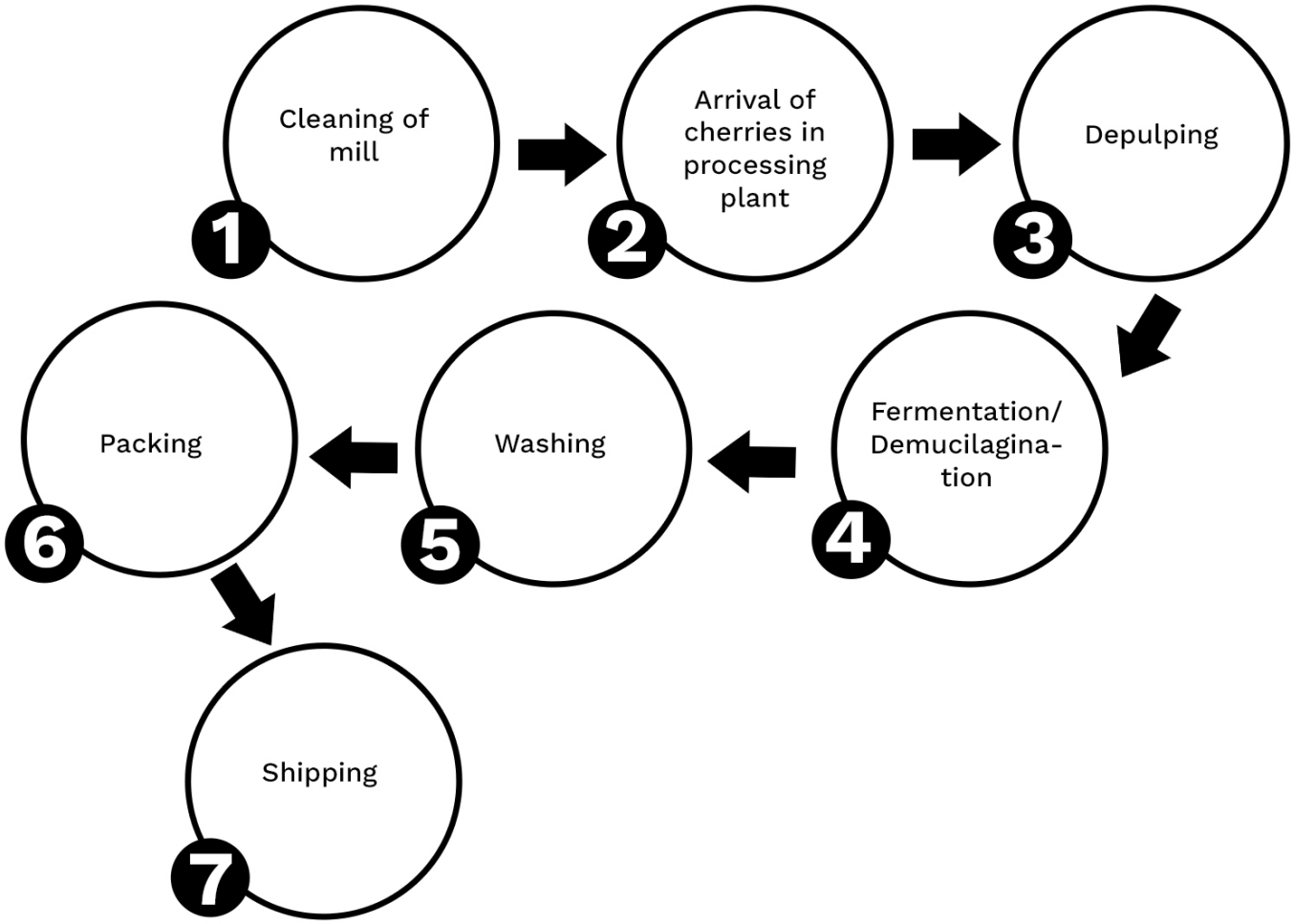
Wet mill processing

The first step in the mill is to receive the fruit. This stage of process is key to achieve uniform quality of coffee beans, making them suitable to serve as seed.

Requirements to process beans to turn them into seed include:

1. In-depth cleaning of site where beans will be received as well as all equipment to be involved in the depulping, fermentation, demucilagination, washing and drying process, to avoid contamination from beans belonging to other varieties.
2. Receive only ripe, optimum coffee beans, (ripe coffee).
3. Not mixing coffee (unripe, green, overripe, dry). To achieve this, collectors are asked to select coffee cherries prior to measuring.
4. Pure coffee (free from leaves, sticks, soil, pebbles, or any other thing)
5. Coffee bags must be clearly identified (weight, lot number, variety, date, signature of harvest manager).

WET PROCESSING STAGES



Not all coffee cherries entering wet processing are appropriate to serve as seeds. To ensure seed viability, a strict process must be followed.

1. First, cherries are separated by density. Cherries are placed in a pool to separate those floating, which are of lower quality. This first stage allows to eliminate many cherries damaged by the borer, seedless beans, and peaberries. Only those sinking will be used as seed and go to depulping.
2. Peaberries can be removed by sorting the parchment.
3. After depulping, best beans can be selected through mechanical sieve selection to separate beans still with pulp. These go to seconds.

These two selection processes help choose only the first line suitable to serve as seed.

Depulping

Depulping is the process to remove the husk of ripe coffee fruit. At this stage the lubrication of the mucilage is used to extract the fruit without damaging the bean:

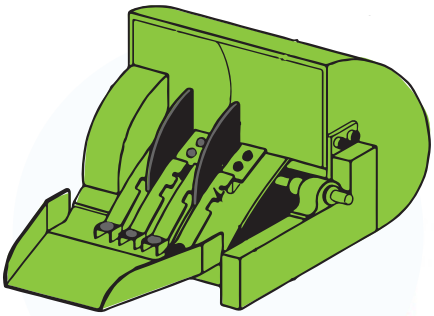
1. Coffee cherries that do not float (the first ones) go to pulpers, where the pulp is separated from the parchment coffee
2. Screen separating pulp with parchment to eliminate unfit beans
3. Use goosenecks to remove stones, sticks or impurities that may be present in coffee bags
4. Washing channels
5. Clean water is used in the process.
6. After depulping it is recommended to screen coffee to eliminate pulp or husks as these negatively affect fermentation

HORIZONTAL CYLINDER PULPER

It is a cylinder made of iron or aluminum. When rotating, it presses the ripe fruit agains a concave plate with channels through which loose beans are forced to move. See illustration.



DISC PULPER



*Source: **Philippine National Standard***
PNS/PAES 252:2011
(PAES published 2011)
ICS 65.060.01

Pulping is carried out by the surface of discs, which have buttons dragging the cherries and depulping them by forcing them over the pulper crest.

VERTICAL CONE PULPER

This pulper reduces water in pulping, minimizes energy, and it has more capacity than other pulpers, among other things. The conical structure is arranged in such a way that it performs its rotation vertically. This way a larger numberr of pulping devices can be installed around it.



Fermentation/Demucilagination

The purpose of fermentation/mechanical demucilagination is to eliminate the mucilage covering coffee seeds. These are two different methods with the same function.

1. Fermentation: it consists of transforming mucilage into a substance soluble in water through the action of microorganisms (fungi, yeasts) and subsequent washing. Recommended fermentation time can vary between 12 and 24 hours, depending on climate conditions at individual wetmill sites as well as on variety, due to mucilage amounts in fruit. Overfermentation and high temperature can kill the embryo; therefore, seeds would not suitable for reproduction. Thus, especially care is needed during this process.
2. Mechanical demucilagination: it consists of eliminating mucilage by physical or mechanical means and its subsequent washing. In this process, the consumption of water is reduced. In addition, a continuous flow of the process is established, and yields are increased without negatively affecting quality. Mechanical demucilage requires immediate drying, which results in an investment in equipment and drying infrastructure. If not properly dried, residues of mucilage will restart the fermentation process, which may negatively affect seed viability.

FERMENTATION AND MECHANICAL DEMUCILAGINATION PROCESS

FERMENTATION

Depulped coffee is placed in fermentation tanks designed to remove mucilage during the process. Seed under fermentation is properly identified with cards allowing to trace information in the process. Fermentation can take 12 to 24 hours, depending on weather conditions. In some cases it can last up to 36 hours under very cold conditions. Variety can also prolong the fermentation process.

MECHANICAL DEMUCILAGINATION

A process by which coffee seeds pass through a rotating machine that causes friction between them to loosen the mucilage.

Important factors to consider with mechanical demucilage:
- Rotor speed
- Ratio between rotor and housing diameters
- Rotor distance, shape, and type



Mechanical Demucilagination

Fermentation is widely used due to the low initial investment, there is less risk of damage to the seeds, energy consumptions is low and if performed correctly the mucilage comes off very easily. Nonetheless, it requires continuous control by staff, a lot of space, takes a longer time and typically mucilage is wasted with wastewater.

Mechanical demucilagination also has many advantages: the process can be carried put continuously, it works well with large quantities of coffee seeds, water consumption is reduced when a recirculation system is used, mucilage can be recovered for other uses and requires less space compared to fermentation tanks. However, there is more energy consumption and the initial investments is higher, and growers need to be trained in calibrating the machinery to avoid damaging the seed.

Machine should be properly adjusted/ calibrated to avoid breakage of the parchment.

Washing coffee beans

After fermentation, beans are washed with clean water to remove mucilage residues adhered to parchment. This procedure can be done through immersion and passing of a stream of water.

Fermented beans are placed in a container, tank, or washing channel and mucilage adhering to them is removed by rubbing them with each other.

Four successive rinses are recommended, as follows:

- Add 30% of water, shake, remove impurities and eliminate
- Add 20% of water, shake, and discard
- Add 20% of water, shake, and discard
- Add 30% of water, shake, discard, and remove impurities

This procedure must be performed at least four times or more until a rough sound between beans is heard. At the beginning of the washing, beans slip from the hand due to residues; when well washed they remain in the hand with a rough consistency, like sandpaper. This activity is used also to eliminate seedless beans that remain and float on the surface of water during washing.



Drying seed

Good drying helps diminish the possibility of fungi or disease proliferation in seeds and to ensure their viability. Drying consists of reducing the humidity of wet parchment grain (50%) to a figure of 20%. The goal is to lower humidity levels preserving the viability of the seed embryo but decreasing the possibility of pathogen proliferation. Seed drying is an important transition point between wet processing and the storehouse where the seed will be preserved (cold room or another).

Good drying requirements:

- Drying yards or tables under shade to reduce direct solar radiation
- Immediate transfer from coffee mill to drying yard to avoid bean viability issues (overfermentation)
- Immediate transfer from drying yard to storage once humidity levels of 25%-30% are reached to avoid bean dehydration
- Slow, homogeneous drying

Keep in mind that coffee seeds are living beings and must be kept alive during the drying and storage processes. Thus, drying must not endanger the embryo.



CHARACTERISTICS OF THE STRUCTURE REQUIRED FOR THE DRYING AREA

- Preferably an open area with shade net roof (60% - 80% shade) or under a high metal warehouse, always looking for good ventilation. Brightness can range between 7000 lux and 20000 lux.

> The lux is the International System unit of illuminance, measuring luminous per unit area. It is equal to one lumen per square metre.

- Minimum height between floor and roof: 2.5m
- The floor must be level to facilitate turning, with slight slope (0.3% to 0.5%) for draining.
- The floor may be made of concrete. However, if the floor is of earth, it must be covered with a geo-textile. Wash before each drying cycle.
- Seed must not be in contact with the ground.
- If not on the ground level, tables 1.5 m wide and 1 m high can be used. Their base should be made of mesh, saran or fine sieve to allow for continuous air flow for faster drying faster than on ground.
- Maintain ditches/gutters around the drying yard to prevent water entry, negatively affecting drying.
- Walls are not recommended to allow for free circulation of wind and prevent temperatures from rising. Temperature must not surpass 40°C as high temperature will kill the embryo, thus negatively affecting seed viability.
- The infrastructure can be made with galvanized iron, structural pipes, or wood, that is, materials able to withstand wind and weather.

Once the infrastructure is ready to receive the seed. The process can begin:

1. Coffee must be labeled with information of seed origin (lot), date of collection and number of kilograms of wet coffee received.
2. Make sure coffee is well washed (free of mucilage, foreign bodies and odors).
3. Next, extend coffee at the drying yard on a 10Kg. layer per square meter. The seed layer must be minimal (1-2cm) to avoid excess humidity.
4. Turn seeds every 30 minutes to homogenize drying and avoid sudden changes of humidity and temperature.
5. Measure humidity continuously with a hydrometer until the desired percentage of humidity is reached (25% -30%). However, once the aired point is reached (30% -40%), the thickness of the layer is increased (+ 30% height) to avoid a sharp drop in humidity.

When drying on tables, seeds can be moved by hand or with a smaller rake, trying to make drying beds for uniform drying.



Be especially careful the first day, when coffee beans have higher moisture content. Stir them more often, every 30 minutes. In the following days stir them frequently, the more it is stirred the faster it dries. Coffee beans spend 3-7 days at the drying yard, depending on humidity percentage at the time it arrives as well as on temperature, external lighting, drying layer thickness, and frequency of turning. Continuous monitoring of seed humidity is required to store it at the time it reaches the optimal humidity level. It is advisable to keep coffee beans piled for the night, covered with a piece of canvas (or thick, black plastic) to protect it against early morning dew.

If high temperatures (40°C or above) is used to accelerate drying, it will cause irreversible damage to seed quality and embryo, resulting in death of the bean. This damage is easily recognizable due to the black spot in the embryo. Over time, the bean turns grayish. If the embryo dies, the plant cannot germinate.

Seed Storage

Storage meeting lighting, temperature, and humidity requirements ensure longer seed life and helps preserve germination percentage.

Storage requirements:
1. Temperature: 20°C (+/-2°C)
2. Relative humidity 65%-90%
3. Closed, dark environment to meet temperature and humidity requirements

The hardest pest to deal with at storeroom/cold rooms is coffee berry borer (*Hypothenemus hampei*). It is key to eliminate every single bean damaged by the borer through manual selection. In addition to their potential to contaminate the lot as borers leave them, damaged beans will not germinate due to internal damage.

Recommendations to control berry borer in stored coffee berries.

- Apply insecticide to seeds before packing them in polyethylene bags.
- Install a berry borer trap in the storeroom/cold room to measure borer population and take corrective action if needed. Organic or chemical insecticide can be applied (check local legislation to see if this is allowed).

Whether seeds are stored in cold rooms or storerooms, seed producers must always conduct monthly germination samplings to monitor seed viability.







Source: World Coffee Research

Part 3

Nurseries



Substrate and container selection

Substrates are the material in which plants will be developed. Coffee growers can buy ready-to-use substrates, but this are typically expensive so nurseries tend to typically mix and create their own. Different handmade mixtures can be used for germination beds, mother plants, transplant, and maintenance. For the different stages the seedling goes through, it is recommended to adjust substrate percentages and provide adequate nutritional management in each phase.

For the development phase of the plant in the container (polybags, tubes, etc.) there is a wide variety of substrates. The most commonly used is topsoil mixed with sand and organic matter, prepared by the nursery owners themselves, or commercial inert substrates which are typically more expensive. The ideal substrate for development must be spongy and light, with good capacity to absorb water but also with good drainage and good aeration to facilitate germination of seeds and good growth of roots. The substrate (soil) must be free of solids (pebbles or objects) that can harmful to the root.

Handmade mixtures are made in many farms due to lower cost and high availability of raw materials. To find the optimal mixture, it is advisable to perform tests at each nursery, varying material percentages to determine the mixture best meeting the needs. Due to variation in terms of type and quality or raw materials available, no specific mixture can be recommended.



Substrates being mixed and prepared in a nursery

A list of the main substrates used and their characteristics follows:

1. Compost:
   - Results from aerobic and anaerobic biological decomposition of organic waste under controlled conditions.
   - Improves the physical properties of the soil, provides moisture, nutrients and helps drain the soil.
2. Coal:
   - Improves soil porosity.
   - Levels the pH of soils making them more alkaline.
3. Vermicompost:
   - Organic fertilizer obtained from earthworms by digesting vegetable waste, among other materials.
   - Provides nutrients such as nitrogen, calcium, magnesium, phosphorus, potassium, and essential micronutrients.
   - It improves the physical condition of soils including porosity, infiltration, and aeration.
4. Bokashi
   - Fermented, semi-decomposed organic fertilizer.
   - Provides nutrients, moisture, and porosity.
   - Made from low-cost raw material.
5. Coconut fiber
   - Can retain a water volume up to 3 - 4 times its own weight.
   - Slightly acidic pH and good porosity.
   - Must be washed prior to use to remove salt.



DISINFECTING SUBSTRATES

Soil disinfection is a practice intended to mitigate the negative impact of fungi, nematodes, insects, bacteria and weed seeds in the soil which affect plant germination and development. It is an indispensable condition for success in plant production to avoid problems from diseases such as *Rhizoctonia solani*, *Fusarium spp* and *Pythium spp*, which are the main phytosanitary problems at coffee seedbeds.

Phytosanitary treatment can be biological, chemical or physical, according to nursery owners' preference. However, effective treatment must be ensured through periodic monitoring. For chemical treatment, disinfectants (fungicides, bactericides, nematicides) allowed in the country are generally used and the guidelines of the safety sheet for each product, also called MSDS (Material Safety Data Sheet) are followed.

Other alternatives to chemicals are:

BOILING WATER TECHNIQUE

1. Get metal buckets.
2. Add the substrate (sand, soil, natural fibers) to be disinfected.
3. Add plenty of boiling water to soak the entire contents.
4. Cover the container with plastic sheet to keep the temperature until the material cools.
5. Drain and let dry; substrate is ready to use.

SOLARIZATION TECHNIQUE

1. Place the substrate on a black plastic and spread a uniform layer.
2. Irrigate the substrate until 50% humidity is reached. It is recommended to use a tensiometer to measure humidity.
3. Cover the substrate with a transparent plastic, stretch it well to avoid air bubbles, and close the edges so that the heat does not escape.
4. Leave it for a week or more under the sun.

STORING SUBSTRATES

1. Choose an enclosed space, with a roof, walls and concrete floor if possible, to prevent previously disinfected substrate from coming into contact with pathogens.
2. Label each substrate indicating mixture type and disinfection date.
3. If possible, store it in bags.
4. In the case of handmade mixture, disinfection is recommended once or twice per year. Peats generally do not require it.

Containers

Selecting the right container for the nursery is a very important decision. Nursery operator should take into account the substrate they have access to, the amount of time plants will stay in the nursery, and is climate conditions make the nursery prone to disease outbreaks. The two most common containers for coffee nurseries are tubes or polybags.





Plant developed in tube - 6 months old

1. TUBES

- No contact of root with soil. Splashing is avoided.
- Lower risk of impact from pathogen agents.
- Good root development.
- It avoids malformations of roots at the base of containers due to self-pruning by light. When light reaches the roots, they stop growing and do not roll up.
- The initial investment is higher
- Designed for plants to stay 6 months in the nursery, depending on the size.
- If the available substrate is high on clay it is not advisable to use tubes.

2. POLYBAGS

- The final plant is older and, consequently, more robust, better developed and stronger to transplant to field since it can stay in the bag 6-12 months depending on the size.
- Soil is typically compacted and can cause problems in the development of the root.
- If left too long in the bag, the main root can curl and cause strangulation of the plant.
- Potential presence of disease since it is closer to the ground.

Germination

Seed germination is key to reproduction. Some requirements exist to avoid any risks during germination that can cause the seed to die.

Risks in propagating seeds

- Mixing varieties if traceability requirements are not met.
- Risk of pest and disease if substrate is not disinfected.
- Heterogeneous plants due to improper selection of germinated seeds.
- Little to no germination due to improper management.

Traceability requirements to propagate seeds

1. Seeds to sow must be certified to ensure both quality and genetic purity of plants.
2. If producer wishes to germinate seeds from different varieties, this should be done in different greenhouses or in physically separated areas in order to ensure seed traceability

PREPARING SEEDS - PRE-GERMINATION TREATMENT

One day before sowing, remove seeds from storage, weigh the amount required, and check seed moisture. If seed moisture is 20% or less, leave it at least 12 hours in water to rewet the seeds. This process is known as imbibition. If moisture exceeds 20%, seeds can just be soaked for four hours before planting. It is recommended to add amino acids to water, as this energizes seeds to germinate.

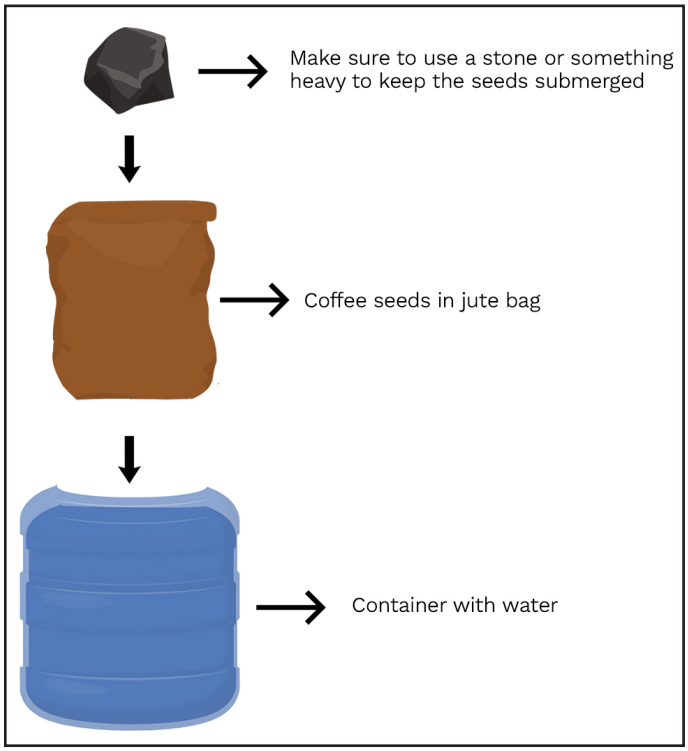
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Plant developed in polybag - 6 months old



Germinated coffee seeds in soldier stage



Seed being submerged in water with amino acids for a few hours to stimulate germination

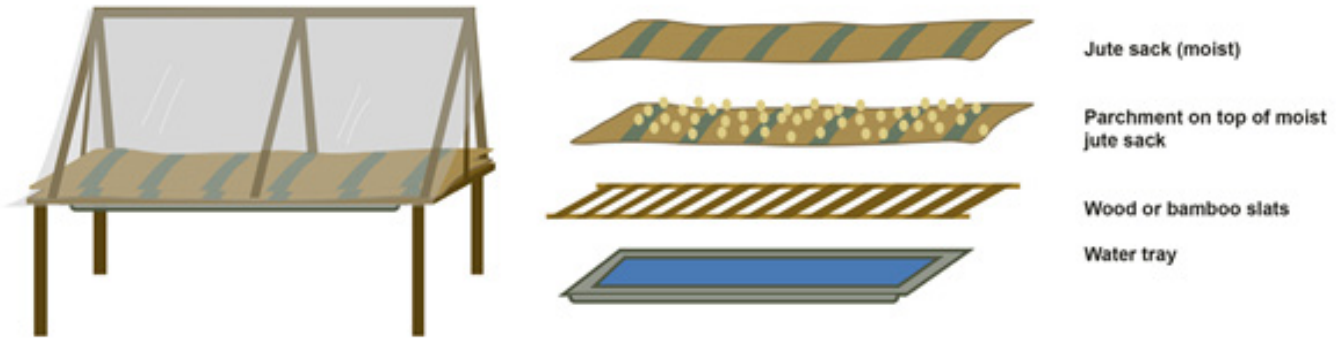
There are different ways to correctly germinate coffee seeds:

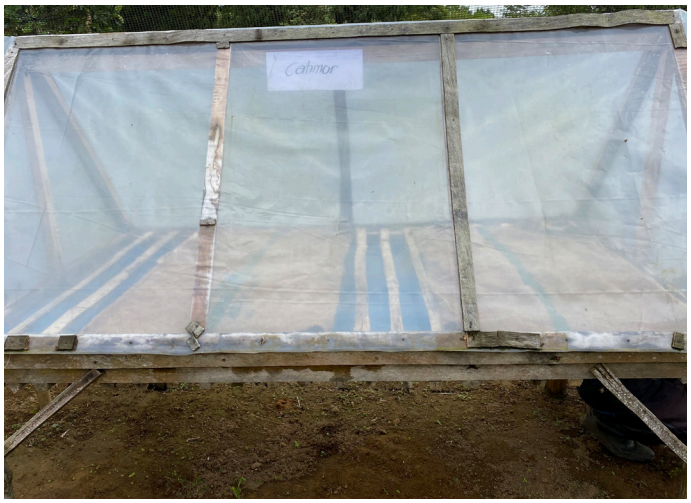
1. GERMINATION BOX

A germination box is recommended to allow seeds to germinate without putting them into a seedbed, avoiding the damage that comes with uprooting and transplanting.
Seeds will start to germinate within nine (9) days, depending on the consistency of temperature and available moisture.

Parts of a Basic Germination House:
UV Cover – A sheet of laminated cover that can be opened and closed.
Jute Sacks – Moistened jute sack retains water for the seeds. Place the seeds on it and cover it with another sack
Water Tray – A shallow tray filled with water that provides moisture to the jute sacks

Materials needed:
- 2x3x10 lumber 4 pieces
- 50 pieces bamboo slat
- 2kg #2 common nails
- 1.5kg #1 common nails
- 3 pieces size 4 inches hinges
- 4 pieces jute sacks







Timeline of Coffee Seed Germination in Germination Box

Day 1: Parchment seed is placed inside the germination house
Day 3: Seed may show no sign of visible bump
Day 6: A small bump appears
Day 9 – 25: Radicle protrusion or growth starts and begins to elongate





Transplanting from the Germination Box

1. Place germinated seed on top of nursery media.
2. Cover lightly with media.
3. Leave a half inch (½) lip on top of polybag or dibble tube to allow water to accumulate without run off.
4. After six (6) weeks, a small sprout should be showing.
5. At the three (3) month mark, the first two (2) leaves should be well developed.



2. GERMINATION BEDS

Beds raised from the ground are one of the most common. These can be supported by boards, bamboo or even concrete. Even though germination can take place on beds directly placed on the ground; this practice has the disadvantage that the plants are more prone to pests, impact from run-off or animals.

The size of the germination beds can vary, but to facilitate work, germination beds 1.25m width are recommended, the length can be determined by the space available of the number of seed that will be germinated.

Substrates for germination: A bottom of volcanic sand (1 mm in diameter) is recommended. To ensure drainage, the bottom layer should be at least 5 cm thick. The substrate layer on top must preferably be made of peat moss mixed with sand or only fine sand, and it needs to be at least 15cm thick. Sand must not be too thin to avoid compaction, nor too thick to avoid problems of root development and germination due to lack of moisture.

On the day of sowing, place the seed homogeneously in the previously moistened substrate. Then, cover the seed with a layer of substrate 0.5 cm to 0.7 cm. thick. Covering the seed is key: if it is covered with a very thick layer, germination is delayed and is uneven. If it is very thin, the seed can dry partially and not germinate. It is advisable to have 1 - 1.5 kg of seeds per square meter. In line with germination and discarding to attain quality, each square meter may yield nearly 3,500 seedlings.

Once this process is over, water the germination bed. If needed, add substrate to areas uncovered by irrigation. Cover the bed with a white plastic sheet to allow light to enter, in the form of a microtunnel. This plastic sheet retains heat to favor the germination process, and avoids substrate dehydration.



Example of germination beds



Another example of germination beds



Seeds being sowed for germination in a germination bed made of sand



Germination beds covered with yute bags after irrigation to mantain humidity

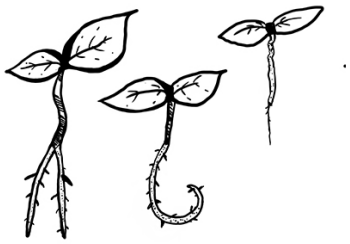
Disadvantages on the establishment of seedbed germination:

1. Seed bed requires constant watering.
2. The top of the seed bed dries out easily.
3. Transplanting requires pulling or digging the seedlings out, resulting in damaged feeder roots if done incorrectly.
4. Transplanting is a shock to the plant and needs time to recover
5. The biggest problem is inserting a small tap root of the coffee seedling into the poly bag without bending and creating J Root.
6. It has less germination rate ranges from 10-30 less compared to using a chamber
7. It requires more manpower/ labor force in the maintenance.

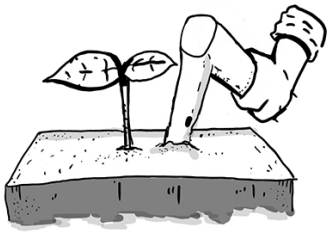
Advantages on the establishment of seedbed germination:

1. Less risk of dehydration of the seed.
2. There is a higher control of the quality of the root system because it can be inspected before planting.
3. Allows the nursery operator to prepare the "matchsticks" for proper grafting techniques on Arabica coffee
4. "J Root" is avoided by clipping the root (as instructed in this manual) and proper planting actions. The "matchstick" should not be pressed to the bottom of the hole, and the substrate is pressed to the "matchstick" from the sides instead of from the top.

All good practices mentioned in this guide should be followed if the grower decided to use seedbeds. Please take into consideration that they must be made of curated sand to avoid disease and have at least 30cm of depth to ensure the quality of the process. Boxes to contain the sand can be made of wood, bamboo or other materials.



Avoid these types of roots



Step 1: Use a tool to gently loosen the seedling from the sand until it pops out



Step 2: Bore a hole in the polybag to accommodate root system of the seedling

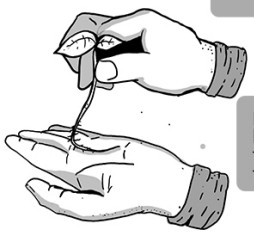


Well-developed roots



Step 3: Place the seedling; the hole should be deep enough for the root.

Seedling roots normally grow longer in seedbed; trim the roots.



Bend the seedling in your hand and cut where it is less flexible. Be careful not to trim it too short.



Step 4: Gently push the soil from the side to avoid bending of the root.

Transplanting from the Germination Beds

Germination in a germination bed can take 45-60 days until the seedlings in soldier stage are ready for transplant. Once they are ready, before the cotyledon leaves appear, they can be taken out of the germination bed and transplanted into the final container.

Main characteristics of seedlings to plant include:

- Healthy plants, with no traces of disease
- Straight hypocotyl
- Large, straight root
- Sorted by size

Seedlings in soldier stage are strictly selected to ensure they meet the characteristics above for optimal growth. Then they are sorted by size for uniform production.

Undesirable characteristics include:

- Double root
- Forked root
- Small, cut, hairless root





Germinated seeds in bed, ready for transplant



Transplant of germinated seeds in a germination box, planted in tubes



Germinated seeds, extracted from the germination bed and selected for planting

Grafting

Grafting in Arabica is commonly used as a practice to enrich the root system of a variety. The most common technique is called the "Reyna" graft, and it is highly practiced in some coffee producing regions, like Latin America.

It is composed of two parts that unite: the "bottom" variety that is typically a germinated seed of Robusta and the "top" variety which is typically a germinated seed in soldier stage high yielding and high cup quality Arabica variety. The intention is to maintain the desirable characteristics of the Arabica variety, but strengthening the plant by providing a Robusta root system, thus obtaining a plant that can produce high quality fruit, but is strong and vigorous as well.
Grafting provides many advantages for coffee growers, since grafted plants are commonly more vigorous than others. However, it is a thorough, innocuous, careful process. Personnel involved in grafting must undergo training to reduce seedling mortality and increase production. Some requirements must be met prior to grafting, as follows:

STAFF REQUIREMENTS

Since grafting involves critical work, staff must be trained in advance. Beginner grafters can perform between 50 and 100 grafts per day. After two to four weeks, they can reach about 250 to 400 grafts per day. Experienced people can perform up to 800 grafts per day.

Requirements for grafting personnel include:

- All operators must wash hands to the elbows with soap at the sink.
- Dirty nails are not tolerated due to health issues. Use soap and brush to clean nails.
- All operators are required to wear aprons and closed, clean shoes at the workshop. Operators wearing dirty shoes or boots are not allowed.

Workers complying with the above may go to their work areas.



United seedlings to create the graft. Grafted plants will maintain the "top" varieties characteristics above the ground, but will have the root system of the "bottom" variety

INFRASTRUCTURE REQUIREMENTS

1. Designated area: the grafting should take place in a dry, cool place of the nursery. Under shade or roof to avoid direct exposure of the seedlings to the sun.
2. Work tables: It is preferable to use surfaces that are easy to clean and do not harbor bacteria or diseases. The tables are typically made of wood, glass or plastic. The disinfection of the tables should be done at least 2 times a day with a disinfectant solution.
3. Prepared seedlings: the germinated seedlings of the Arabica and Robusta must be prepared and selected for the grafting process. Only healthy seedlings should be grafted, and roots have to be carefully selected for the "bottom" part.
4. Blades: razor blades can be used to make the cuts but should be disinfected regularly to avoid diseases.
5. Disinfectants: alcohol or iodine-based disinfectants can be used for the blades, tables and hands of the personnel.
6. Parafilm: this is the tape used to join the graft. It is important to use enough to join the graft but not too much or too tight since it will asphyxiate the plant as it grows if not done properly.

Grafting Procedure



Step 1: Receiving Arabica germinated seeds – "Top" variety: Buds are received, cut and selected. Only healthy material should be selected.



Step 2: Receiving rootstocks or Robusta germinated seeds – "Bottom" variety: Previously selected rootstocks with good root development and bare roots are received.



Step 3: Preparing rootstock roots: It is advisable to have an operator in charge of this task that inspects and rejects rootstocks with poor quality, including those with forked roots, short roots, affected by pathogens, etc. He/she must disinfect scissors (for example, with Iodine - 4cc / l) between cuts made. Cut rootstocks evenly 5cm from their necks (+/- 3mm). Once rootstocks are prepared, they must be grouped by packets and delivered to the grafting team. Rootstocks are sprayed with water and protected mainly to limit root dehydration. The operator is responsible for continuously delivering rootstocks to individual grafters and leaving his/her work area clean.



Step 4: Preparing Parafilm strips: It is advisable to have an operator in charge of this task. This person will prepare homogeneous Parafilm strips for the grafters' team and to keep the grafting area clean. The Parafilm strip is used to preliminary bind rootstock and buds to ensure graft viability. The operator is also responsible for continuously delivering rootstocks to individual grafters and leaving his/her work area clean, not only at the end of the day. In addition, once this activity is over, he/she must leave the grafting workshop clean.





Take a good "top" variety, take a blade and disinfect it thoroughly. Make a lateral incision on both sides, the same length that the one made in the rootstock.

Step 5: Graft

5.1. First, take a rootstock. Take a blade and disinfect it. Cut the upper part of the rootstock (leaves and buds), then make a longitudinal incision at least 2.5 cm long. Leave it on a clean stand.
5.2. Then, take a good "top" variety, take a blade and disinfect it thoroughly. Make a lateral incision on both sides, the same length that the one made in the rootstock.
5.3. Join both varieties as quickly as possible without touching the bare tissues with hands.
5.4. Tie with Parafilm from bottom to top, making sure it is not loose. To do so, it must be stretched. It is important to go above the cut so that Parafilm ties tissues properly. There is no specific length for the Parafilm strip, the most important thing is that it is easy to handle. Strip width must not exceed 1.7 cm to avoid strangling the graft.
5.5. The completed graft is placed in a plastic container and sprayed with water. A group of the finished grafts can be taken to be planted in the tube or the bag, always cover them with wet paper or cloth to protect from dehydration.
5.6. Plant grafts in substrate.
5.7. Clean the working table with cotton and alcohol disinfectant; restart the process.
5.8. Each lot of grafted plants is labeled with its information for traceability. (Variety, grafting date, week, lot, grafter name or code). In addition, a color code can also be used to distinguish varieties.



Take a blade and disinfect it. Cut the upper part of the rootstock (leaves and buds), then make a longitudinal incision at least 2.5 cm long. Leave it on a clean stand.



Join the bottom variety and the top variety as quickly as possible without touching the bare tissues with hands



Tie with Parafilm from bottom to top, making sure it is not loose. To do so, it must be stretched. It is important to go above the cut so that Parafilm ties tissues properly. Strip width must not exceed 1.7 cm to avoid strangling the graft.

Nursery Nutrition

To obtain quality seedlings, good nutrition adapted to plant needs at each stage is essential. For nurseries it is recommendable to make a nutrient analysis of substrates to compensate nutritional deficiencies through a formula, if needed. Fertilization plans can be conventional or organic, but there are certain requirements to be met for efficiency:

Requirements for effective fertilization

- Fertilization in line with variety/substrate nutritional requirements
- Apply in line with growth stage

Risk from inappropriate nutrition

- Improper development of the coffee seedling
- Higher risk of disease due to nutritional deficiencies, productivity problems, and greater susceptibility to pests in adult plants
- Toxicity that could lead to plant death

Coffee shrubs require several nutrients to reach their maximum production potential from a nutrition point of view. To grow coffee, nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg) and sulfur (S) are considered macronutrients for coffee plants, meaning that they are needed in a larger amount.

N

Nitrogen is the key element for coffee, especially for vegetative development, growth of new shoots, and green color.

P

Phosphorus helps develop good roots thus providing plants with greater support.

K

Potassium plays a key role in hardening tissues.

Ca

Calcium plays a major role in the development of roots and cell walls.

Mg

Magnesium plays a major role in photosynthesis and plant development.

S

Sulfur is essential to produce chlorophyll.

Micronutrients are needed in a smaller amount, but they are as important as macronutrients since they play a key role in the development of coffee shrubs. Main micronutrients are Iron (Fe), Manganese (Mn), Copper (Cu), Zinc (Zn), Boron (B), Chlorine (Cl), and Molybdenum (Mo). Many coffee fertilizer formulas include micronutrients also, since only little amounts of these are needed.

For optimal plant growth nutrients must be absorbed and then distributed in adequate proportions. Maintaining this nutritional balance can create or expand synergism and antagonism between nutrients in the soil. The excess of one of them can cause lack of another.

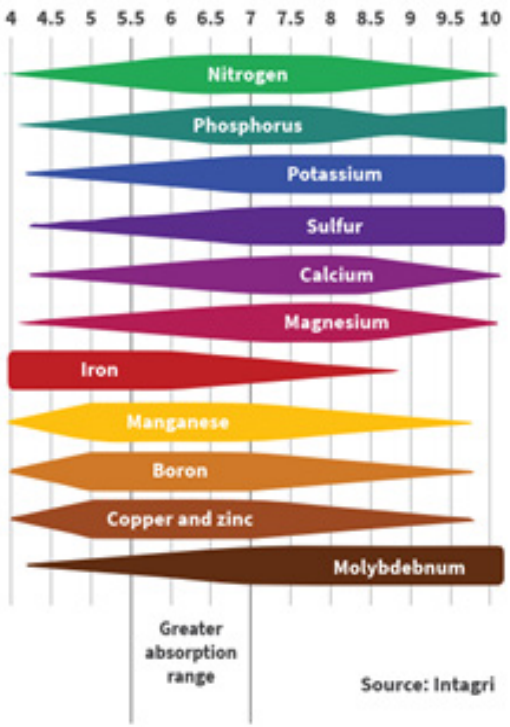
Apart from the importance of the presence of nutrients, some factors are closely related to correct absorption of nutrients by plants.

WHAT IS PH AND HOW DOES IT IMPACT NUTRIENT AVAILABILITY?

The potential of hydrogen, pH, measures acidity (low pH = acid) or alkalinity (high pH = basic or alkaline) of a soil. pH controls chemical reactions determining if nutrients are or are not available (soluble or insoluble) for absorption. For this reason, the most common nutritional problems occur in crops when the pH is outside its optimum range. Therefore, even if the plant is given all the nutrients it needs, if the pH is out of appropriate range, absorption is impossible. In a very acidic environment, deficiencies of nitrogen, potassium, calcium and magnesium may occur; while with high pH the solubility of iron, phosphorus, manganese, zinc and copper may decrease.

The pH range recommended for coffee is 5.4 - 6.8.

The level of pH in a substrate can be measured in the farm using pH color strips.



NUTRITIONAL DEFICIENCIES

When a plant is being developed in a substrate that is not fertile, or elements in the substrate are not available for absorption, different symptoms may appear. The lack of each nutrient will show a different symptom, commonly presented by changes in the color, shape, or growth of leaves, stems or roots. It is important that growers learn to identify the symptoms of each deficiency so nutrition plans can be corrected in time.

Notice that the symptoms mentioned below may also be related to poisoning, pests or diseases, and can also present themselves combined with other deficiencies. Please check well before taking remedial action.



DEFICIENCY OF NITROGEN
Symptoms of deficiency:

- Chlorosis or general yellow color of mature leaves
- Lower vegetative growth
- Possible defoliation
- Decrease in chlorophyll content

DEFICIENCY OF PHOSPHORUS
Symptoms of deficiency:

- Slow plant growth
- Little root
- Small leaves
- Not common in nurseries



DEFICIENCY OF MAGNESIUM
Symptoms of deficiency:

- Decreased vegetative growth
- Yellow spots seen against the light between leaf veins



DEFICIENCY OF IRON
Symptoms of deficiency:

- Yellowing of the leaf, but the leaf veins remain green
- Mainly caused by drainage issues



DEFICIENCY OF BORON
Symptoms of deficiency:

- Often seen in only the new leaves
- Leaves deform and twist on themselves, may also affect the stem



DEFICIENCY OF ZINC
Symptoms of deficiency:

- Yellowing of the leaf in the border lines
- Observed in the new leaves
- Leaves deform and close around the main vein



TOXICITY

Toxicity can occur at nurseries during the entire production process since growing plants are very susceptible to high doses of fertilizers. Therefore, it is key to manage fertilization carefully and to ensure good pH range. Very high levels of toxicity can even cause death to seedlings. In case they do not cause death, they still can stop growth, cause leaves to turn yellow and even fall in certain cases.

In cases of fertilizer application toxicity, wash the substrate with water to drain excess nutrients and/or use lime to increase pH. Applying molasses in drench (irrigation to roots) or foliar amino acids helps recover plants. It is recommendable to stop fertilizing the soil for some time until the plant recovers. Fertilization on ground must be stopped.

Examples of nutrition plans for nurseries

To maintain seedlings, first they are transplanted from beds or trays to tubes or polybags where they will grow for later planting in the open field. At this stage, seedlings are given the conditions they need to grow quickly and with good health. The time they spend at the maintenance stage depends on plant demand of customers, most plants will be in the nursery for at least 6 months.

Note that there are many ways to manage plants. Thus, it is best to ask an agronomist for a plan for the nursery and continuously assess it, adapt it and make changes for seedling welfare. An example of nutritional and phytosanitary recommendations for a conventional farmer are below:

	Fertilization	Time
Edaphic fertilization	Controlled released fertilizer (3 - 5g /plant+ amendment to add lime to substrate + granulated fertilizer 18-46-0 diluted	All three are combined with substrate only one time
Nutritional application plan (leaves)	Nutritional fertilization (NPK+ME)	Every two weeks
Phytosanitary application plan	Fungicide/ bactericide	Every two weeks

An important point about phytosanitary control is the daily inspection of nurseries to detect problems in time and try to control the problem in a localized way

Integrated Pest Management (IPM) in Nurseries

Integrated Pest Management (IPM) is a pest management approach that uses all available pest control methods, including but not limited to the judicious use of pesticides, to optimize a crop's ability to resist the pest with the least hazard to man and the environment (BPI).

There are many methods to manage pests or disease in a nursery, and the combination of a series of them will provide better results, as oppose to using only on alternative.

Summary of Pest Control Measures

BIOLOGICAL CONTROL

Use living organisms for pest control. (1) microbial pesticides (2) plant pesticides (3) biochemical pesticides

PLANT RESISTANCE

Bred to produce varieties that resist insects and other pests

Genetically altered to allow them towithstand herbicides

CHEMICAL METHODS

Synthetic chemicals which are intended to prevent, destroy, repel or mitigate any pest, or intended for use as plant regulator, defoliant or desiccant.

MECHANICAL AND PHYSICAL METHODS

Collecting pests with traps, suction devices or by hand, using fire, heat, cold, sound, barriers or screens

CULTURAL METHODS

Crop rotation, soil tillage, use of trap crops, change in planting or harvesting time, intercropping

To apply a combination of this methods, growers should observe and understand several concepts regarding the possible pests or diseases that may affect the nursery:

1. Crop phenology
2. Cultural management
3. Pest indentity, biology and damage
4. Pes/weather monitoring
5. Beneficial organisms
6. Pesticide management

The economic threshold: a pest or disease is said to be needed to be controlled once it crosses the economic threshold. This is defined when the population or incidence of the pest or disease negatively affects the crop to a pint in which the losses caused are greater in cost than the expense it represents of controlling the pest or disease. This means, a producer can tolerate small populations of plagues, as long as they do not cause great damage to the plantation. Sampling pest populations or disease incidence provides the information needed to know when this threshold has been crossed and therefore when control of this organism is necessary

As discussed for seed production, an important component of a IPM plan is the definition of "pests". These are organisms or populations of organisms that negatively affect a crop and decrease its yield. They can affect different parts of the plant, such as fruits, foliage or roots. It is sometimes overlooked by producers to think about pests and other pathogens as living organisms just like any other, it is indispensable for them to stay active and reproduce. Unfortunately, this means they affect coffee plants or seedlings in order to survive. It is important to note that, being living organisms, having a detailed knowledge of their behavior, habitat or reproductive cycle allows to better control them with a plan that is effective in reducing pest populations or the incidence of diseases, or even avoiding them completely. IPM plans must be constantly updated as well since pest and disease populations, as living organisms, are constantly affected by factors such as temperature, relative humidity, precipitation or wind speed.

These are the most important pests and diseases that may affect the production of seedlings in a coffee nursery. Please notice that many pathogens that affect coffee in general are not listed here, since these are only the most relevant for coffee in nursery stage.

Constant sampling is a basic tool for implementing an IPM plan as they assess the incidence of the negative effects of pests and diseases, and also the performance of the measures used for their control. Sampling and observation should be supported by laboratory sampling and analysis if necessary.

Most common insect pests

Mealy Bug *(Planococcus citri)*
There are several species of mealy bugs, and they can be aerial (attack foliage) or root. The mealy bug is usually 3 to 5 mm long, oval-bodied and has a yellow cuticle, which is actually a glandular secretion. It is covered in floury white shell.

Main Symptoms
- Yellowing of the plants
- They produce sugary secretions, where the fungi *Capnodium sp.* develops. and *Meliola sp.* (Fumagina) that forms a black film on the leaves, which interferes with the photosynthesis of the plant. Ants feed on these secretions so symbiosis forms between the two organisms. Ants are responsible for mobilizing mealy bugs to different plants and spread contagion.

Prevention
Remove weeds around and inside the nursery. Take precautions when entering materials from other nurseries that may be contaminated.

Cultural methods
- Elimination of plants highly infested with the pest.
- Nitrogen fertilization can encourage its onset, it is recommended to make constant sampling and have a balanced nutrition plan.

Biological Control
Natural predators such as *Chrysoperla sp.* can be used.

Chemical Control
- The insecticide should be mixed with mineral oil for agricultural use, since the mealy bug through has a shell that is difficult to enter for the insecticides, the oil pierces this barrier and makes them susceptible.
- Applications must be made alternating systemic products with contact products.
- Applications should be directed at ants as much as mealy bugs.
- Use only insecticides allowed in your country and follow the guidelines on the safety sheet of each product, also called MSDS (Material Safety Data Sheet).
- Applications targeting root mealy bugs must be made in "drench" for the product to penetrate and cover the root system.



Aphids *(Aphis coffeae)*

They are small insects (2mm long), yellow, light green or black. They reproduce quickly forming large colonies in a short time. They like tender leaf shoots because they feed on the sap.

Prevention

- Remove weeds around and inside the nursery. Take precautions when entering materials from other nurseries.

Cultural Methods

- Elimination of plants highly infested with the pest.
- Nitrogen fertilization can encourage its onset, it is recommended to make constant sampling and have a balanced nutrition plan.

Biological Control

- Among the predatory insects that regulate aphid populations are: coccinelides, chrysoids and syroid.

Chemical Control

- Insecticide applications should be performed by alternating systemic products with contact products.
- Use only insecticides allowed in your country and follow the guidelines on the safety sheet of each product, also called MSDS (Material Safety Data Sheet).
- It is recommended to delimit and mark areas of high population, in order to treat only the attacked coffee seedlings, and therefore not affect the beneficial organisms.



Coffee leaf miner *(Leucoptera coffeella)*

It's a micro lepidoptera or butterfly. The female lays the eggs, these last 6 to 10 days to hatch, the larvae penetrate the leaf tissue to feed, where irregular spots of dead tissue called "mines" form. It passes through four larval stages, lasting between 16 and 26 days. After the fourth stage, the larva steeps on the leaves building a white cocoon with silk threads on the underside of the leaf, during which it is not vulnerable to insecticides, this state lasts about 14 days. Strong attacks cause plant defoliation.

Prevention

- Remove weeds around and inside the nursery.
- Take precautions when entering materials from other nurseries.

Cultural methods

- Constant irrigation, drought or dry season benefits the development of larvae.

Biological control

- Some biological controlling wasps exist such as: *Polistes spp., Polybia spp.* Fungi such as *Beauveria bassiana* and *Metarhizium anisopliae* can also be used.

Chemical control

- Cultural and biological control is urged to be used first, as insecticides have a detrimental effect on beneficial insect populations. However, if the damage is too large insecticides can be applied.
- Insecticide applications should be performed by alternating systemic products with contact products.



Nematodes *(Meloydogyne spp. y Pratylenchus spp.)*
There are two main types of nematodes that attack coffee plants. They can be present from the nursery stage to the adult plantations. They are living beings, similar to a worm but cannot be seen with the naked eye. They attack the root system of plants, causing severe injuries and deformations. In addition, they decrease the absorption capacity of the plant, so they can cause chlorosis, defoliation and loss of vigor which directly affects plant development. In cases of presence of *Meloydogyne spp.*, the roots deform and the lesions look like small spheres

Prevention
- Perform a laboratory test on the substrate to check for nematode.
- In areas with high incidences, sow only grafted plants with Coffea canephora, especially Nemaya.

Chemical control
- If the incidence of nematodes is high, nematicides should be used. It needs to be left as a last resort as they are overly toxic products.
- Use only insecticides allowed in your country and follow the guidelines on the safety sheet of each product, also called MSDS (Material Safety Data Sheet)



Most common fungal diseases

Damping off *(Rhizoctonia solani Kuhn, Phytium spp. and Fusarium spp.)*
It manifests itself in spotlights where seedlings are with black, yellow or dead seedlings. The symptoms seen are dark spots on the roots and lesions at the base of the stems, the stems typically bend and then die. In some cases, black spores may be seen in the dark lesions of the stems. These lesions hinder the translocation of water and minerals, causing the seedlings to die. In the seedling stage and after transplant is when there is the greatest vulnerability. The causing fungi are inhabitants of the soil and survive in infected plant material or forming specialized structures. They can appear alone or associated with each other. They are spread by particles of contaminated soil through wind, splashing raindrops, tools or other activities in the propagation area.

Prevention
- Change the substrate each time you start a new germination or graft transplant process.
- The material to cover the sown area or plastic tunnel if used for germination must be clean (new, not have not touched the floor or washed with disinfectant if it has).
- Disinfect tools, materials used in nursery, workers' hands and boots.
- Use clean water sources.

Cultural methods
- Promote aeration between seedlings by distributing them at the recommended density.
- Remove very sick or dead seedlings to prevent spread.
- Avoid excess water/squat.
- Use substrates that have good drainage.
- Avoid very acidic pH in the substrate.

Biological control
- There are different fungi or mycorrhizals that can help fight and/or compete for space like *Trichoderma sp.* These can be applied to substrates after disinfection to be inoculated.

Chemical control

- If the fungus is present, you should apply permitted contact fungicides, such as strobilurins, carbamates and copper-based. (It is preferable to avoid triazoles since they tend to poison seedlings).
- There are specific fungicides for *Rhizoctonia*. If you determine that the damping off is caused exclusively by this fungus, you can attack it in this way.
- Use only permitted fungicides in your country and follow the guidelines on each product's safety sheet, also called MSDS (Material Safety Data Sheet).
- Fungicides may be applied as a preventive measure to seedlings in very wet areas.





Coffee stem necrosis and leaf spot *(Myrothecium roridum)*

There are symptoms in the leaves and stems. In the leaves the first symptom is the appearance of dark circular spots with a light center, then these spots increase in size and develop concentric rings, finally, black reproduction structures can be observed in the lesions. On the stems, infected plants show symptoms of deformations or lesions in the lower portions of the stems and/or rot of the pivoting root. There is blockage of the stem conduction tissues as the stem thickens, this induces the formation of adventitious roots in the portions of the stem under the lesion or at the base of the pivoting root. When the severity of the infection is high, young plants die. In other cases, plants can survive the nursery, but when the plants are larger and transplanted to the field they die.

Prevention

- Treat the substrate with a preventive fungicide before establishing the seedbeds or nursery.
- Transplant only healthy seedlings.
- Carry out transplant activities washing workers' hands, boots and tools.

Cultural methods

- Promote aeration between plants by leaving a space between each pair of rows and provide height to the shadow mesh.
- Carry strict humidity control.
- Remove plants that have died.
- Keep an eye on the nursery for damaged and chlorotic leaf plants. Separate these coffee seedlings and examine for lesions and/or presence of adventitious roots and destroy diseased plants.

Chemical control

- There is no effective chemical control so far for *Myrothecium roridum*. The indication is to separate the sick plants and destroy them, if the attack is severe, it should be considered to eliminate everything and make a deep disinfection of the structures.

Coffee brown-eye spot *(Cercospora coffeicola)*

The infection in the leaves is initiated forming circular lesions with dark brick edge, clear center and in some cases a chlorotic halo is present. Injuries are between 3 and 10 mm in diameter. Initially they are small, but can increase in size, eventually causing premature leaf fall. The disease occurs under stressful conditions, which can be caused by environmental factors (such as drastic changes in humidity and temperature), although in nursery the most common is that it is caused by a poor nutrition program.

Prevention

- Promote good nutritional balance for young coffee trees in the nursery
- Use healthy and vigorous plants to start planting
- Avoid very abrupt changes in the final stage of acclimatization when removing the nursery shade net

Chemical control

- If the disease progresses, the grower should apply permitted contact fungicides, such as strobilurins, carbamates and copper-based. (It is preferable to avoid triazoles tend to poison seedlings).
- Use only permitted fungicides in your country and follow the guidelines on each product's safety sheet, also called MSDS (Material Safety Data Sheet).



Sooty mold *(Capnodium spp. y Meliola spp.)*
This fungus does not invade the tissues of coffee leaves, but it interferes with the photosynthesis process and the development of the plant because it prevents light from reaching the leaves. As mentioned above, it is caused in association with insect pests such as mealy bugs, although it can also appear when there is a presence of aphids. The main symptom is that leaves are covered in a black layer.

Prevention
- Eliminate the presence of ant hills in the nursery.
- Perform the practices mentioned in the insect pest sections to prevent the appearance of mealy bugs or aphids.

Chemical control
- Foliar sprays may be performed, using contact fungicides on the top and underside of the leaf.



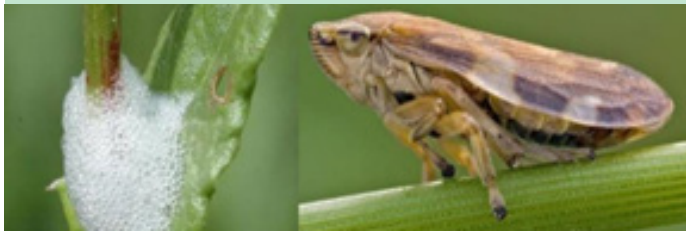
Most common bacteria diseases

Xylella fastidiosa
The bacteria *Xylella fastidiosa* proliferates in the inner ducts of the roots, stems and leaves. The ducts of infected plants are blocked due to the infection caused by the bacteria. This bacteria is transmitted by cicadélid insects. If one of these insects bites an infected plant, the bacteria multiply inside the vector insect and after several days infected, it is able to transmit the disease to healthy plants.

Main symptoms
- Formation of a type of foam or slime on the plants
- Loss of turgor of the leaves at the top of the plant
- Progressive weakness of the plant with symptoms of stress and defoliation.
- Malformation of the leaves, especially by the presence of narrow, small and elongated leaves with wavy edges and a yellowish to reddish green coloration.
- Short internodes, proliferation of shoots.

Cultural methods
- Eliminate plants that have died.
- Keep an eye on the nursery for damaged leaf plants with the bacteria's characteristic slime. Separate these coffee trees and examine them for a few days.
- Keep the area around the nursery free of weeds that can host the vector insect.
- Use of living barriers around the nursery to reduce vector dispersion.

Recommended sanitary control
- Eliminate sick plants in case of strong attack.
- Perform copper-based fungicide applications.
- Lower relative humidity, and promote adequate drainage.
- Control excess shadow.
- Lower nitrogen fertilization and increase applications with potassium.



Pseudomonas syringae

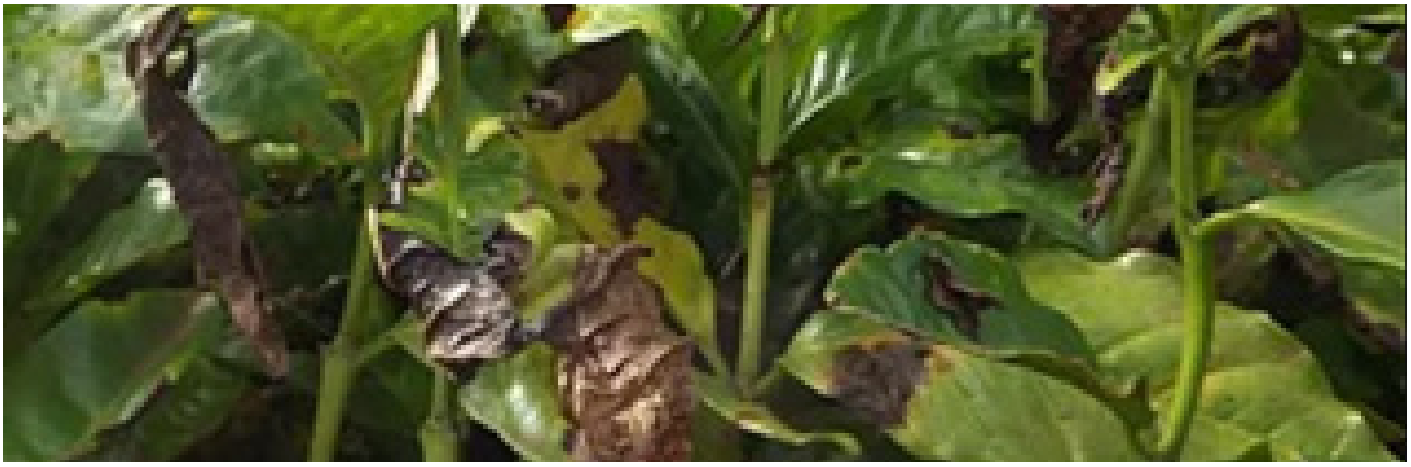
Symptoms begin with brown to black necrotic spots with yellow halos around these spots. In extreme cases it causes the leaves to fall. The spots are characterized by an oily texture.

Cultural methods

- Remove bags where plants have died.
- Keep an eye on the nursery for damaged leaf plants with the bacteria's characteristic symptoms. Separate these coffee trees and examine them for a few days.
- Protect the nursery from strong winds.
- Lower relative humidity, and promote drainage.
- Control excess shade.

Recommended sanitary control

- Eliminate sick plants in case of strong attack.
- Perform copper-based fungicide applications.



Strong temperature changes increase the degree of bacterial attack. So growers should be aware of actions that can promote these changes, such as, removal of the shade net, maintenance or irrigation systems, etc.

Part 4

PLANT NURSERY ACCREDITATION



Source: Department of Agriculture
Bureau of Plant Industry
National Seed Quality Control Services
Plant Material Certification Section

- *Office Address: NSQCS Building, BPI Compound, Visayas Avenue, Diliman, Quezon City*
- *Contact No.: (02) 8288-2468/8936-2546/ 8376-1004/ 8920-0968*
- *Email Address: plantmaterialcertification@gmail.com/ nsqcs.co@gmail.com*

REQUIREMENTS FOR ACCREDITATION

For government nurseries:

Documents	Remarks
1. Letter of Intent	
2. Filled-up application form	
3. Authorization of applicant duly signed by designated authority of the agency	
4. Certificate of training on nursery establishment and operation including plant material certification (issued within two (2) years prior to application	Minimum of 2 persons
5. Location map, lay-out plan and photos of the nursery	
6. Copy of the official receipt of payment for application of accreditation of the nursery in the amount of Php 1,000.00, non-refundable	Except for DA-attached agencies, DA RFO's and its Centers/Station

For private nurseries:

Documents	Remarks
1. Letter of Intent	
2. Duly accomplished form	
3. Mayor's permit	Current Year
4. Bureau of Internal Revenue (BIR) registration	
5. Duly notarized authorization of the applicant	For partnership, corporation, cooperative, or association
6. Department of Trade and Industry (DTI) registration	For sole proprietorship and partnership
7. Cooperative Development Authority (CDA) Registration Certificate	For Cooperative
8. Securities and Exchange Commission (SEC) or Department of Labor and Employment (DOLE) Certificate of Registration	For Association
9. Securities and Exchange Commission (SEC) Certificate of Registration	For partnership and corporation
10. Certificate of training on nursery establishment and operation including plant material certification (issued within two (2) years prior to application	Initial application for accreditation: Sole proprietorship/partnership: One (1) person Cooperative/Association/Corporation Minimum of two (2) persons Renewal Accreditation: Sole proprietorship/partners: One (1) person Cooperative/Association/Corporation All person doing propagation work
11. Location map, lay-out plan and photos of the nursery	
12. Copy of the official receipt of payment for application of accreditation of the nursery in the amount of Php 1,000.00, non-refundable	

TECHNICAL REQUIREMENTS FOR ACCREDITATION

The applicant must comply with the following requirements for the purposes of evaluation of its application for nursery accreditation

- Nursery shall be established and in operation at least one (1) year prior to application and develop a manual of operation on crop species being applied for by the nursery operator.
- For sole proprietorships and partnerships, the nursery must have a minimum of 1,000 seedlings ready for planting of NSIC-registered variety/ies of the crop being applied for, and an area of at least 500 square meters within a municipality/city.
- For juridical persons such as corporation, association, and cooperatives, the nursery must have a minimum of 5,000 seedlings ready for planting on crop variety being applied for, and an area of at least 1,000 square meters within a municipality/city.
- For government agencies, nursery must have a minimum of 1,000 seedlings ready for planting on crop variety being applied for and an area of at least 500 square meters.
- Develop a manual of operations on the crop species being applied for by the nursery operator.

CPD
PNA-Form # 1

DEPARTMENT OF AGRICULTURE
Bureau of Plant Industry
Manila

APPLICATION FOR ACCREDITATION OF PLANT NURSERY

☐ New ☐ Renewal

Crop/s Applied (Kind) _____

Name of Applicant _____

Name of the Establishment or Business _____

Address _____

Contact No. _____

Region _____

Location of Nursery _____

Area of Nursery (sq.m.) _____

I hereby certify that I will abide and follow the guidelines/instructions of the Bureau of Plant Industry for proper nursery management.

_____
Applicant

EVALUATED/ INSPECTED BY:

_____
Designated Inspector/Evaluator

_____
Office

Copy Distributed (2 copies)
1. Regional Office, DA
2. Provincial Office, DA

Date of Application: _____

Application form for Plant Nursery Accreditation
Source: Bureau of Plant Industry



The nursery must have the following facilities:

✓ Access to water source
✓ Potting area and propagation area
✓ Seedbed/germinating facility
✓ Permanent storage facilities (for chemicals, ferti lizers, and other nursery supplies)
✓ Propagating equipment and other tools
✓ Composting facility
✓ Waste disposal facility
✓ Comfort room
✓ Rest Area/Receiving Area

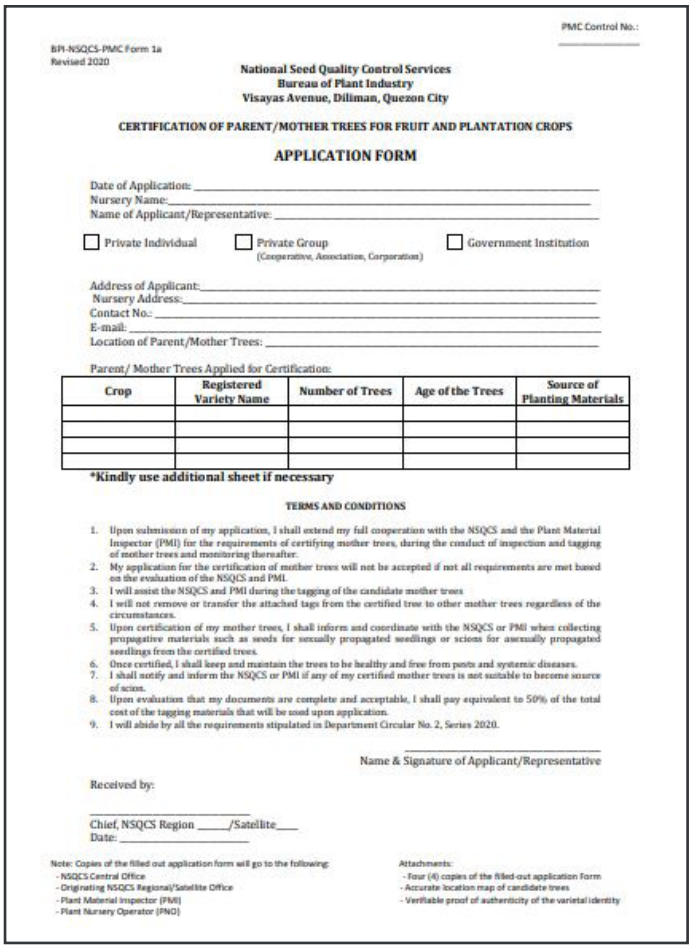
MOTHER TREE TECHNICAL REQUIREMENTS

- Must have a label in each mother tree of NSIC-approved variety on the crop being applied for.
- Must have at least 5 mother trees of the crop variety being applied for sole proprietorship, partnership and government institutions and 20 trees of the crop variety being applied for cooperatives, associations, and corporations.
- For new applicants, the initial mother trees of the NSIC-registered variety/ies of the crop being applied for must be certified.

ACCREDITATION PROCESS

BPI-Deputized Plant Nursery Evaluator (PNE)

- Applicant shall submit a letter of intent, filled-up application form, pay the appropriate application fee, and other necessary documents to the concerned BPI-NSQCS Regional/Satellite Office.
- The concerned BPI-NSQCS Regional/Satellite Office conducts an evaluation of the documents submitted by the applicant.
- The concerned BPI-NSQCS Regional/Satellite Office endorses the application to the DA-Regulatory Office for their appropriate action.
- The concerned DA-Regulatory Office shall assign the PNE who will conduct the evaluation and proper recommendation.
- The Deputized PNE shall inspect the nursery and its facilities in terms of the necessary requirements stated above, correctness of location map and layout, and conduct geotagging activity.
- The Deputized PNE shall make the report using the prescribed form and make the preliminary recommendations to the concerned DA-Regulatory Office for endorsement by the concerned DA-Regional Executive Director to the Director, BPI.
- BPI-NSQCS Central Office shall review the documents submitted and make the final recommendation for approval/disapproval of the BPI-Director. In addition, a notification letter will be issued to the nursery operator on the action taken by the BPI-NSQCS Central Office on his/her application and a copy shall be provided to the concerned DA-Regulatory Office.
- BPI through the BPI-NSQCS Central Office shall issue the certificate of accreditation signed by the BPI Director indicating the crop/s accredited and its validity.
- The certificate of accreditation shall be issued to the nursery operator through the concerned BPI-NSQCS Regional/ Satellite Office. The photocopied certificate of accreditation will be sent back to the BPI-NSQCS Central Office and providing a copy to the concerned BPI-NSQCS Regional/Satellite Office and DA-RFO Regulatory Division.



PMC Control No.:

BPI-NSQCS-PMC Form 1a
Revised 2020

National Seed Quality Control Services
Bureau of Plant Industry
Visayas Avenue, Diliman, Quezon City

CERTIFICATION OF PARENT/MOTHER TREES FOR FRUIT AND PLANTATION CROPS

APPLICATION FORM

Date of Application: _____
Nursery Name: _____
Name of Applicant/Representative: _____

☐ Private Individual ☐ Private Group (Cooperative, Association, Corporation) ☐ Government Institution

Address of Applicant: _____
Nursery Address: _____
Contact No.: _____
E-mail: _____
Location of Parent/Mother Trees: _____

Parent/ Mother Trees Applied for Certification:

Crop	Registered Variety Name	Number of Trees	Age of the Trees	Source of Planting Materials

*Kindly use additional sheet if necessary

TERMS AND CONDITIONS

1. Upon submission of my application, I shall extend my full cooperation with the NSQCS and the Plant Material Inspector (PMI) for the requirements of certifying mother trees, during the conduct of inspection and tagging of mother trees and monitoring thereafter.
2. My application for the certification of mother trees will not be accepted if not all requirements are met based on the evaluation of the NSQCS and PMI.
3. I will assist the NSQCS and PMI during the tagging of the candidate mother trees
4. I will not remove or transfer the attached tags from the certified tree to other mother trees regardless of the circumstances.
5. Upon certification of my mother trees, I shall inform and coordinate with the NSQCS or PMI when collecting propagative materials such as seeds for sexually propagated seedlings or scions for asexually propagated seedlings from the certified trees.
6. Once certified, I shall keep and maintain the trees to be healthy and free from pests and systemic diseases.
7. I shall notify and inform the NSQCS or PMI if any of my certified mother trees is not suitable to become source of scion.
8. Upon evaluation that my documents are complete and acceptable, I shall pay equivalent to 50% of the total cost of the tagging materials that will be used upon application.
9. I will abide by all the requirements stipulated in Department Circular No. 2, Series 2020.

_____
Name & Signature of Applicant/Representative

Received by:

_____
Chief, NSQCS Region _____/Satellite____
Date: _____

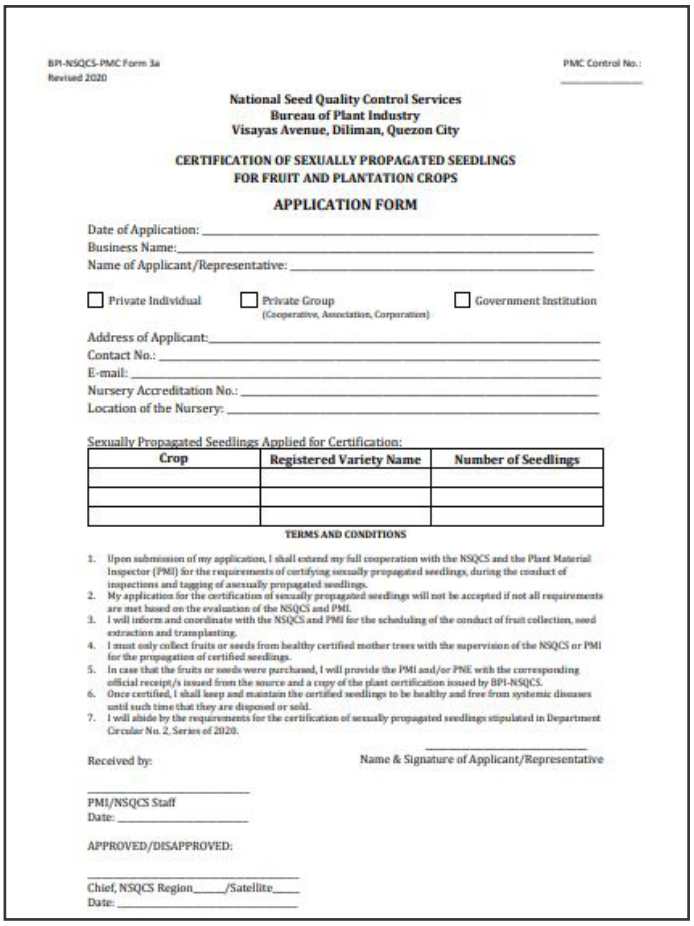
Note: Copies of the filled out application form will go to the following:
- NSQCS Central Office
- Originating NSQCS Regional/Satellite Office
- Plant Material Inspector (PMI)
- Plant Nursery Operator (PNO)

Attachments:
- Four (4) copies of the filled-out application Form
- Accurate location map of candidate trees
- Verifiable proof of authenticity of the varietal identity

Application form for Mother Tree Certification
Source: Bureau of Plant Industry

BPI-Designated PNE

- Applicant shall submit a letter of intent, filled-up application form, pay the appropriate application fee, and other necessary documents to the concerned BPI-NSQCS Regional/Satellite Office.
- The concerned BPI-NSQCS Regional/Satellite Office conducts an evaluation of the documents submitted by the applicant.
- The concerned BPI-NSQCS Regional/Satellite Office provides the concerned DA-Regulatory Office a copy of the filled-up application form.
- The concerned BPI-NSQCS Regional/Satellite Office will assign the Designated PNE who will conduct the inspection of the nursery and its facilities in terms of the necessary requirements stated above, correctness of location map and layout and conduct geotagging activity.
- The Designated PNE shall make the report using the prescribed form and make the preliminary recommendation which the NSQCS Regional/Satellite Chief endorses to the concerned DA-Regulatory Office for endorsement by the concerned DA-Regional Executive Director to the Director, BPI.
- BPI-NSQCS Central Office shall review the documents submitted and make the final recommendation for approval/disapproval of the BPI-Director. In addition, a notification letter will be issued to the nursery operator on the action taken by the BPI-NSQCS Central Office on his/her application and a copy shall be provided to the concerned DA-Regulatory Office.
- BPI through the BPI-NSQCS Central Office shall issue the certificate of accreditation signed by the BPI Director indicating the crop/s accredited and its validity.
- The certificate of accreditation shall be issued to the nursery operator through the concerned BPI-NSQCS Regional/ Satellite Office. The photocopied certificate of accreditation will be sent back to the BPI-NSQCS Central Office and providing a copy to the concerned BPI-NSQCS Regional/Satellite Office and DA-RFO Regulatory Division.



BPI-NSQCS-PMC Form 3a
Revised 2020

PMC Control No.: _____

National Seed Quality Control Services
Bureau of Plant Industry
Visayas Avenue, Diliman, Quezon City

CERTIFICATION OF SEXUALLY PROPAGATED SEEDLINGS FOR FRUIT AND PLANTATION CROPS

APPLICATION FORM

Date of Application: _____
Business Name: _____
Name of Applicant/Representative: _____

☐ Private Individual ☐ Private Group (Cooperative, Association, Corporation) ☐ Government Institution

Address of Applicant: _____
Contact No.: _____
E-mail: _____
Nursery Accreditation No.: _____
Location of the Nursery: _____

Sexually Propagated Seedlings Applied for Certification:

Crop	Registered Variety Name	Number of Seedlings

TERMS AND CONDITIONS

1. Upon submission of my application, I shall extend my full cooperation with the NSQCS and the Plant Material Inspector (PMI) for the requirements of certifying sexually propagated seedlings, during the conduct of inspections and tagging of asexually propagated seedlings.
2. My application for the certification of sexually propagated seedlings will not be accepted if not all requirements are met based on the evaluation of the NSQCS and PMI.
3. I will inform and coordinate with the NSQCS and PMI for the scheduling of the conduct of fruit collection, seed extraction and transplanting.
4. I must only collect fruits or seeds from healthy certified mother trees with the supervision of the NSQCS or PMI for the propagation of certified seedlings.
5. In case that the fruits or seeds were purchased, I will provide the PMI and/or PNE with the corresponding official receipt/s issued from the source and a copy of the plant certification issued by BPI-NSQCS.
6. Once certified, I shall keep and maintain the certified seedlings to be healthy and free from systemic diseases until such time that they are disposed or sold.
7. I will abide by the requirements for the certification of sexually propagated seedlings stipulated in Department Circular No. 2, Series of 2020.

_____
Name & Signature of Applicant/Representative

Received by:

_____
PMI/NSQCS Staff
Date: _____

APPROVED/DISAPPROVED:

_____
Chief, NSQCS Region_____/Satellite_____
Date: _____

Application form for Sexually Propagated Seedlings Certification
Source: Bureau of Plant Industry



POST ACCREDITATION REQUIREMENT

For Accredited Nurseries

1. Additional nursery/ies located in a different province must undergo a new accreditation process.
2. Additional nursery/ies located within the province must be reported by the owner to the concerned BPI-NSQCS/Regional/Satellite office immediately.
3. Nursery operator must inform the concerned BPI-NSQCS Regional/Satellite Office immediately if the nursery is relocated within the province. When outside the province a new accreditation is needed
4. Each member participating in the production of planting materials of cooperatives and associations must be trained within one year from the approval of the initial application.
5. The accredited nursery operator must submit a quarterly report on their stock inventory.
6. For the propagation of additional NSIC registered variety on the accredited crop species, the accredited nursery operator must inform immediately the concerned NSQCS Regional/Satellite and a corresponding certificate of inclusion in the accreditation .
7. If there is change in either the ownership or management of the accredited nursery, a new accreditation is necessary
8. The accredited nursery must have installed a permanent placard/signboard (at least 1.2 meter wide and 2.0 meter-long) indicating the name of the establishment ,owner/operator, address, accreditation number, validity date and list of accredited crop/s after approval of the certificate of accreditation

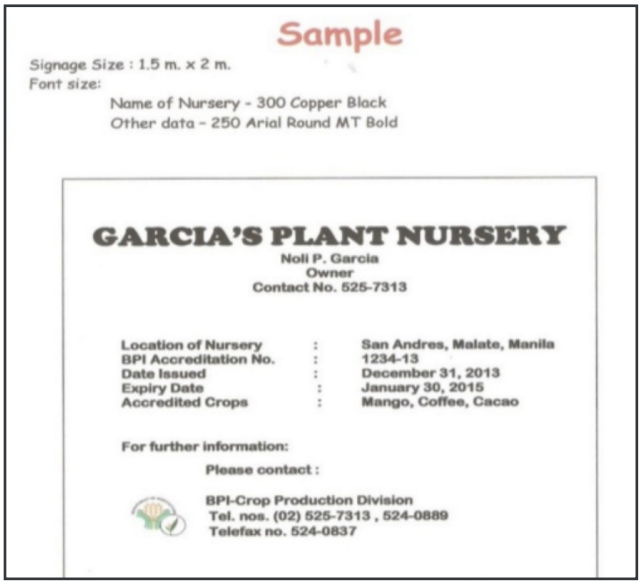
For Mother Trees

1. Additional mother trees planted and certified must be reported immediately to the concerned BPI-NSQCS Regional/Satellite Office.
2. Mother tree must be maintained regularly through proper management practices .
3. The nursery operator shall report immediately infection of systemic disease death of certified mother trees and surrender the certification tag to concerned NSQCS Regional/Satellite office.

MONITORING

Monitoring of accredited plant nursery shall be done at least once a year, or as the need arises, by PNE to determine their conformity with its manual of operations and compliance with the requirements and guidelines set by BPI for each crop species and verify the number of existing certified mother trees. If during the monitoring there is/are non-conformity/ies found, the nursery operator shall be given six (6) months to make the necessary corrections. In addition, the nursery operator shall notify the concerned NSQCS Regional/Satellite Office for any changes in the manual of operation.





Example of a permanent placard/signboard
Source: Bureau of Plant Industry

SANCTIONS

Offense	Penalty
1. Falsification of Certificate of Accreditation	Blacklisting
2. Unauthorized use of certificate of accreditation by another nursery operator or additional nursery located in different provinces	Blacklisting
3. Non-display of permanent signboard with the required size necessary information	1st Offense- Reprimand 2nd Offense- Suspension (one year) 3rd Offense- Cancellation of Certificate
4. Refusal to allow the monitoring team to enter his/her PTCF premises for monitoring and inspection within the period of accreditation	1st Offense- Reprimand 2nd Offense- Suspension (one year) 3rd Offense- Cancellation of Certificate
5. Improper record keeping of various activities based on manual of operations	1st Offense- Reprimand 2nd Offense- Suspension (one year) 3rd Offense- Cancellation of Certificate
6. Non-submission of quarterly stock inventory report for available planting materials to NSQCS Regional/Satellite Office	1st Offense- Reprimand 2nd Offense- Suspension (one year) 3rd Offense- Cancellation of Certificate
7. Any violation of the terms and conditions stipulated at the back of the Plant Nursery Accreditation Certification	1st Offense- Reprimand 2nd Offense- Suspension (one year) 3rd Offense- Cancellation of Certificate

- The above cited sanctions shall be without prejudice to the filing of appropriate case pursuant to Section 19 of RA 7308.
- The concerned nursery operator may re-apply for accreditation after three (3) years from the time that the certificate of accreditation was cancelled by BPI. Appropriate notice will be issued prior to enforcing penalties.

VALIDITY OF CERTIFICATE

The Certificate of Plant Nursery Accreditation shall be valid for a period of five (5) years from the date of issuance. Upon recommendation of the monitoring team, the BPI has the right to cancel the certificate of accreditation in case the accredited nursery fails to follow the requirements and guidelines set by BPI within the accreditation period.

PROCEDURE FOR RENEWAL OF ACCREDITATION

Documents	Remarks
1. Letter of Intent	
2. Duly accomplished form	
3. Mayor's permit	Current year
4. Duly notarized authorization of the applicant	For partnership, corporation, cooperative, or association
5. Certificate of training on nursery establishment and operation including plant material certification (issued within two (2) years prior to application	Sole proprietorship/partnership: One (1) person Cooperative/Association/Corporation All person doing propagation work
6. Location map, lay-out plan and photos of the nursery	
7. Copy of the official receipt of payment for application of accreditation of the nursery in the amount of Php 1,000.00, non-refundable	

General Guidelines for Certification of Mother Trees and Planting Materials of Fruit and Plantation Crops

Plant Certification Process

A. Mother Trees

1. For the certification of mother trees, the following process shall be observed:
   Applicant must submit the following documents at the nearest BPI- NSQCS office:
   a. Filled out Application Form for mother trees;
   b. Proof of varietal identity of mother tree being applied for certification any of the following:
      i. copy of purchase receipt;
      ii. certification from the source of planting material;
      iii. certification from knowledgeable person such as experts or those who have experience regarding the crop being applied for in varietal identity;
      iv. DNA analysis; and
      v. result of re-evaluation of varietal characteristics based on NSIC parameters for one fruiting season.
   c. Location map and layout of trees being applied for certification; and,
   d. Copy of receipt of payment of application fee.
2. The concerned Regional/ Satellite NSQCS office shall initially evaluate the submitted documents and endorse to NSQCS Central Office for further evaluation.
3. The Plant Material Inspector (PMI) shall inspect the mother tree to determine its general condition, varietal identity, correctness of the location map and layout, and geotagging.
4. The BPI-NSQCS Central Office shall undertake final evaluation of the application and endorse it to the Director of BPI for the approval or disapproval of the certification.
5. Corresponding tags will be prepared by NSQCS upon submission of order form with applicant's consent and signature.
6. BPI-NSQCS shall issue the certificate and corresponding tag to the individual tree that satisfies the requirements for certification. A tree will be tagged as either Foundation Tree or Scion Tree.
7. The PMI shall monitor the certified mother trees at least once a year or as the need arises.



B. Planting Materials

For the certification of planting materials, the following process shall observe the:

1. Asexually Propagated

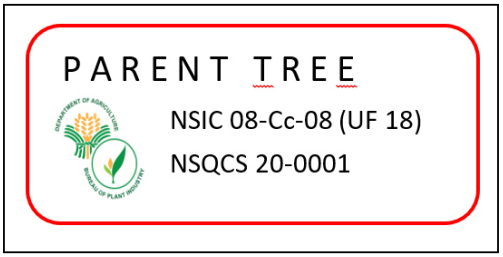
Applicants must submit the following documents at the nearest BPI- NSQCS office:

a. The concerned Regional/ Satellite NSQCS office shall evaluate the submitted documents for approval or disapproval.
   i. Filled out Application Form for asexually-propagated seedlings;
   ii. Plant nursery accreditation certificate;
   iii. Plant Material Certificate of Mother Trees; and,
   iv. Copy of receipt of payment of application fee.
b. The concerned Regional/ Satellite NSQCS office shall evaluate the submitted documents for approval or disapproval.
c. The concerned BPI-NSQCS Regional/Satellite Office shall assign the Plant Material Inspector (PMI).
d. One month prior to the collection of propagules, the applicant shall notify the assigned PMI through the NSQCS Regional/ Satellite Office of their intent to conduct the collection of propagules.
e. The assigned PMI shall be present during the collection of propagules to ensure that they were sourced from certified mother trees. In case the scion will be outsourced from other nurseries, the presence of the PMI covering the area during the collection of scions is necessary and the corresponding certification must be issued.
f. The assigned PMI shall be present during asexual propagation to ensure that the propagules collected for certification are used for propagation.
g. Asexually propagated seedlings shall be monitored by the assigned PMI at least once prior to final inspection or as the need arises.
h. Corresponding tags will be prepared by NSQCS upon submission of order form with applicant's consent and signature. Tags shall be issued by NSQCS to asexually propagated seedlings that have passed the final inspection. Certificate will be issued by the Regional/Satellite NSQCS Office upon request.
i. The PMI shall be present during the tagging of individual asexually propagated seedlings. The fee for the tags shall be paid prior to tagging operation.

2. Sexually Propagated.

a. Applicants must submit the following documents at the nearest BPI- NSQCS office:
   i. Filled out Application Form for sexually-propagated seedlings;
   ii. Plant nursery accreditation certificate;
   iii. Plant Material Certificate of mother tree; and,
   iv. Copy of receipt of payment of application fee.
b. The concerned Regional/ Satellite NSQCS office shall evaluate the submitted documents for approval or disapproval.
c. The concerned BPI-NSQCS Regional/Satellite Office shall assign the PMI.
d. One month prior to the collection of fruits, the applicant shall notify the assigned PMI through the NSQCS Regional/ Satellite Office of their intent to collect fruits from certified mother trees.
e. Applicant shall notify the assigned PMI of the schedule of seed extraction from the harvested fruits of certified mother trees.
f. The assigned PMI shall be present during the collection of fruits, seed extraction, and seed sowing. In case the seeds will be outsourced from other nurseries, the presence of the assigned PMI covering the area is also necessary during the collection of fruits and seed extraction, and corresponding certification must be issued.
g. The applicant shall ensure that sown seeds are properly labeled and shall provide a layout to the PMI.
h. In case that the seeds were sown in a seedbed, the assigned PMI must be present during transplanting of seedlings from seed bed to individual plastic bags.
i. Sexually propagated seedlings shall be monitored by the PMI at least once prior to final inspection by the assigned PMI.
j. Corresponding tags will be prepared by NSQCS upon submission of order form with applicant's consent and signature. Tags shall be issued by BPI-NSQCS to seedlings that have passed the final inspection. Certificate will be issued by the Regional/Satellite NSQCS Office upon request.
k. The PMI shall be present during the tagging of individual seedlings.
l. The fee for the tags shall be paid prior to tagging operation.

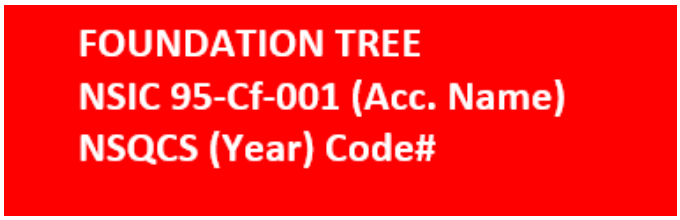
Sample Layout for tagging materials of Trees:







For Foundation/Scion Tree: Color Code Red background with white letters embossed in a 31 x 12.6 cms tin plate



For Nursery seedlings: White background with black letters in a waxy paper measuring 15.3 x 2.8 waxed paper with the following information:

1. Nursery Owner
2. Address
3. PM Inspector
4. Crop/Variety
5. PMC Number
6. Date Certified



Monitoring

Monitoring of certified mother trees shall be done at least once a year, or as the need arises, to determine the condition of trees. Trees shall become ineligible for certification if found to be no longer fit as source of propagules.

Fees

Payment of fees under this Circular shall be made and based on the applicable guidelines on Schedule of Fees.

Sanctions

OFFENSES	PENALTIES
1. Transfer of tags	Cancellation of Plant Material Certification for mother trees or plant material and Blacklisting
2. Failure to declare or inform NSQCS of the dead mother trees	1st offense – Reprimand 2nd offense – Cancellation of Certificate 3rd offense – Blacklisting from the Plant Material Certification Program
3. Any violation of the terms and conditions stipulated at the back of the Plant Material Certificate	1st offense – Reprimand 2nd offense – Cancellation of Certificate 3rd offense – Blacklisting from the Plant Material Certification Program

Sanctions shall be without prejudice to the filing of appropriate case pursuant to Section 19 of RA 7308.

GUIDE FOR GOOD AGRICULTURAL PRACTICES

FOR SEED PRODUCTION & NURSERIES IN THE PHILIPPINES

