Propagation of quality planting materials

a training manual








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Learning objectives

After reading this training manual, trainees should be able to:

- describe the qualities of good planting material of both sexual and asexual propagation; and
- conduct a successful practical exercise in propagation using seeds, asexual propagation techniques, and wildlings.

Introduction

Before establishing an agroforestry farm or implementing reforestation programs, planting materials should be produced in a nursery. This manual will discuss the different ways of producing planting materials within a nursery.

1. **Seed propagation:** seedlings are produced using seeds or propagules.
2. **Asexual propagation:** seedlings are produced from a tree's existing vegetative parts.
3. **Wildlings:** planting materials are produced from seedlings that have grown in the forest.

Regardless of the way it is produced, the goal is to produce quality planting materials that will be productive in the field.

What is this manual about?

Through text and technical illustrations, this manual discusses the following topics:

- sources of planting materials
- ways of collecting seeds
- process of seed processing
- vegetative propagation
- propagation using wildlings

Who is this manual for?

This manual is written particularly for 1) extensionists working in agroforestry and natural resources management projects; and 2) farmers, especially those who want to share their agroforestry knowledge with their fellow farmers.

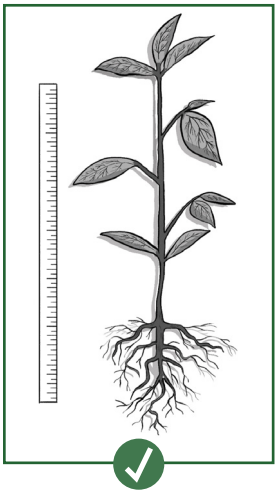
The manual can be used as reference material for training sessions and other learning activities.

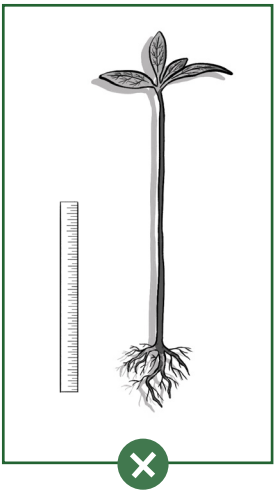
Quality planting materials

Quality planting materials exhibit good characteristics that show productivity and vigor. These qualities indicate that the material will thrive when planted in the field.

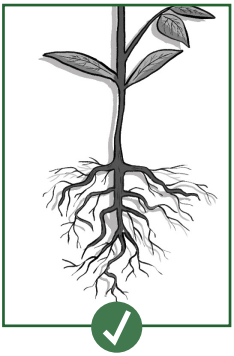
Planting materials produced from seeds and asexual propagation techniques have the following quality standards:

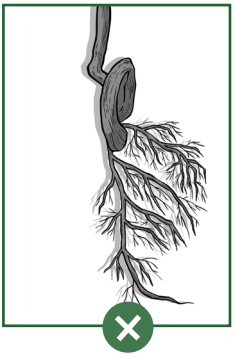
1. **Sturdy**, with a balanced shoot and root ratio, and relatively large root collar diameter





2. With a **straight** primary root and **dense** root hairs





3. Free from disease





If quality planting materials are used, success will follow: the agroforestry farm or the tree plantation will be bountiful, income will be good during harvests, and farmers will be motivated to continue planting and caring for the farm.

Sources of planting materials

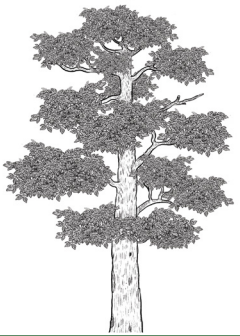
The choice of planting material to use depends on the farmer's timeframe, budget, and purpose of growing the material. Planting materials can either come from seeds, asexual propagules, or wildlings.

Seeds

Selection of mother trees by potential use

This is the most common way of producing planting materials. In this method, seedlings are grown from seeds sourced from **mother trees**. Good mother trees exhibit the following characteristics:

- Fast-growing
- Free from any pest or disease and growing within a healthy stand of the same species
- In its best years as overly mature trees may not produce good seeds
- Produces products with specific desirable characteristics.



Good timber tree

Since there are trees produced for timber, fodder, and fruit, mother trees for such trees should not only display the general desirable characteristics but also specific characteristics for the intended products.

For **timber trees**, a mother tree should be the tallest in its stand, with a straight trunk from base to top. It should have the biggest diameter of all the trees in the stand and it should be free from any growth defects.

For **fodder trees**, a good mother tree is short so that it can be easily reached by animals. It should have a wide crown with many leaves. Trees from this mother tree will have abundant fruit, high nutritive value of fruits or leaves, and be free from any pest and disease. If possible, fodder trees should be located near animal pens for less effort and cost of transport.



Good fodder tree

For **fruit trees**, a mother tree should produce good quantities of tasty fruits of marketable size. It is also wise to collect seeds from mother trees growing well in dry or flooded areas to produce drought- or flood-tolerant seedlings.

Sources of seeds



Seeds can either come from natural forest stands or from artificial forest stands, which are established and carefully managed to provide high quality seeds. The success of any plantation or reforestation program depends on the quality of the seeds used. Quality can be assured based on the following criteria:

- amount of information available on the seed source;
- level of technical supervision during seed collection, processing, and handling;
- conduct of seed testing;
- process of selection of mother trees; and
- conduct of progeny testing, where offspring of selected trees that manifest desired characteristics are tested to see if the said characteristics endure through generations. It can take years, depending on the growth rate of a particular tree species, before a reliable performance record of a progeny is known.

With these criteria in mind, seed sources are broadly categorized as:

1. Uncontrolled General Collection Areas

Seeds from this kind of source are called **unclassified seeds**, with little to no documented information of any kind.

Seed information such as **location, date of collection, prevailing site conditions, seed ecology, applied silvicultural treatments** and timing

of such treatments, **applied seed collection, processing and storage, genetic testing history,** and **progeny testing history** are very important. It gives a picture of how well-managed a seed source is and if the seeds truly originated from superior parent trees. It can also serve as reference if a farmer wishes to return to a certain source for future seed collection activities.

As such, this is the least desirable seed source, and as much as possible, a farmer should avoid getting seeds from this kind of seed source.

2. Controlled General Collection Areas

The different site factors and other information for this kind of seed source are well-documented. Some controlled general collection areas are supervised by technically capable personnel. Seed testing is being conducted, yet no selection of mother trees and progeny tests are done because this is not intended to be a plantation that will serve primarily as a source of seeds but rather for other production objectives like timber or fruit.

Ideally, seeds are to be collected from a minimum of 30 trees to ensure genetic diversity.

The following seed sources are intentionally established to be seed plantations. The quality of seeds produced in each seed source increases with every criterion a source meets.

3. Seed stands

These are plantations established from the seeds of plus stands or stands made up of trees that exhibit excellent physical characteristics such as exceptional growth rate, high wood density, resistance to pests or other adverse environmental factors, or a combination thereof. These plantations have complete information regarding the seeds, including its performance, which is the first criteria to ensure quality seeds.

Selection of mother trees are undertaken at some point, but the improvements on observable characteristics — or genetic gain — expected with this may be quite low or even be insignificant since plantations usually use clones to produce a stand where all trees will contain all the desired characteristics. There is adequate level of technical supervision during seed collection, processing, and handling. As for tests, the stands are routinely subjected to seed testing but no progeny tests are done.

4. Seed production areas

Seed production areas (SPA) are existing tree stands of proven genetic quality where inferior or defective trees are removed (rogued) and

the remaining trees exhibiting desirable characteristics are managed as mother trees. Prior to roguing operations, mother tree selection is done.

SPAs usually have an area of five hectares or more. Areas less than this size will result to inefficiency in operations since it has to meet a minimum required number of trees to lessen the risk of cross-pollination with species outside the SPA.

The information on prevailing conditions, detailed characterization of the various site factors, and reproductive behavior of the species within the SPA is available and abundant. Seed testing is routinely done but progeny testing is rarely conducted because it takes years which may outlast objectives of the SPA and further additional costs.

Seeds sourced from SPAs are very desirable with only the seeds from seed orchards trumping it in quality.

5. Seed orchards

Seed orchards are tree plantations, with the same area size requirement as SPAs, consisting of clones or seedlings from rigorously tested and selected trees that produce early, abundant amounts of seeds which promotes balanced, random mating.

All the criteria mentioned earlier are met by a seed orchard. Seeds coming from this source are guaranteed to be of highest quality in both physical and genetic aspects. Since seed orchards supply seeds accredited by certifying bodies such as the Bureau of Plant Industry, seeds from this source are called **certified seeds**.

If possible, secure seeds from seed stands, SPAs, and seed orchards, and not just from an uncontrolled natural forest stand. Some trees in an uncontrolled forest stand may have excellent observable characteristics but could have descended from trees that have undesirable characteristics or poor genes. These undesirable characteristics may appear in some of the seedlings.

In the seed sources mentioned above, there is a measure of quality control since mother trees were carefully chosen and mother trees of seed sources, like SPAs and seed orchards, have undergone genetic testing to ensure its overall characteristic superiority.

Asexual propagules

Asexual propagules are parts of good quality mother trees that can be used to produce planting material that is a copy of the mother tree. There are three sources of asexual propagules.

1. Scion groves

A scion grove is a nursery where registered varieties of fruit trees are tended for their scions, which growers acquire and propagate.

2. Ramet garden

A ramet garden is where clones produced from the cuttings of the same plant species are multiplied.

3. Budwood garden

A budwood garden is where certified, high quality, and sturdy plant varieties are tended for their buds for later budding and grafting.

Seed propagation

Seed propagation, also known as sexual propagation, involves pollination or fertilization between the male and female parts of a plant to produce seeds having the combined characteristics of the parents. In commercial settings, this method is not preferred because the combination of characteristics cannot be controlled and the preferred characteristics, such as color, fruiting, and form, may be lost in the process.

Using seeds to produce trees and other plants involves several processes including collection and extraction, storage, treatment, testing , and care and maintenance.

Types of seeds

Seeds can be classified according to its behavior in storage. It is important to understand seeds' behavior so they can be stored appropriately. Improper storage methods and techniques can lead to either seed death or early germination.

Orthodox seeds are usually small- to medium-sized seeds, with a hard seed coat, which can be stored for a long time. These seeds can tolerate drying and storage at low temperatures.

Recalcitrant seeds cannot tolerate drying and storage at low temperatures. Therefore, they can only be stored for a very short period before they lose viability or their ability to grow.

Intermediate seeds are much more tolerant to drying than recalcitrants but not at the level of orthodox seeds and lose viability quickly at low temperatures.

Collecting seeds

If buying seeds from seed orchards or seed production areas is not possible, selecting mother trees with desirable physical qualities is the easiest way to get good seeds. Seeds can be collected either from the ground, from standing trees, or from felled trees.

From the ground

The most common and convenient method is collecting seeds from the ground. This is especially the case for large-fruited species and tree species whose fruit falls to the ground after maturity.

However, this method increases the risk of collecting immature, empty, deteriorated, and sprouted seeds. It can also be difficult to identify the mother tree because the seeds may have been spread by wind, water, or animals to that area.

Some reminders when following this method:

- Avoid collecting the first fruits of the season because the seeds are usually of poor quality.
- Lay a mat on the ground and employ the following methods to encourage the tree to shed its mature fruit and seeds.

For short trees, shake the tree's trunk or the branches.



For tall trees, hook and rope the fruit or branches.



2. From standing trees

Seeds can be collected by picking fruit by hand from low-hanging branches. Bending of branches or picking using a hooked pole can be done.



Fruit can be picked from higher branches by climbing the tree using a ladder or by using a long pole with a hook at one end.



This method is best for small-seeded species, winged seeds, fruit/pods that split open at maturity, and fruit that is prone to attack by pests and diseases soon after they fall to the ground. However, this method poses some hazards for the collectors and requires tools.

3. From crowns of felled trees

This is another easy method where seeds can be collected from trees that were cut down.

This is not applicable in places where there is a moratorium on tree cutting. This is also not generally advisable because doing so will thin the tree stand and encourage soil erosion.

Note: *Crowns of wind-thrown trees should not be considered for seed collection since quality is not assured and it may even have traits that make it susceptible to wind damage.*

Seed processing

Seed processing involves extracting, drying, and screening viable seeds. Through proper seed processing, damage to the seeds and wastage of planting material can be avoided. This also helps ensure that the processed seeds reach maximum viability in storage.

Seed extraction

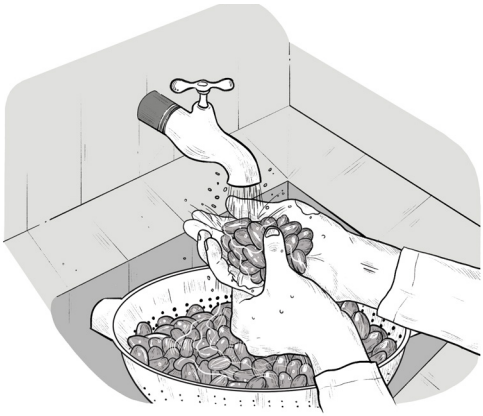
Fruit type

These are seeds of species which are enclosed in a fleshy structure surrounded by an outer layer. Even until maturity, the fruit remains closed, unless it is deliberately opened. Below is the procedure of extracting seeds from fruits.

1. Soak ripe fruit in water according to the recommended time to soften it (refer to the Seed collection, processing, and pre-treatment table on page 44 for recommended soaking times of different species).
2. While the fruit is soaking, break the fruit covering and remove the flesh manually, either by hand or by rubbing it against a rough surface like fine wire mesh or sandpaper.



3. Place the seeds on a strainer to prevent them from being washed away.
4. Wash the seeds with running water.



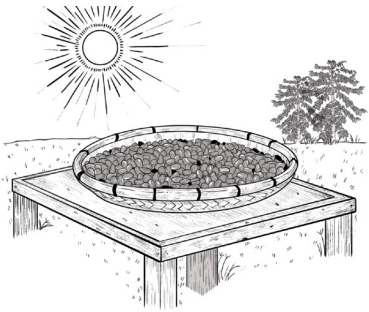
5. Air-dry the seeds before storage.



Pods, cones and encapsulated species (dry fruits)

These are species enclosed in cases that split or burst open upon maturity. Follow the extraction procedure below.

1. Sun-dry the pods in the open or within sacks until they open.



To encourage pod splitting, beat the sack with a paddle or pry open the pods.

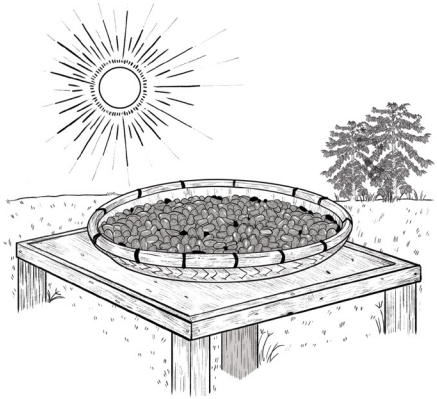


2. Separate the seeds from non-seed debris.



3. Air-dry the seeds before storage. Skip this step if the seeds are to be planted immediately.

Drying seeds



Orthodox seeds must be cleaned and dried well before they are stored. The drying process forces the seed into a dormant state, which allows it to be viable for a longer period.

For farm or field situations, the moisture content of seeds can be reduced either through sun-drying or air-drying.

For sun-drying, seeds should be exposed to direct sunlight for the prescribed period and moved indoors and placed in containers before sundown (refer to the Seed collection, processing, and pre-treatment table on page 44 for prescribed sun drying period per species). Under humid conditions and during periods of heavy rain, the prescribed period of sun-drying can be extended.

For air-drying, large and/or heavy seeds can be dried indoors using electric fans, if available.

A seed is dry enough when:

- it is easy to crack or cut and produces a sharp snapping sound when cracked;
- it produces a rustling or crackling sound when mixed or shaken;
- there is no mark left when the seed is bitten or when a fingernail is pressed against it;
- it passes the salt-jar test.

The salt jar test

1. Put 1 teaspoon of salt in a dry glass jar or bottle. Make sure that it is dry so that the salt will not stick to the jar's inner surface.



2. Fill 3/4 of the jar with seeds. There is no prescribed volume but make sure to leave some space to shake the seeds and the salt.



3. Shake the jar and roll it gently for three minutes. If the salt does not form lumps or stick to the sides of the jar, the seeds are dry.

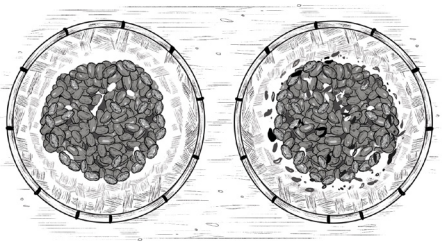


Screening seeds

Before storing seeds, it is important to sort through the seedlot and remove any non-viable seeds. This can be done with any of the following methods.

1. Sorting

Separate the defective (rotted, discolored, crushed) seeds from the seedlot. This method applies to medium- (as big as a 5-centavo coin) to big-sized seeds (as big as a 1-peso coin).



2. Flotation

Flotation involves soaking the seeds in cool water and removing the seeds that float. The floating ones are empty. This method should be employed for big seeds.



3. Sieving

Some seeds have forest-floor debris clinging to them. To remove the debris, sieve the seeds through a screen.



4. Blowing

By exposing the seeds to wind, the seeds that are empty and not viable will be carried away. This method is not applicable for very small and lightweight seeds.



Storing seeds

If it is possible to sow the seeds right after processing, then do so. However, if some factors, like timing, are important then storage should be considered to avoid wasting the seeds. Storage preserves a seed's viability from the time it was collected until the time it will be sown.

Importance of seed storage

1. **Timing:** Seeds should be properly stored when the ripening and collection times do not correspond with the right times for seedling production and tree planting.
2. **Practicality:** If seed sources are far from planting sites, seeds should be stored to avoid wasting them.

Things to coonsider when storing seeds

- Ensure that the seeds to be stored have been screened. They should be free of any fungus or disease-causing organisms and other defects.
- Store at relatively low temperatures. However, this depends on the kind of seed; recalcitrant seeds will be injured at low temperatures.
- Store at lowest possible moisture. This, likewise, depends on the kind of seed; for instance, recalcitrant seeds will not survive intensive drying.
- Store in a dark place.
- Clean the seeds of debris and pathogens before storage.

Basic guidelines for seed storage

The seeds must be stored in containers and placed in good locations. The type of container depends on the quantity, value, and species of seeds.

Seed containers

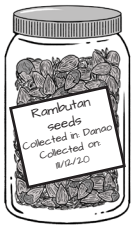
- Large quantities of seeds can be stored in tightly tied sacks or bags, baskets, and tins.
- Small quantities of seed and seeds of high value should be stored in tightly-sealed glass or plastic jars.



Sacks for large quantities of seeds



Jars for small quantities of seeds



Note: *It is important to remember that storage containers must be clean and* ***filled completely****. Empty spaces in containers will allow an increase in moisture inside which may lead to rotting or germination of the seeds. If it is not possible to fill the container with seeds, stuff it with air-absorbent material, such as charcoal, rice hulls, or crumpled newspapers.* ***Do not forget to label the containers properly.***

Seed storage room

An optimal seed storage room is cool, dry, dark, well ventilated, sterilized, and free of insects. The room should be dedicated to seed storage alone to protect the seeds from contaminants that might affect their viability.

Pre-sowing treatments

Pre-sowing treatments are applied to seeds to break its dormancy. **Seed dormancy** is the inability of healthy seeds to completely germinate even if favorable conditions — like adequate moisture, light, space, and air — are present. This is usually caused by tough seed coats that do not allow water to enter the seed, oils on the seed coat that insulate the seed within from germination signals, and the underdevelopment of seeds, among others.

Treatments applied to break seed dormancy depend on the type and species of seed. Pre-sowing treatments are applied to:

- ensure that the seeds in the plot germinate at the same time; and
- shorten the period spent by seedlings in the nursery, thus conserving space and maximizing seedling production time.

Tap-water treatment

1. Soak the seeds in a container with tap water, depending on the recommended soaking time per species and the toughness of the seed coat (refer to the Seed collection, processing, and pre-treatment table on page 44 for soaking time recommendations).
2. If the seeds are swollen or the recommended time has passed, proceed to planting.



Hot-water treatment

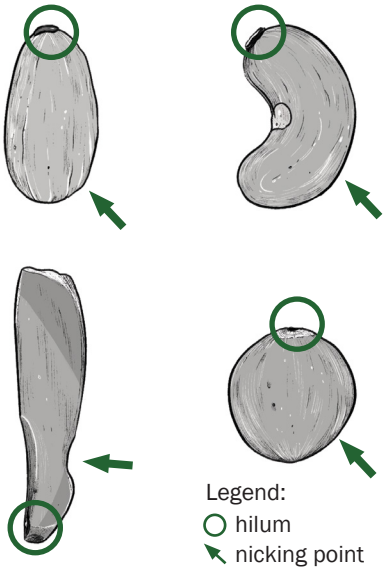
1. Boil tap water and cool it for about 10 minutes (or until it reaches about 80°C). For every unit of seeds (e.g., cup), boil 10 units of water.

2. Pour the hot water into the container of seeds. Be sure that it is not made of plastic or a non-heat-resistant glass.
3. Let the seeds soak according to the recommended soaking time (refer to the Seed collection, processing, and pre-treatment table on page 44 for soaking time recommendations).



Nicking or scarification

1. Nick the seed coat with a sharp knife. Be careful not to nick the internal portion of the seed. The seed can also be rubbed with sandpaper or a rock with a rough surface.
2. For hard seed coats, lightly crack the coat with a stone or hammer to avoid crushing the seed.
3. After nicking or cracking, apply soaking treatment before planting.



Biological treatment

Fruit can be fed to farm animals, such as goats. Digestive juices clean the seeds, penetrate the seed coats, and break their dormancy.

The methods described above are general practices in seed processing. A Seed collection, processing, and pre-treatment table that details how to process the seeds of certain tree species can be found in page 44 of this training manual.

Seed testing

Tests determine a seedlot's capacity to produce healthy and vigorous seedlings. There are two types of tests — viability and germination. Both of these are done in a laboratory.

Vegetative propagation

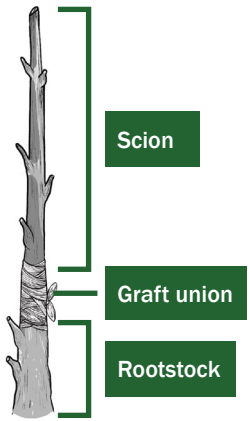
In commercial plantations, the aim is to reproduce a desirable characteristic of a certain plant species, such as fruit yield and taste, in the easiest and fastest way. To reproduce the characteristic, parts of the existing plant with the desirable attributes are cut and nurtured to produce new plants that carry the same. This method is known as vegetative or asexual propagation.

Grafting, marcotting, and propagation using rooted cuttings are some examples of vegetative propagation techniques.

Grafting

This technique joins two parts of two different plants that eventually grow into a single plant. Generally, both parts should each have the desired plant characteristic.

Parts of a grafted plant

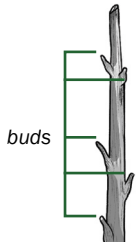


Scion

Scions are buds or shoots detached from parent plants that have the desired characteristics for the top part of the plant, such as fruiting and flowering behavior. For fruit trees, the parent plants of scions are the "cultivated" varieties.

Scion collection

1. **Collect before sunrise**. Take advantage of the high turgor pressure of plants before sunrise. When the turgor pressure is high, it means that the attached scion is still hydrated and will not suffer from shock during collection. The turgor pressure decreases once the sun is up.
2. **Choose scions that have buds.** A scion with buds means that it is reproductively viable for propagation.
3. **Choose budded scions that are near the size of the rootstock.** Thicker or bigger scions will more likely fail to establish affinity when joined to a rootstock because of their weight and will most likely die. This will also cause physical deformities if it does develop.



4. **Clean the scions.** Make sure to use sharp pruning shears to cleanly detach the chosen scions from the parent plant. Remove the scions' leaves and retain their buds or nodes.

Rootstock

Rootstock is a portion of the stem or trunk down to the roots. This is where the scion will be grafted. Traits such as improved yield, hardiness, and disease resistance are required for rootstocks but, usually, the most desired trait is the ability to create dwarf trees. Dwarf trees lessen a fruit farmer's effort in maintenance and picking fruit.

The preferred rootstock is the native or "wild" variety of the plant species that will be grafted. The planting material grown from seeds can also serve as rootstock.

Graft union

This is where the scion and the rootstock meet. If the grafting succeeds and the grafted plant develops, the union between the scion and rootstock will heal and leave a scar showing that the plant has been grafted. It is important to check this when buying seedlings that are marketed as grafted plants.

Types of grafting

There are several types of grafting but cleft and side grafting are the most commonly practiced types in tree nurseries.

Cleft grafting

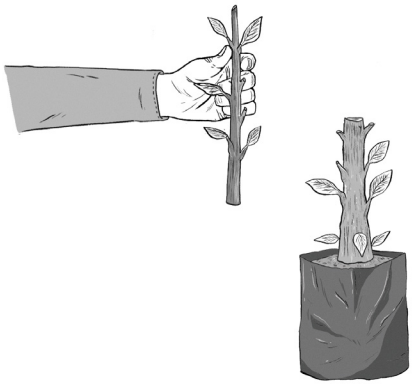
Materials needed:

- Sharp grafting knife
- Two long, flat bottomed, gusseted plastic bags (per grafted plant)

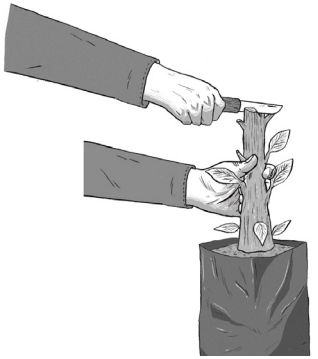
- Cleaned scion
- Chosen rootstock

Process:

1. Select a rootstock that is approximately the same size as the scion.

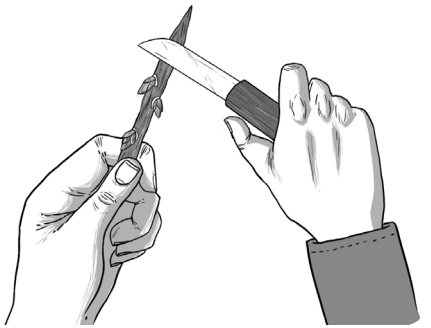


2. Cut the rootstock, leaving six to eight leaves on its base.
3. Split-cut the top end of the rootstock.

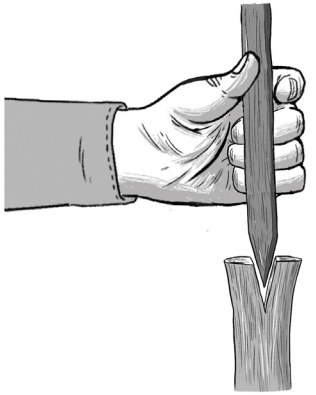


4. Using a sharp grafting knife, make a 3- to 4-centimeter (cm) incision on both sides of the scion.

   Note: *Be sure to leave only three to four nodes on the scion.*

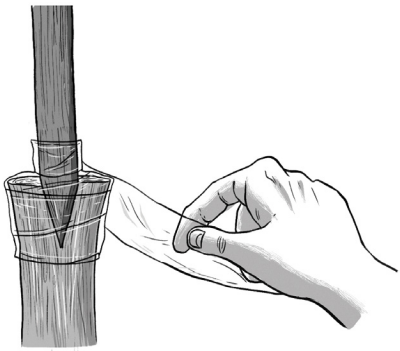


5. Insert the scion in the incision of the rootstock.



6. Tightly wrap the union with a long strip of flat-bottomed, gusseted plastic bag, without including the nodes. Test the union by lightly flicking the scion; if it does not move then it is secure.

   Note: *Ensure that the entire union is wrapped with plastic. An unsealed part of the incision may become an entry point for disease-causing organisms.*



7. Cover the grafted portion loosely with another plastic bag.
8. Remove the cover when young leaves appear but leave the wrap of the graft union.
9. After about five months, remove the wrap. If the plant at the union is fully developed (healed union, with young leaves growing vigorously), then the grafted plant is ready for planting.



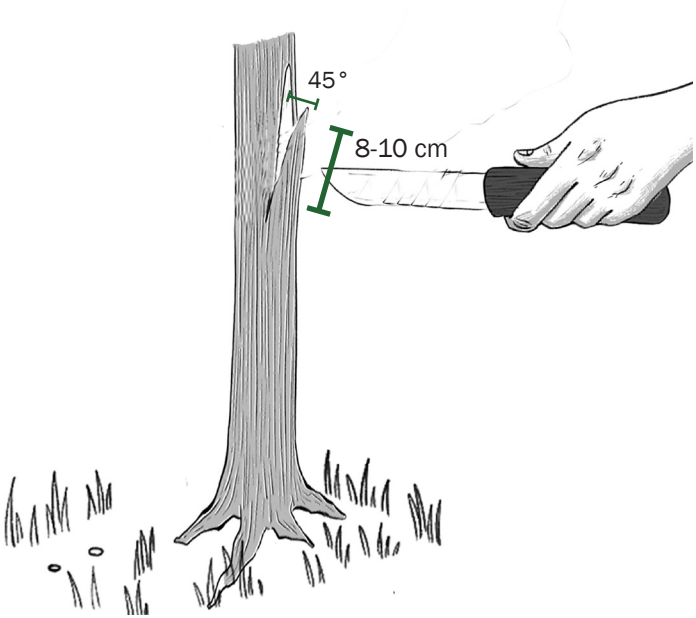
Side grafting

Materials needed:

- Sharp grafting knife
- Pruning shears
- Long, clear plastic sheet
- Plastic twine
- Cleaned scion

Process:

1. Choose a healthy and branch-free trunk of a fully developed tree.
2. Using a sharp knife, slash a 45° inverted 'V' on the trunk. The incision should be around 2-cm deep with a length of 8 to 10 cm, creating a triangular flap on the bark.

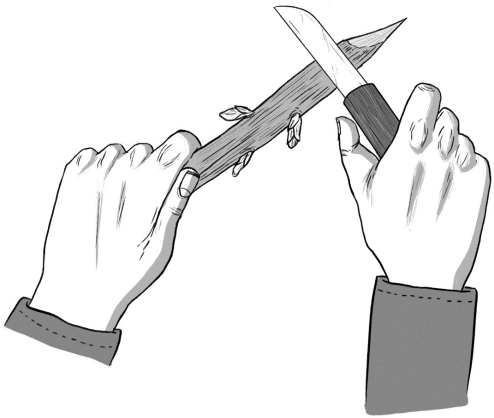


3. Hold the pointed top of the flap and pull it down until it reaches the ends of the incision to expose the cambium. If it is not exposed, carefully cut away at the inner bark to expose it.

   Note: *The cambium is the light-colored and slightly moist layer after the outer and inner barks. Do not touch it with your bare fingers.*

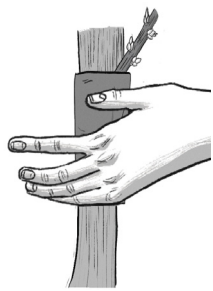
4. Using a sharp grafting knife, scrape a long slice on one side and a short one on the other side of the scion.

   Note: *Leave only two to three nodes on the scion.*





5. Insert the scion into the incision. Ensure that it is the long scrape that is in contact with the cambium.
6. Cut out the pointed tip of the flap. This will strengthen the flap so that it will be able to support the scion as it fully develops.
7. Push the flap back to hold the scion in place.
8. Lay the plastic sheet over the graft union. Make sure the plastic sheet is long enough to cover the entire union with an allowance of 6 cm or longer above the scion sticking out from the flap and below the ends of the incision.



9. Wrap the plastic twine twice over the covered flap to secure the union of the cambium and the scion and twice again above the scion to seal the plastic sheet.
10. Pull down the plastic cover allowance to prevent water from seeping into the graft union.
11. Remove the cover when the new leaves from the scion have fully developed (approximately three to five months).

Note: *There can be multiple scions on a single rootstock but* ***months or years should pass*** *after each grafting to give the rootstock time to recover.*

Marcotting

Marcotting is also known as air layering. This vegetative propagation technique can be used for any plant but it is commonly done to plants that do not produce shoots at their base and do not readily root from cuttings.

Marcotting versus grafting

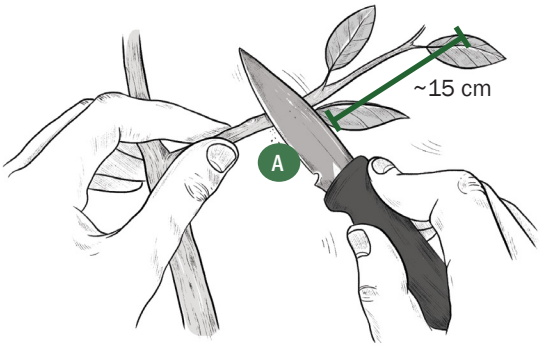
Unlike grafting, marcotting does not involve joining two different plants. Instead, it allows root growth and development on the stem of a mother plant.

Materials needed

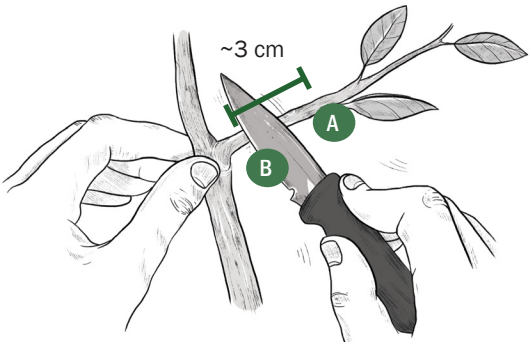
- Sharp grafting knife
- Loamy soil
- Coco or cacao coir or peat moss
- Clear, flat bottomed, gusseted plastic bag
- Roll of plastic twine
- Bucket of water

Process

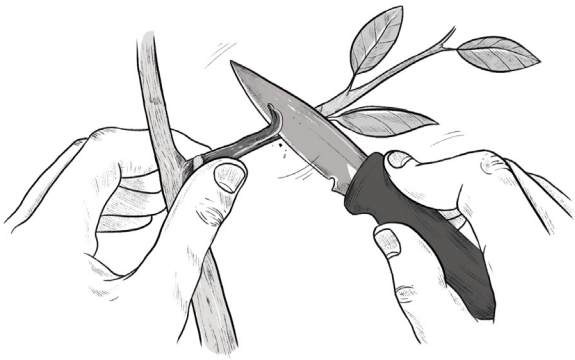
1. Select a mature stem (one to two years old) that is straight and healthy.
2. About 15 cm or more away from the tip of the stem, carve a ring (A) around the bark of stem using a sharp knife.



3. About 3 cm away from ring (A), carve another ring (B) around the bark.

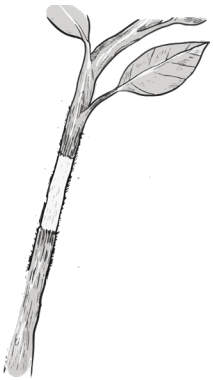


4. Lightly slice a straight line that will connect ring (A) to ring (B) on one side of the stem. Repeat on the other side.



5. Use the tip of the knife to pry the cut lines on both sides. Open and remove the bark to expose the cambium.

   Note: *Lightly deepen all the slices if the bark does not come off easily. The cambium is the moist, light-colored layer of the stem. Do not touch it with your bare hands.*



6. Fully expose the cambium layer by completely scraping off the bark layers. A sign of a fully exposed cambium layer is uniformity in color.

   Note: *This step is very crucial, so it is very important to do this step properly or else the technique will fail.*

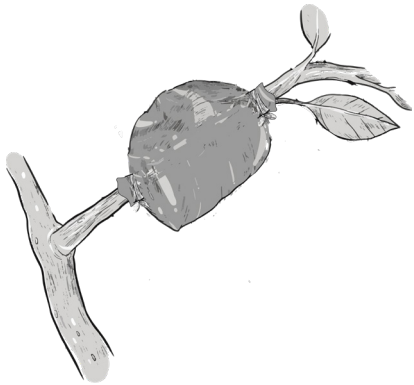
7. Mix one-part loam soil with one-part wet coir or wet peat moss. Place it inside a flat-bottomed, gusseted plastic bag and tie the bag. Ensure that the bag is not heavy enough to break the stem.



Note: *If it is not possible to use coir or peat moss, layering with pure soil is suitable as long as the soil is damp. Do not mix in any kind of manure because it will burn the young roots.*

8. Wash the cambium layer of the stem with water until the clinging sap is removed.
9. Make a vertical slice on the surface of the plastic bag filled with soil.
10. Place the bag on your palm with the slice facing upwards to avoid the soil mixture from spilling.
11. Slowly insert the exposed cambium layer between the plastic bag's incision to deeply bury it in the soil mixture inside and fold the bag tightly against the stem.
12. Wind the plastic twine tightly around the plastic bag and the stem to hold it in place. Use several twines to ensure that the bag does not slide off the stem.
13. Once roots appear in the bag, cut the new plant at the part below its roots.
14. To plant the new plant, loosen the ties of the plastic bag. Do not remove the soil mix from the roots. Then transfer it to a new container. Water it after completely repotting the new plant.





Propagation using cuttings

Cuttings are portions of a stem, root, or leaf of a parent plant that are cut and placed in favorable conditions to bring about development of roots and shoots. The non-mist propagation method for cuttings is the cheapest and most practical way since it is somewhat similar to wildling propagation.

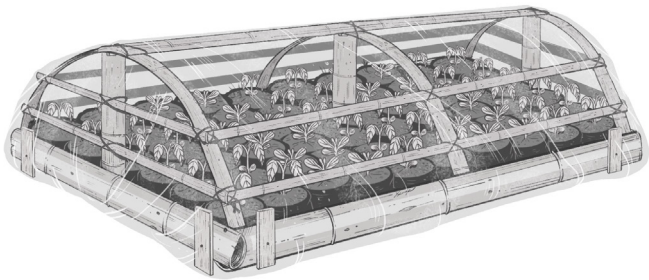
Materials needed

- Pruning shears
- Rooting medium of light materials
- Planting containers (hiko tray or seedling bags)
- Non-mist propagation chamber
- Fungicide (e.g. benlate)
- Rooting hormone (e.g. 1-Napthalene Acetic Acid (NAA) or Indole-3 Butyric Acid (IBA))

Prior preparations

Building the non-mist propagation chamber

It is recommended to build the propagation chamber a few days before preparing the cuttings for propagation to save time.



A wildling recovery chamber can be restructured to become a non-mist propagation chamber. Refer to pp. 9-15 of *Tree nursery establishment: a training manual* for the materials needed and steps in building the chamber. Like the wildling recovery chamber, ensure that the chambers are also well-shaded to avoid water loss.

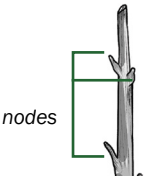
Preparation of the rooting medium and planting containers

The rooting medium should be of light materials where water and roots can easily penetrate. Any of these materials can be prepared with the corresponding ratios:

- sterilized river sand and coco coir dust (1:1)
- sterilized river sand and sawdust mixture (1:1)
- sterilized coarse gravel and rotted sawdust mixture (1:1)

Fill the planting containers, a hiko tray or seedling bag whichever are readily available, with the rooting medium.

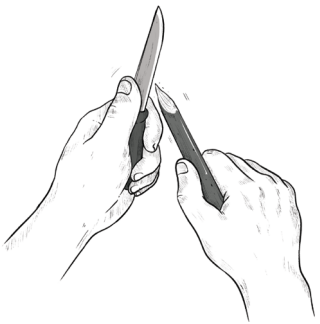
Collection and preparation of cuttings



1. Collect stems of young shoots before the sun is hot and high in the sky to prevent them from drying out. Make cuts below the nodes.
2. Using a pruning shear, cut the shoots so that only two nodes per cutting are left. Then, horizontally prune each leaf blade in half to minimize water loss.



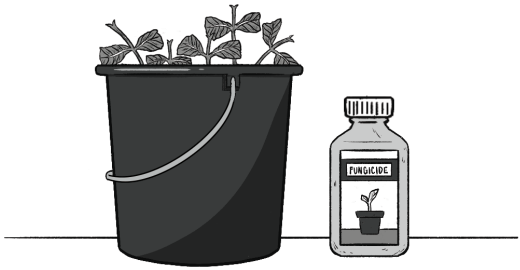
3. Using a sharp knife, scrape a long slice on one side and a short one on the other side of the basal portion of the cutting.



4. Immediately soak the cuttings in water after preparing it.



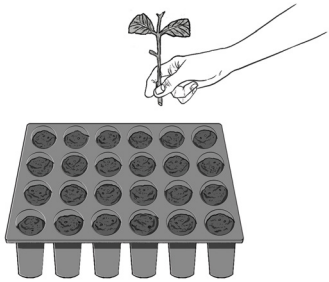
5. Sterilize the cuttings by soaking them in fungicide solution. Carefully read and follow the dosage instructions and recommended soaking time written on the fungicide container before use.



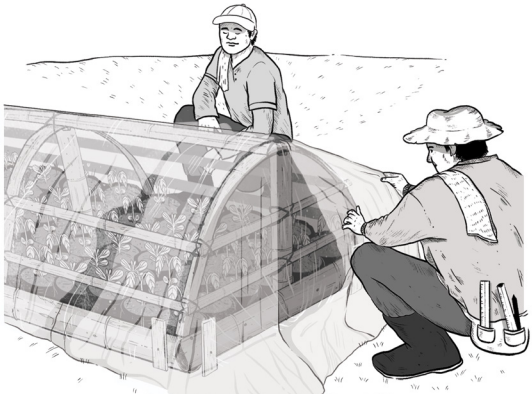
6. Dunk the cuttings immediately, stem first, in a container with rooting hormone solution. Follow the preparation and use instructions written on the container of the rooting hormone.

Rooting the cuttings

1. Thoroughly water the planting containers filled with potting medium.
2. Plant the treated cuttings in the container.



3. Place the containerized cuttings inside the non-mist propagation chamber.
4. Seal the chamber in the same manner of sealing the wildling recovery chamber as detailed in page 35. The cuttings shall remain inside the chamber for two to five months.



Hardening and outplanting

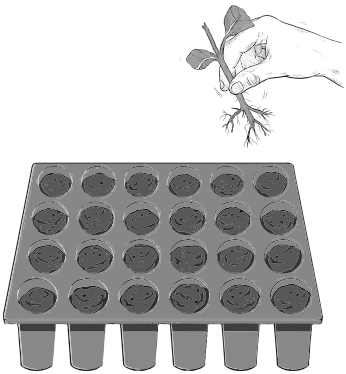
1. After carefully opening the chamber and removing the planting containers from it, thoroughly water the planting containers until the water overflows.



2. Carefully uproot the cuttings and check the formed roots.



3. Plant the rooted cuttings in another planting container with the recommended potting media (4 : 2 : 1 ratio of soil, rice hull, decomposed manure or 3 : 2 ratio of soil and rice hull).



4. Water the newly-planted rooted cuttings.
5. Return them to the chamber and seat them for a week for recovery.
6. Gradually open the chamber for every week for the next three weeks, this will enable them to adjust to field conditions.
7. Transfer the potted cuttings to the hardening area of the nursery. After four to eight months, they are ready for outplanting.

Propagation using wildlings

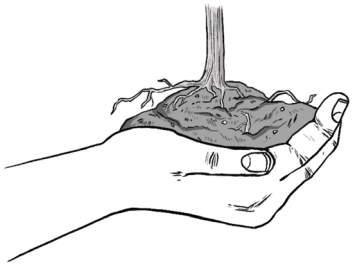
Seedling collection needs good timing. When the fruiting season is finished and there are no more seeds to source, wildlings can be collected, reared in a recovery chamber, and planted in the field. The process to build the recovery chamber is found in *Tree nursery establishment: a training manual*.

Wildling collection

It is best to collect wildlings that are 10- to 20-cm long because these are still young enough to adjust to new environments. A wildling any taller might not survive.



Wildlings should be collected when the soil is soft to avoid damaging the fine roots. The best time is after a heavy rain. If it has not rained, thoroughly wet the soil before gently lifting the wildling. **Do not remove the soil clinging to the roots.**

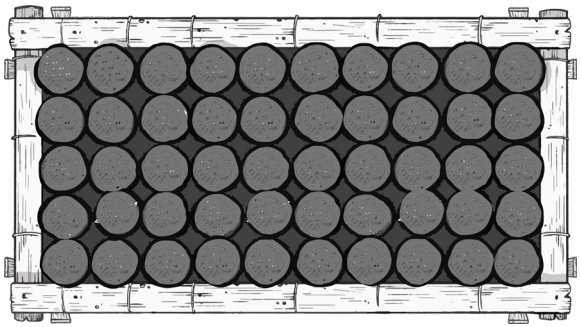


Wrap the collected wildlings in a banana stem sheath to preserve the moisture. Secure it with a tied knot from a strip of the banana stem sheath. If there are no banana stems, the wildlings can be wrapped in a wet shirt or a damp newspaper before storing in a styrofoam box with ice.



Preparation of potting media

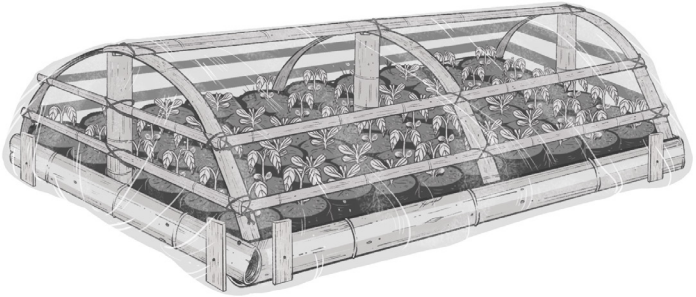
The potting media (a mix of soil, aeration material, and organic matter) must be placed in seedling bags. A recommended seedling bag size is 2.5 in x 2.5 in x 8 in: a bag that is narrow and long enough to encourage straight, upward growth of the seedlings and prevent bent or curved roots.



Bagging of wildlings

- Thoroughly water the bagged potting media.
- Drive holes into the middle of the thoroughly watered soil.
  Note: *If the soil does not cling to the holing stick, then the soil has been watered thoroughly.*
- Gently insert a prepared wildling in the hole and leave at least a 2-inch space between the wildling and the bottom of the seedling bag to give the roots space to grow.
- With one hand holding the prepared wildling in place, insert the other hand deep into the bag and pinch the hole close from the bottom to the top.
  Note: *If the hole is not properly closed, the wildling will die because its roots cannot obtain the water and nutrients it needs from the soil.*
- After bagging all the wildlings, water the bagged wildlings until the soil looks thoroughly soaked.

Sealing the recovery chamber



- Dig a half-foot to 1-foot-deep canal around the plot and keep the dug-out soil nearby.



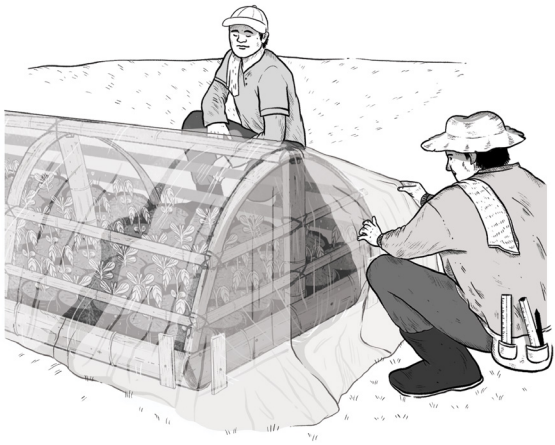
- Carefully lay a 6-meter-long, 6-millimeter-thick polyethylene (PE) sheet over the recovery chamber's frame.

  Note: *When adjusting the PE sheet over the frame, do not drag it over the frame's surface. Lift it carefully to avoid it catching and ripping on the frame's sharp edges.*

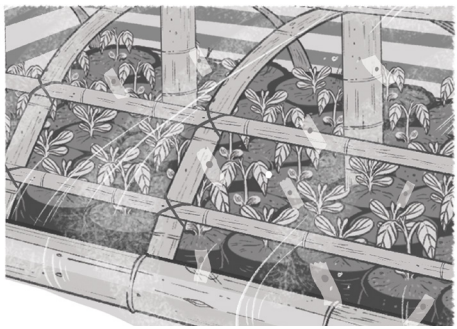
- Insert the PE sheet in the canals and fold the edges inward towards the plot.



- Fold the rest of the PE sheet to ensure a good fit over the frame.



- Bury the inserted PE sheet edges by putting back the dug-out soil.
- Check the recovery chamber a day after establishment. If condensation is clinging inside then the chamber is working.



Note: *If there is no condensation, look for a hole or a rip on the surface of the PE sheet and seal it with narrow scotch tape. Using wide scotch tape will wrinkle the PE sheet over time.*

Opening the wildling chamber

- After a month, open the chamber by rolling up half of the PE sheet on all its sides. Water the wildlings whenever the soil is dry.
- After two months, roll the PE sheet higher on all its sides and water it once a week.
- By the third month, remove the PE sheet and water the wildlings only when they are starting to droop and wilt, to fully harden them. Do this for 30 days.
- By the start of the fourth month, the wildlings can be transplanted in the field.

Care and maintenance

The end goal of following all the steps in producing quality planting materials is to ensure that they will have a great chance of surviving in the field. Proper care and maintenance of the planting materials in the nursery is essential.

Watering



This is the most important factor in producing planting materials. Watering frequency and quantity is called the watering prescription. Watering prescriptions vary with the intensity of sunlight, seedling age, and species. General good watering practices include the following:

- **Making sure that the water has low chlorine and saline levels** because too much of either is toxic to plants. Tap water from urban areas and seawater are examples of water with high chlorine and saline, respectively.
- **Watering according to container size**. Too much water will cause waterlogging, which makes the plants more susceptible to pests and diseases. A sign of waterlogged conditions is when the potting medium and the container become mossy. On the other hand, too little water will stunt the planting material's growth. Signs of insufficient watering are dry soil and wilted and/or discolored plants.
- **Watering in the absence of the sun**, during the early morning and/or late evening.

Weeding



Weeds are plants that grow where they are not wanted. If left uncontrolled, they will compete with the planting material for light, space, water, and nutrients.

- Since planting materials in nurseries are still young, with delicate stems and roots, it is recommended to pull weeds by hand to prevent any damage to the planting material.
- A weekly check of the plots, bags, and pots for any weeds should be done. Remove any weeds immediately.

Mulching



Mulching is laying on material called 'mulch' on the soil of the planting material. Mulch can be organic — such as rice hulls, wood chips, decomposing plant matter, prunings, crop residue, litterfall, and compost — and inorganic, such as gravel, rocks, and pebbles that may come in different shapes and colors for aesthetic purposes.

Organic versus inorganic mulch

Both kinds of mulch can help retain soil moisture, regulate soil temperature, prevent soil erosion, and suppress weed growth.

Organic mulch decomposes and adds nutrients to the soil. During watering or the rainy season, the layer of decomposing mulch can hold water, thus helping with moisture retention and, conversely, slowing the heating of the soil that can damage fragile plant roots. However, the excellent moisture retention qualities of organic mulch and the use of plant residues as mulch can attract pests that may affect the planting material.



Inorganic mulch, specifically rocks and pebbles, can come in different colors and styles that can enhance aesthetic quality in landscaping. This type of mulch does not offer the nutrients nor the regulation of soil temperature that organic mulch offers. If temperatures are very high, inorganic mulch heats up easily, thus drying the water in the soil faster and possibly burning the plants' roots.

Mulching considerations

For farm and nursery applications, inorganic mulch — such as gravel — is applied to clayey soil types but, ultimately, organic mulch is preferred. Here are some general considerations on application of organic mulch.

Mulching schedule

Assuming that the seedlings receive proper amounts of shade and sunlight, it is recommended to apply mulch at the onset of the rainy season.

Mulch selection

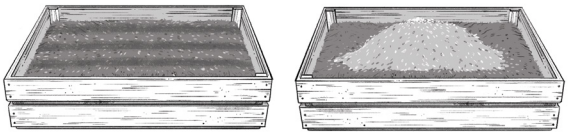
Choose mulch with the following characteristics:

1. **Free from diseases and infections:** Ensure that crop and plant residues that will be applied as mulch are not diseased nor infected to avoid contamination of the new planting materials.
2. **Appropriate and balanced mix of material:** Nitrogen-rich mulch material (plant parts, manure) that decomposes easily will protect the soil for a short period and can deliver nutrients to the soil quickly. Carbon-rich material (rice straw, wood chips, dry leaves, sawdust) that decomposes slowly will protect the soil but will not immediately add nutrients to the soil.

   It is a challenge but it is important to ensure that the mulch materials are a balance of both materials. Too much carbon-rich material will use up all the nitrogen in the soil as it decomposes and too much nitrogen-rich material will make the mulch smelly and might increase phosphorus levels, which is poisonous to plants, animals, and humans.

Mulching application

1. **Mulch thickness:** A very thick mulch layer will retain too much moisture underneath and encourage root rot and growth of snails, ants, and termites. Applying a layer of mulch 5-cm-deep is recommended because it can suppress weeds and retain moisture.
2. **Mulching before sowing seeds:** Add the mulch to the seedbox or seedbed then sow the seeds in between the mulch. Ensure that the seeds are not covered with mulch.



Mulching outplanted planting material: Adding a mulch layer can boost seedling survival in the field. Around 3 cm away from the stem, evenly distribute a 5-cm-deep mulch.



3. **Watering the applied mulch layer:** Water the newly applied mulch layer up to a point that it looks wet.

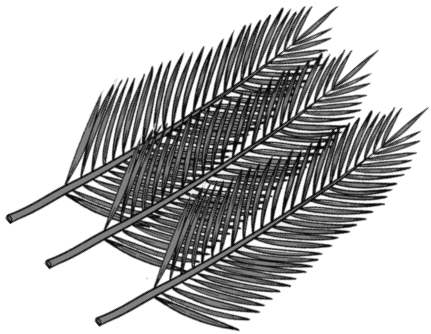
   Note: *Do not let the water pool over the mulch layer or else it will create a waterlogged condition that will drown the plant.*

4. **Change the mulch layer yearly:** Organic mulch will decompose over time. Refresh the mulch layer by removing the old mulch layer and laying a new one. Piling upon older layers can be done but too many layers may allow waterlogged conditions and cause root rot.

Shading

Direct sunlight is harmful for planting materials that has just been transplanted. Gradual exposure should be made so that the planting material can adjust to a sudden increase in soil temperature and rapid water loss. Shading is the use of different material to protect planting materials from direct sunlight.

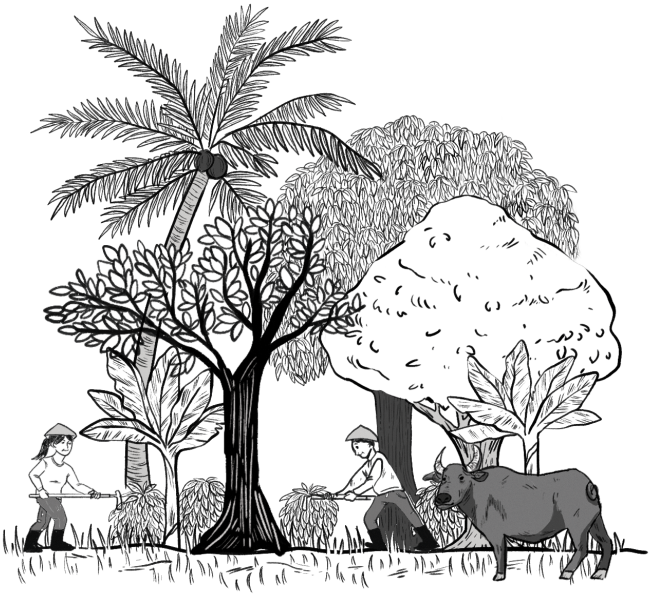
Fronds: Fronds of palm or coconut trees can be used for shade.



Rice sacks: If fronds are not available, build a frame which the sack can fit over.



Live plants: Standing trees and plants can be used to shade other trees and agricultural crops underneath.



The shading material must only be applied when it is needed. Generally, it is recommended to remove it after a month for outplanted seedlings. Planting material that is left to mature under the shade will grow too tall, too weak, and discolored.

Root pruning

Root pruning will prevent the breakage of roots, which have grown out of a polybag and into the nursery soil, during lifting for transport. Root breakage causes plant shock which might stunt growth or even kill the plant before it can be planted in the field.

Advantages of root pruning

Root pruning can also influence root growth: fast-growing and bigger roots that might destroy a container before outplanting can be pruned to slow growth. This also encourages the growth of small root hairs that will make absorption of water and nutrients easier for the plant.

Root pruning process

1. **Considerations:** To know if there is a need for root pruning, gently lift the container. If there is difficulty in doing so, then the roots may have anchored into the nursery soil and need pruning.
2. **Schedule:** This depends on the growth rate and management of the seedlings. A general rule is to prune the roots one to two months before the planned transport of the seedlings.
3. **Time:** It is recommended to prune roots late in the afternoon.
4. **Implements:** It is better to use sharp tools, such as scissors, a knife, or razor blades, to cut the roots because they can be used for both small and big roots. This makes pruning neater and less likely to cause damage than breaking off by hand.

Hardening

In the nursery, the seedlings have grown in a controlled environment and given the best care. In the field, the seedlings will be surviving in uncontrolled conditions on their own.

Hardening-off is the gradual process of adapting seedlings to field conditions. It involves a gradual reduction of watering, gradual increase of exposure to sunlight, leaf trimming, and root pruning.

Gradual reduction of watering

Increase the time between watering by two to three days. The period between watering can be extended up to two weeks or longer but no planting material should be allowed to wilt.

Gradual exposure to the sun

Initially remove shade for two hours a week. Lengthen the removal of shade by one to two hours, continuing until the planting material can tolerate full sunlight.

Before hardening, sorting and grading must be done to remove inferior planting materials and ensure that only the best will continue to the field.

Sorting and grading

Planting materials are graded according to a standard and sorted accordingly. Nowadays, this is done before hardening and before planting. Plants who receive 'failing grades' will be grouped and removed.

The following is the grading scale for each plant criterion:

Criteria and importance	Description
Health	**Absence of pests and diseases**
0	POOR: More than 30% of the planting stocks exhibiting infestation and disease
1	MODERATE: 20–30% of the planting stocks
2	GOOD: 10–19% of the planting stocks
3	EXCELLENT: less than 10% of the planting stocks
Stem form	**Stem straightness**
0	POOR: More than 30% of the planting stocks with 2 or more main stems and bent shoots
1	MODERATE: 20–30% of the planting stocks
2	GOOD: 10–19% of the planting stocks
3	EXCELLENT: less than 10% of the planting stocks
Root form	**Root deformation (J-roots, pot bound and root curling) and growth out of the container**
0	POOR: More than 30% of the planting stocks have deformed roots/container outgrowths
1	MODERATE: 20–30% of the planting stocks
2	GOOD: 10–19% of the planting stocks
3	EXCELLENT: less than 10% of the planting stocks
Sturdiness	**Stem robustness (use Sturdiness Quotient to assess this. Ideal is SQ = 6) (SQ = seedling height (cm) / seedling diameter (mm))**
0	POOR: More than 30% of the planting stocks have an SQ that is more than 6
1	MODERATE: 20–30% of the planting stocks
2	GOOD: 10–19% of the planting stocks
3	EXCELLENT: less than 10% of the planting stocks

Seed collection, processing and pre-treatment

Indigenous species

Common name	Scientific name	Fruit type	Storage behavior	Collection method	Extraction method	Storage method	Viability	%G[1]	Pre-treatment	Methods of Propagation A – Seeds; B – Vegetative; C – Either
Langka/ Nangka	*Artocarpus heterophyllus* Lam.	Syncarp	recalcitrant	From standing trees	Extract seeds from fruit by hand. Remove fleshy sheath, thoroughly wash seeds to remove slimy coating. Use only the largest seeds.	Air-dry for an hour before storage. Bury in sawdust or coir dust in ambient temperatures. It is best to sow seeds immediately.	1 month	80–100%	Remove the horned part of the pericarp. Scrape off seed coat, wash, and soak in tap water for 24 hours.	C (Grafting)
Marang/ Madang	*Artocarpus odoratissimus* Blanco	Syncarp	recalcitrant	From standing trees	Extract seeds from fruit by hand. Wash seeds thoroughly to remove clinging fruit flesh.	It is best to sow seeds immediately as they lose viability quickly.	-	About 100%	None required but soaking in tap water can be done.	A
Pomelo/ Suha	*Citrus maxima* (Burm.) Merr.	Berry (hesperidium)	intermediate	From standing trees	Pick the seeds in between the fruit flesh. Remove papery layer surrounding the seeds, then wash the seeds.	Store in moist paper towel enclosed in plastic at 5 °C. It is best to sow seeds immediately.	80 days	N/A	Wash off slime build up on seed.	C (Marcotting and Budding/ Grafting using buds)
Kamagong/ Mabolo	*Diospyros discolor* Willd.	Berry	recalcitrant	From the ground Fallen fruits or seeds from forest floor	Pick the seeds by hand or pulp the fruit by hand and wash extracted seeds. Rub seeds against sieve if needed.	a) Store in sealed container at ambient temperature. b) It is best sown immediately after extraction.	1 month	a) N/A b) 85–100%	Scrape off seed coat and soak in tap water for 24–48 hours or soak in boiling water for about 5 minutes.	A
Dao	*Dracontomelon dao* (Blanco) Merr. & Rolfe	Drupe (hesperidium)	recalcitrant	From the ground	Soak the fruit in tap water for 2-3 days then pulp the fruit by hand to extract seeds. Rub seeds against sieve to remove clinging fruit flesh. Then wash the seeds again in running water.	a) Air-dry for 2–7 days or sun-dry for 2 days then store in a plastic bag at 7–15 °C. Viable for a year. If unable to store in cool and dry place, sow the seeds a day after air-drying.	About 1 year	About 33%	Scrape off seed coat and alternate soaking and sun-drying for 6 days.	A

Common name	Scientific name	Fruit type	Storage behavior	Collection method	Extraction method	Storage method	Viability	%G[1]	Pre-treatment	Methods of Propagation A – Seeds; B – Vegetative; C – Either
Durian	*Durio zibethinus* L.	Capsule	recalcitrant	From the ground (fallen fruits)	Wash the seeds in running water to remove any clinging fruit flesh ('aril').	a) Store surface-sterilized and moistened seeds in airtight containers at ambient temperature. b) Same preparation but stored at 15˚C It is best to sow seeds immediately.	a) About 10 days b) 3 months	a) 100% b) 79%	No further treatment, aside from removing the aril	C (Grafting)
Dap-dap/ Anei	*Erythrina variegata* L.	Pods	orthodox	a) From standing trees b) From the ground	Collect the pods during maturity (when they turn brown). Spread the pods in a mat and sun-dry to open. Extract the seeds by hand.	a) Dry seeds before placing the seeds in an airtight container and store in a refrigerator. b) Sow immediately after treatment.	Several years	a) 70–90% b) About 90%	Soak in cold/ tepid water for 24 hours.	C (Cuttings)
Banaba	*Lagerstroemia speciosa* (L.) Pers.	Capsule (woody)	intermediate	From standing trees	Collect the capsules when they turn dark brown. Sun-dry the capsules for 5–7 days until it turns brittle when a fingernail is pressed to its surface. Break the pods and carefully extract the small winged seeds.	Air-dry seeds for 5–7 days before storage. Store in an airtight container under ambient temperature. It is recommended to sow seeds immediately.	1–6 mos	~64%	Soak seeds in hot water that is twice its volume for 5 minutes.	C (Cuttings)
Lanzones	*Lansium parasiticum* (Osbeck) K.C. Sahni & Bennet	Berry	recalcitrant	From standing trees	Extract seeds from mature fruit and soak in tap water for 24–48 hours. Thoroughly clean the seeds from clinging flesh and washing in running water. Air-dry seeds for 24 hours or until dry, then spray suitable fungicide[2] on the seeds.	a) Sow the seeds 1–2 days after removal from fruit. They cannot tolerate storage in ambient conditions. b) Store seeds in polyethylene bags at 4–6˚C.	a) – b) 14 days	a) About 90% b) N/A	No further treatment necessary	C (Grafting)
Bagalunga	*Melia azedarach* L.	Drupe	orthodox	From standing trees (hooking) From the ground (shaking branches)	Soak fruit in tap water for 2–3 days and then extract stones by hand. Carefully extract the seeds by cracking the stones using pliers. A small rock can be used but it might damage seeds.	Store in PE bag at room temperature (28˚C).	14 months	About 85%	Soak extracted seeds in tap water for another 24 hours.	A

Common name	Scientific name	Fruit type	Storage behavior	Collection method	Extraction method	Storage method	Viability	%G[1]	Pre-treatment	Methods of Propagation A – Seeds; B – Vegetative; C – Either
Rambutan	*Nephelium lappaceum* L.	Drupe	recalcitrant	From standing trees	Extract seeds from ripe fruit. Scrape clinging flesh (aril) by rubbing against a sieve or material with rough surface (ash, canvas cloth, sandpaper) and wash seeds thoroughly.	Place washed seeds in an airtight container packed with moist sawdust (can be sphagnum moss or charcoal). Some seeds will germinate in storage.	3–4 months	About 65–95%	No further treatment owing to recalcitrance.	C (Grafting)
Kupang	*Parkia timoriana* (DC.) Merr.	Legume	orthodox	From standing trees	Extract seeds from mature pods. Winnow seeds to get rid of pod debris and then soak seeds in tap water overnight and discard those that float. If seeds will be sowed immediately, there is no need for air-drying.	Air-dry for around 10 days after soaking and store in cans or plastic bags at ambient room temperature. It can also be stored in a refrigerator.	1–2 years	About 80%	Scarify to expose a small part of the cotyledon then soak in hot water (~80°C). Leave it for 24 hours before sowing.	A
Narra	*Pterocarpus indicus* Willd.	Samara	orthodox	From the ground	Collect seeds immediately after fall. If insects are found after collection, spray the pods with insecticide. Dewinging is not needed.	Sun-dry pods for about a week. Place the pods in a sealable container then add small amount of calcium carbonate and/or magnesium oxide.	About 3 years	About 24%	Soak in hot water (50˚C) for 10 minutes.	C (Cuttings)
Lipote	*Syzygium polycephaloides* (C.B. Rob.) Merr.	Berry	recalcitrant	From standing trees	Extract the seeds by hand. Ensure that no fruit flesh is clinging to the seed. Wash repeatedly if necessary.	Seeds lose viability the moment they are extracted from the fruit. It is best to sow immediately after processing.	-	About 80%	Aside from washing the seeds, no further treatment is needed.	A
Anabiong/ Hanagdong	*Trema orientalis* (L.) Blume	Drupe	recalcitrant	From standing trees	Soak fruits in tap water and separate seeds. Discard those that float and rewash the remaining seeds.	a) Air-dry and store in an airtight container at room temperature . b) Air-dry then store at 2°C. Sowing as soon as possible is recommended.	a) About 6 months b) ~3–4 months	a) About 30% b) About 16%	Soak in concentrated sulfuric acid for 15 mins. or Soak in gibberellic acid (GA3) dissolved in agar at 500 ppm.	A

Common name	Scientific name	Fruit type	Storage behavior	Collection method	Extraction method	Storage method	Viability	%G[1]	Pre-treatment	Methods of Propagation A – Seeds; B – Vegetative; C – Either
Molave	*Vitex parviflora* A. Juss.	Drupe	recalcitrant	From standing trees (hooking)	Soak seeds in tap water overnight. Remove fruit flesh, wash, and sun-dry under a canvass for 7 days.	Store in a jar or tin can. Sowing as soon as possible is still recommended.	≤1 yr	~70%	Soak seeds in hot water until water cools down.	A
Calamansi	*Citrofortunella x microcarpa* (Bunge) Wijnands	Berry (hesperidium)	recalcitrant	From standing trees	Lay a strainer on a clean container's opening. Squeeze the fruit to extract the juice and the seed. Wash the separated seeds to remove natural sugars from the fruit juice.	Treat with fungicide[2], fold in damp paper, and seal in a thin plastic bag. Store in the refrigerator (ideally 2–5˚C)	2 years	N/A	Wash seeds again to remove fungicide and any build up on the seed surface before sowing.	C (Grafting and Marcotting)

[1]G% means germination percent, the estimate viability of a population of seeds. [2]Follow insecticide instructions and precautions carefully to avoid accidents. A systemic fungicide (fungicides that gets absorbed by plants) should be used to inhibit infection of fungi on the seed coat. [3]Hot water temperature estimation: in the absence of a thermometer to accurately measure the water's temperature, boil the water and allow it to cool for about 10 minutes.

General remarks: Most of the time, vegetative propagation methods using the best varieties are usually employed to propagate fruit trees rather than growing from seeds.

Seed collection, processing and pre-treatment

Exotic species

Common name	Scientific name	Fruit type	Storage behavior	Collection method	Extraction method	Storage method	Viability	%G[1]	Pre-treatment	Methods of Propagation A – Seeds; B – Vegetative; C –
Auri	*Acacia auriculiformis* Benth.	Legume	orthodox	From standing trees (collect from higher branches) Standing trees (with access from ground)	Sun-dry pods to open and manually scrape or pick the seeds from the opened pods. Red or yellow funicle (tail-like growth) can be removed by gently rubbing the seeds against a sieve.	Enclose seeds in plastic bags at room temperature.	6–12 months	40–100%	Immerse in boiling water for 1–2 minutes then soak in cold water overnight. Tap water can be used but soak for 24 hours.	A
Manguim	*Acacia mangium* Willd.	Legume	orthodox	From standing trees (collect from higher branches) Standing trees (with access by climbing)	Sun-dry pods for 24–48 hours. When they open, winnow to remove pod debris and rub seeds gently to remove yellow or orange funicle.	Store in small airtight containers and in a dark area at room temperature.	Several years	70–90%	Immerse in boiling water for 30 seconds (1 part seeds to 10 parts water) then soak in cold water or cool tap water for 24 hours.	A
Alnus	*Alnus japonica* (Thunb.) Steud	Samara	orthodox	From standing trees (collect from higher branches)	Harvested catkins should be placed in mesh sacks or net bags to allow ventilation and prevent being blown by the wind. Sun-dry to dry fruit and release the seeds.	a) Store in small airtight containers at room temperature. b) Same storage container but refrigerated at 3–5˚C.	a) 1 month b) 1–6 months	88%	Immerse seeds in hot water (90°C).	A
Cashew	*Anacardium occidentale* L.	Drupe	orthodox	From standing trees (nut falls to the ground when mature)	Separate the nuts from the fruit, making sure no flesh is left on the nut. Place seeds in water and discard those that float.	Sun-dry seeds for 2 days after flotation test. Do not remove shells. Store the seeds in airtight containers at room temperature.	2–6 months	100% after 4 months; 50% after 10 months	Fresh nuts: none required After storage: soak in cool tap water for 24 hours; nicking seed coat can be done.	A

Common name	Scientific name	Fruit type	Storage behavior	Collection method	Extraction method	Storage method	Viability	%G[1]	Pre-treatment	Methods of Propagation A – Seeds; B – Vegetative; C –
Guyabano	*Annona muricata* L.	Syncarp	orthodox	From standing trees	Extract seeds from fruit by hand. Remove fruit flesh by rubbing against sieve. Wash thoroughly. Soak overnight and air-dry.	Store in PE bags. It is best to sow seeds immediately.	1 month	85-90%	Soak overnight in tap water	C (Grafting)
Orange species	*Citrus* sp.	Berry (hesperidium)	intermediate	From standing trees	Extract seeds from fruit by hand, wash seeds, and air-dry.	Fold seeds in a moist paper towel and refrigerate (0-4°C) It is best to sow seeds immediately.	2 years	N/A	Wash off slime build up on seeds.	C (Grafting and Marcotting)
Coffee species	*Coffea* sp.	Drupe	intermediate	From standing trees	Pulp the fruit. Soak in tap water overnight. Then extract the seeds and wash the seeds clean. Air-dry for 36–48 hours. Remove small or abnormally shaped seeds.	a) Store in a sealed bottle at room temperature. b) Store in carbon-dioxide-absorbent medium in a sealed bottle at 4–7°C. Viable for 6–10 months. c) It is best to sow seeds immediately.	a) 3 months b) 6-10 months	About 85%	Remove paper layer surrounding seeds and soak in cold water for 24 hours.	C (Cuttings)
Mangosteen	*Garcinia mangostana* L.	Berry	recalcitrant	From standing trees	Extract seeds from fully ripe fruit. Thoroughly clean the clinging white fruit flesh from the seeds by alternating washing and gently rubbing against a rough material (sandpaper, sieves, canvas cloth, etc.).	Pack cleaned seeds in dampened peat or sphagnum moss or coconut fiber in airtight containers. It is best sown immediately after processing owing to recalcitrance.	3 months	About 22%	Soak seeds in tap water for 24 hours.	A
Pararubber	*Hevea brasiliensis* (Willd. Ex A. Juss.) Müll. Arg.	Capsule (bursts open upon maturity)	recalcitrant	From the ground	Capsules burst open when ripe and the seeds are scattered up to 33 m from the tree. Immediately gather the seeds because they lose viability rapidly.	a) Store moist seeds in perforated plastic bag with moist charcoal and sawdust at 7–10°C. b) It is best sown immediately after processing owing to recalcitrance.	3 months	a) About 89% b) About 91%	No treatment is needed. Seeds are best sown fresh owing to recalcitrance.	C (Budding or grafting using buds instead of stem cuttings)

Common name	Scientific name	Fruit type	Storage behavior	Collection method	Extraction method	Storage method	Viability	%G[1]	Pre-treatment	Methods of Propagation A – Seeds; B – Vegetative; C –
Gmelina/ Yemane/ Paper tree	*Gmelina arborea* Roxb.	Drupe	orthodox	From standing trees and from the ground	Collect fruits when they are still green or yellow and place in an open basket to avoid damaging the fruit. Spread green fruit under shaded area and wait until it turns yellow. Soak yellow fruits in tap water for 1–2 days and separate the stones by hand. Wash the stone and rub it against to sand or sieves to remove clinging flesh.	Air-dry stones in a shaded area for 1 week. If there is still deposited pulp in the hollow point of the seeds, sun-dry for at least 2 days or until it is completely dried. Air-dry for 2–3 hours before storage. a) Store stones in containers at room temperature. b) Storage in containers at 4-7˚C.	a) 3 months b) 2–3 years	About 90%	Soak seeds in tap water for 24 hours.	A
Ipil-ipil	*Leucaena leucocephala* (Lam.) de Wit	Legume	orthodox	From standing trees	Collect the pods before they split open. Spread pods on shaded surface until the pods open. Pack the pods in a sack and beat with a stick to extract the seeds. Use screens and sieves to separate pod debris and seeds.	Ensure seeds are dry before storing in airtight containers.	1–3 years	About 90%	Soak in hot water and let it stand for 24–72 hours. Immerse in boiling water twice the volume of the seeds for 2 minutes then replace with tap water and let it stand for 24 hours.	A
Musizi	*Maeopsis eminii* Engl.	Drupe	orthodox	From standing trees	Remove outer skin and air-dry until fruit flesh dries.	Store in jars or PE bags in cool temperatures (28˚C and below).	1 year	65-80%	Nick the seed coats and soak the seeds in tap water for 1–2 days.	A
Mangga	*Mangifera indica* L.	Drupe	recalcitrant	From standing trees	Collect seed from mature fruit. Use a knife to create a small slit at the stalk end of the seed husk. Carefully pry the seed husk open to extract the seed. Remove the papery layer on the seed and wash thoroughly.	Store seeds in sealed plastic bags with moist charcoal at room temperature.	About 4 months	About 60-90%	Nick the seed coats before sowing.	C

Common name	Scientific name	Fruit type	Storage behavior	Collection method	Extraction method	Storage method	Viability	%G[1]	Pre-treatment	Methods of Propagation A – Seeds; B – Vegetative; C –
Falcata	*Paraserianthes falcataria* (L.) I.C. Nielsen	Legume	orthodox	From standing trees	Collect the mature pods (brown) before they split open. Spread pods on shaded surface until the pods open. Pack the pods in a sack and beat with a stick to extract the seeds. Use screens and sieves to separate pod debris and seeds.	Ensure seeds are dry before storing in sealed PE bags at room temperature.	2 years	80-100%	Immerse seeds in hot water and allow to cool for 12 hours or soak in tap water for 24 hours.	A
Avocado	*Persea americana* Mill.	Berry-like	recalcitrant	From standing trees	Extract medium- and large-sized seeds and clean thoroughly then air-dry prior to storage or sowing.	Store moist seeds in dry peat at 5 °C without allowing the seeds to dry completely It is best sown immediately owing to recalcitrance.	8 months	About 50-70%	Remove seed coat and horizontally cut around 1.5 cm at the bottom part of the seed. Wash it again after cutting.	C (Grafting)
Guava/ Bayabas	*Psidium guajava* L.	Berry	orthodox	From standing trees	Extract seeds by hand and thoroughly wash with a small amount of dishwashing soap. Air-dry in a shaded area.	For storage, dry seeds for a week, treat with fungicide[2] and store in airtight containers at room temperature.	15 years	About 70-93%	Soak in hot water and let it stand for 48 hours or soak in tap water for 2 weeks.	A
Mahogany	*Swietenia macrophylla* King	Capsule (w/ winged seeds)	orthodox	From the ground	Collect seeds immediately after they fall. If collected from standing trees, collect before capsule opens. This is the best method if collecting from natural stands.	a) Sun-dry seeds and store in a sealed container with charcoal or sawdust at room temperature. b) Sun-dry seeds for 1 to 2 weeks and store in paper bags at room temperature.	a) About 1 year b) 2-3 months	About 80%	Break off the wings and soak the seeds in tap water overnight.	A

Common name	Scientific name	Fruit type	Storage behavior	Collection method	Extraction method	Storage method	Viability	%G[1]	Pre-treatment	Methods of Propagation A – Seeds; B – Vegetative; C –
Cacao	*Theobroma cacao* L.	Berry-like	recalcitrant	From standing trees	Using a bolo, carefully break the pod to avoid damaging seeds and pick the seeds by hand. Immerse the seeds in tap water for 10 minutes then roll them in dry soil, ash, or sawdust and submerge again in water. Repeat until pulp is removed.	At room temperature, place cleaned seeds in containers lined with cotton, sprinkle tap water, and stir the seeds to prevent surface drying.	About 21 days	80–100%	After storage, sprinkle water on the seeds, then stir and lay on a mat in a well-ventilated area. Sow when first parts of the seedling breaks the seed coat.	C (Grafting)

[1]G% means germination percent, the estimate viability of a population of seeds. [2]Follow insecticide instructions and precautions carefully to avoid accidents. Application of systemic fungicides (fungicides that plants absorb) is recommended to inhibit infection of fungi on the seed coat. [3]Hot water temperature estimation: in the absence of a thermometer to accurately measure the water's temperature, boil the water and allow it to cool for about 10 minutes.

General remarks: Most of the time, vegetative propagation methods using the best varieties are usually employed to propagate fruit trees rather than growing from seeds.

Session Guide 1

Topic: Seed technology

Logistical considerations:

Time allotment: About 8 hours

No. of participants: Ideally 15–30 pax (ensure a ≥30% attendance of females)

Venue: A farmer's field and a sheltered area near or in the field (mix of outdoor and indoor)

Purpose: The most common way to source planting materials is to grow it from seeds or obtain seedlings from a nursery. When using seeds, it is important that the farmer is knowledgeable about the proper techniques involved in the collection, pre-treatment, and storage of seeds. Another skill that farmers must have is identifying seedlings that exhibit superior characteristics, which will enable them to ensure good quality of trees and their products.

Objectives:

By the end of this training session, the participants will be able to:

- describe the characteristics of a good quality seedling;
- identify good quality seedlings; and
- demonstrate seed collection, pre-treatment, and storage techniques.

Resources:

- Freshly collected fruit—both orthodox and recalcitrant—from tree species common in the area. Seed collection will be done in the training but collect beforehand in case unable to do so before training.
- Hook mounted on a pole
- Sandpaper (at or greater than 120 grit), 'katsa' or cheesecloth, trays with fine wire mesh bottoms (size of screens should vary, for example, 1.5 mm, 1.8 mm, 12.5 mm), sharp knives (for nicking and scarifying)
- Used tarpaulin or old rice sacks (to dry seeds), 'bilao'/winnowing basket (for seed drying)
- Glass jars of different sizes (avoid plastic jars) and plastic bags (for seed storage)
- Containers that can withstand hot to boiling water (glass or steel)
- Salt (1/4 kg)

Methods:

- Lectures; and/or
- Demonstrations followed by guided hands-on sessions (refer to pages 8 to 18 of this training manual)

Modifications and variations:

It should be noted that the session plan is only a guide for the trainers and their creativity in conducting the training is still encouraged so long as all the topics in the session plan are covered.

If there are uncontrolled events, such as a sudden change of weather (e.g. strong rain), it is advised to conduct the training inside the nursery or a training hall. Utmost care is needed to avoid injury to the planting material if the seedlings need to be transferred to the location. It is important to establish rapport with the participants to be able to facilitate a smooth, frequent reporting process regarding the survival rates of the grafted and marcotted plants.

Activity	Time	Learning check
Introductory Introductions/Greetings Presentation of training objectives	15 minutes	Confirm that the participants understood the flow of activities. Check if they have any concern or anything to add to the training.
Training proper (Outdoor) Lecture: Seed or sexual propagation 101 (definition) Advantages and disadvantages of using seed propagation ■ **Advantages:** inexpensive, used most widely, can create varieties, easy transport and storage, low risk of disease wiping out an entire population of seed-grown plants (owing to genetic diversity) ■ **Disadvantages:** takes time to reach maturity, some seeds cannot be stored, variations in the plants from seeds might not have the desired characteristics	6 hours	Divide the participants into groups. Make sure that each PO is represented in each group, and the men and women are well-distributed. These will be the groupings for the entire training session. ***Note:*** *For every phase, make sure to go around and/or ask the facilitators to ensure that everyone in the group was able to experience applying the method/s demonstrated and to answer any questions that may arise.*
I. Seedling collection *(Discuss and demonstrate)* ■ From the ground (page 8) i. picking from the ground and shaking the tree ii. points to remember when using this method ■ From standing trees (page 10) i. tips on collecting from lower branches and higher branches ii. points to remember when using this method ■ From crowns of felled trees (page 11: definition; where it is not applicable and when it should not be done)		I. Seedling collection ■ From the ground: Let the participants collect with the methods mentioned after discussion. ■ From standing trees: Let female and male participants take turns in using a hooked pole to collect seeds as well as collecting by bending or hacking off the branches.
II. Seed processing *(Discuss and demonstrate)* ■ Seed extraction (pages 11-12): Demonstrate methods to clean the seeds. ■ Drying of seeds (page 14) ■ Seed screening (page 15): Discuss and demonstrate sorting, flotation, sieving, and blowing.		II. Seed processing ■ Seed extraction: Let the groups extract the seeds from the fruit. ■ Seed screening:Let the groups apply the seed screening methods.

Activity	Time	Learning check
III. Seed storage *(Discuss)* ■ Seed storage behavior (page 8: orthodox, recalcitrant, intermediate) ■ Seed storage options (Refer to Seed collection, processing and pre-treatment table on page 44 to discuss the different options)		III. Seed Storage ■ Storage behavior: The resource person shall describe the storage behavior of the seed they are using then quickly ask the group to make a show of hands to vote on the seed's storage behavior. ■ Seed storage options: Using a handful of the sample seeds, the resource person shall demonstrate how to store the seeds. Remove the seeds from its container if there are only a few seeds available.
IV. Seed pre-treatments *(Discuss and demonstrate)* ■ Hot water treatment (discuss difference from boiling water treatment) ■ Nicking/scarification (using knife then a coarse-surfaced material (sandpaper, wire mesh, 'katsa'/cheesecloth. Discuss each option) ■ Biological treatment ■ Discuss possible combinations of these pre-treatments (Refer to the Seed collection, processing, and pre-treatment table)		IV. Seed pre-treatments Nicking/scarification: Instruct each member of the groups to nick a single seed then let them scarify some seeds by rubbing against a coarse material of choice.
Wrap-up Summary of the discussion on wildlings and Activity 1 in the practical session **Group activity:** Let a representative from each group summarize what they have done during the practical session	20 mins	Check for questions and clarifications.
Open session (Q&A)	25 mins	Check for questions and clarifications.
Evaluation	15 mins	Translate into the local language, if possible.

Remarks: In case the venue and the materials will not be available to each group, freshly collected fruit and seeds for hands-on training will do. Then, there will be no hands-on learning check. Instead, participants should gather around for the demonstration.

Session Guide 2

Topic: Grafting and marcotting

Logistical considerations:

Time allotment: About 8 hours

No. of participants: Ideally 15–30 pax (ensure a ≥30% attendance of females)

A small audience is preferred to be able to fully monitor each participants' work in the grafting and marcotting process.

Venue: A nursery in a farmer's field

Purpose: Vegetative propagation is used to produce clones of a certain plant. The parent plant may contain desirable characteristics — such as, fruit taste, color, ripening behaviors — and a farmer may want to have as many seedlings as possible with those characteristics. Vegetative propagation will give assurance that those traits will be reproduced in seedlings within a shorter time, unlike in seed propagation which takes longer and where traits cross and may be lost.

Objectives:

By the end of this training session, the participants will be able to:

- identify and collect good scions that can be used for grafting;
- demonstrate the cleft and side-grafting processes on seedlings; and
- apply the marcotting process on branches of selected parent plants.

Resources:

- Rootstock and freshly collected scions (Material needed and process of scion collection is on page 20 of this manual).
- Material and tools for grafting and marcotting (pages 20 to 25 of this manual)
- Training evaluation form

Methods:

- Short lectures
- Demonstrations and hands-on training (The steps for each method are on pages 20 to 25)

Remarks: It is advised to assemble a team of co-facilitators who will meticulously oversee the work of the participants so that the trainer is free to facilitate.

Modifications and variations:

It should be noted that the session plan is only a guide for the trainer and their creativity in conducting the training is still encouraged as long as all the topics in the session plan are covered.

If there are uncontrolled events, such as a sudden change of weather (e.g. strong rain), it is advised to conduct the training inside the nursery or a training hall. Utmost care is needed to avoid injury to the planting material if the seedlings need to be transferred to the location. It is important to establish rapport with the participants to be able to facilitate a smooth, frequent reporting process regarding the survival rates of the grafted and marcotted plants.

Activity	Time allocation	Learning check
Introductory Introductions/Greetings Presentation of training objectives	15 minutes	Confirm that the participants understood the flow of activities. Check if they have any concerns or anything to add to the training.
Theoretical (Discussion) Vegetative propagation 101 (definitions and key differences from seed propagation) Advantages and disadvantages of using vegetative propagation ■ **Advantages:** assures production of parent plant clones with desired characteristics and less production time (relate this to why this is the method employed in commercial plantations) ■ **Disadvantages:** potential impact on biodiversity (no variety leads to monocropping and if the clone is susceptible to a certain disease then the whole monocrop stand will be wiped out) and needs time and dedication to master the techniques	30 minutes	Check for questions and clarifications.
Practical Divide the participants into groups. Make sure that each PO is represented in each group and men and women are well-distributed. ***Note:*** *Let the participants apply the processes after each demonstration to allow for correction and maximize their retention. Make sure to highlight important steps and usual common errors in each technique.* I. Grafting ■ Short discussion: the parts of a grafted plant (page 19), types of grafting to be done during this training (i.e. cleft and side grafting) and when to use specific types ■ Demonstration: cleft grafting (Application proper: Cleft grafting, more than 5 plants per participant) ■ Demonstration: side grafting (Application proper: Side grafting, more than 5 plants per participant) II. Marcotting/Air layering ■ Short discussion: where it can be applied, its key differences from grafting, material and methods (pages 25-27) ■ Demonstration: marcotting (Application proper: Marcotting, more than 5 plants per participant)	6 hours	Make sure to do the process slowly and, if possible, explain each step before doing it. Make sure to repeat each demonstration at least twice. Check and encourage participants to ask questions every after demonstration. For every application, make sure that co-facilitators are intent on helping the groups they are assigned to. Make rounds to ensure each step is followed. **Cleft grafting:** Always reiterate that the union should be tightly joined. **Side grafting:** Always reiterate to wrap the union well to avoid mold or rot. **Marcotting:** Always reiterate to scrape carefully and thoroughly and to avoid touching the exposed cambium.

Activity	Time allocation	Learning check
Wrap-up ■ Discuss care and maintenance of grafted plants, when to remove cap and ties on grafted plants, and when to outplant ■ Discuss when to remove marcot (2 to 4 months or when the formed roots are in some shade of brown)	20 minutes	Check for questions and clarifications.
Open session (Q&A)	25 minutes	Check for questions and clarifications.
Evaluation	15 minutes	Translate into the local language, if possible.

Session Guide 3

Topic: Rapid production of quality planting material using wildlings

Logistical considerations:

Time allotment: About 8 hours

No. of Participants: Ideally 20–30 pax (ensure a ≥30% attendance of females)

Venue: A farmer's field

Purpose: Wildlings can be used in case the farmer's objective is to offset mortality of their planted seedlings but there is not much time to produce using seeds and vegetative means. Wildlings are also used when money to procure seedlings from nurseries is an issue. In order to successfully use wildlings as planting material, proper selection, collection, rearing and management should be mastered

Objectives:

By the end of this training session, the participants will be able to:

- describe the characteristics of a good wildling with a high chance of surviving in a nursery;
- explain and demonstrate the process of establishing a wildling recovery chamber, as well as the proper collection of wildlings;
- build three wildling recovery chambers; and
- establish an alternative source of planting material.

Resources:

- Wildlings (for the proper collection of wildlings refer to page 33 of this manual)
- Material and tools needed to build a wildling recovery chamber (refer to page 65 of this guide)
- Training evaluation form

Methods:

- Short lectures/discussions
- Hands-on demonstration: The steps in building the shed and the wildling recovery chamber are outlined and illustrated on pages 10-16 of the *Tree nursery establishment: a training manual*. During the training proper, it is highly recommended to do the activities simultaneously to conserve time.

Modifications and variations:

It should be noted that the session plan is only an outline guide for the trainer and that their creativity in conducting the training is still encouraged as long as all the topics in the session plan are covered.

If there are uncontrolled events, such as a sudden change of weather (e.g. strong rain) or there are few wildlings available, it is advised to conduct the training inside the nursery or in a training hall. Utmost care is needed to avoid injury to the planting material if the seedlings need to be transferred to the location. It is important to establish rapport with the participants to be able to facilitate a smooth, frequent reporting process regarding the survival rates of the grafted and marcotted plants.

Activity	Time allocation	Learning check
Introductory Introductions/Greetings Presentation of training objectives	15 minutes	Confirm that the participants understood the flow of activities. Check if they have any concerns or anything to add to the training.
Theoretical (Discussion) What are wildlings? Advantages and disadvantages of using wildlings as planting material ■ **Advantages:** cheap, easily sourced, short production time, adjusted to local conditions and easy accounting for billing purposes ■ **Disadvantages:** genetic quality is not assured, availability of wildlings dependent on forest conditions (climate and competition)	30 minutes	Check for questions and clarifications.
Practical Divide the participants into groups. Make sure that each PO is represented in each group and men and women are well-distributed. ***Note:*** *A demonstration shall be made before each phase of this training* I. Wilding collection and preparation (balling the roots of the collected wildlings with soil from where they came from, wrapping the wildlings for transport, pruning, root hormone application) ■ Discuss importance of balling the roots of the wildlings with the soil from where they came from. ■ Discuss why they should be wrapped in moisture-retentive material after collection. ■ Discuss what is a rooting hormone, its action on plant development and emphasize difference from fertilizer. II. Preparation of potting media (soil and additive ratio, 4 : 2 : 1 ratio of soil – rice hulls – decomposed manure or 3 : 2 soil and manure, in case there is no decomposed manure available) III. Thorough watering of media, holing and planting ■ Discuss the need to drench the potting media in water. ■ Demonstrate proper driving of holes in the middle of the potted planting media and the proper planting of wildlings.	6 hours	Call a random participant to demonstrate how to wrap the wildlings in a banana bract. Call a female then a male participant and let them replicate the steps in pruning the wildling. Make rounds to ensure that the pruning of the roots and leaves of the wildlings is correct. Always reiterate the proper way of potting the wildlings and for emphasis, always emphasize that the wildlings' roots should be in full contact with the potting media or they will die. The trainer should make rounds and check if the steps mentioned on page 33 of this manual are followed for wildling preparation and pages 10 to 16 of *Tree nursery establishment: a training manual* for the construction of the wildling recovery chambers.

Activity	Time allocation	Learning check
IV. Bulding and sealing of recovery chambers ■ Demonstrate the proper way of folding the PE sheet over the wildling recovery chamber within the canals to ensure snug fit. ■ Demonstrate how to look for holes or tears in the PE sheet over the recovery chamber and how to patch it with narrow, clear tape. Mention that wide, clear tape will cause the PE sheet to have more tears and will deform its surface over time.		
Wrap-up I. Discuss when and how to open the recovery chamber and proper way of using a narrow, clear tear to seal tears (page 36 of this manual). II. Summary of the discussion on wildings and activities in the practical session **Group activity:** Let a representative from each group summarize what they have done during the practical activity.		
Open session (Q&A)	25 minutes	Check for questions and clarifications.
Evaluation	15 minutes	Translate into the local language, if possible.

Remarks: To save time, build the shed and the plots and prepare the materials 2–4 days before the training. If possible, collect the wildlings on the day of the training.

Materials and tools required in building the wildling recovery chamber

The following materials will be used for the establishment of three wildling recovery chambers, spaced 2 ft (50 cm) from each other.

1. One hundred and nineteen (119) pieces of bamboo cut into the following lengths and widths.

Number of pieces	Width/size	Length	Function
6	Whole	10 feet	Plot
6	Whole	3 feet	Plot
50	1-inch wide slat	1 foot	Plot support/stabilizer
4	Whole	8 feet	Post/Shade
2	Whole	17 feet	Beams (roof)
6	Whole	15 feet	Purlins (roof)
9	2 inches	3 feet	Recovery chamber arch support
9	1-inch slat	6 feet	Recovery chamber arch (fresh culm)
15	1-inch slat	10 feet	Recovery chamber arch support (vertical)
12	2-inch slat	3 feet	Recovery chamber arch (vertical)

2. Three sheets of UV-treated PE: 6-m-long per sheet
3. Two pieces double-layer shade net (60% shade): 15 ft long per piece (roof)
4. One piece double-layer shade net (60% shade): 25 m long (outer area covering)
5. Quarter kilogram #2.5 GI nails
6. Quarter kilogram #1.5 GI nails
7. One roll of twine
8. Rooting hormone (Alpha Naphthalene Acetic Acid (ANAA); Indole-3 Butyric Acetic Acid (IBAA)
9. Five thousand (5000) pieces plastic potting bags: 2.5” x 2.5” x 8”
10. Collected wildlings

Tools

Four or more sharp bolos, 4 shovels, 2 hammers, 2 sledgehammer, 2 steel tapes, 2 pick mattocks, 2 crosscut saws, 1 posthole digger, 1 crowbar, 12 pruning shears

Glossary

Affinity. The compatibility between aerial and rooting parts of a grafted tree that allows it to grow into one plant later on

Air-dry. Reducing moisture of seeds by putting it under a shaded area to allow contact with unheated air

Bole. The main stem or trunk of a tree that is of sufficient size to yield lumber

Budwood. A shoot of a plant bearing buds used for grafting

Crown. All the aboveground structures of a woody plant that includes branches, leaves, and reproductive structure

Defective seeds. Seeds that show flaws such as rot, discoloration, and physical injury that could negatively affect its ability to sprout or grow into a healthy plant

Dehiscent. Dry fruit types (i.e. pods, capsules) that burst or split open upon maturity

Drupe. A simple fleshy fruit that contains a single seed. The outer layer of the ovary wall is thin, the middle layer is thick and fleshy, and the inner layer is a hard pit

Felled trees. Trees that are cut down

Fodder. Coarse or dried plant given to livestock as feed

Fodder tree. Trees that are easy to grow, require little land, labor, and capital that primarily serve as source of feed for livestock

Forest stand. An area mainly covered by trees and its undergrowth

Fronds. Often large and finely-divided leaf or leaf-like part of ferns and certain palms

Genetic gain. The improvements on observable characteristics of the mother tree

Germination. The stage where a seed starts to grow and produce a shoot or seedling when the conditions are right

Germination test. Tests that are done to seedlots to determine and compare its maximum germination potential. It also indicates whether or not the seedlot is able to develop into satisfactory plants under right conditions in the field

Graft union. The part where the scion and the rootstock meet and are bound together

Hesperidium. A modified berry resulting from a single ovary that has tough, leathery rind

Indehiscent. Fruit types that remains enclosed even when it reaches maturity

Moratorium. A delay or suspension of a certain activity or a law

Mother tree. A mature tree exhibiting superior characteristics desired for that certain tree species that makes it a prime candidate as source of planting materials

Mulch. Any material, organic or inorganic, spread or laid over the surface of a soil as a covering to retain soil moisture, improve soil fertility, and suppress weed growth

Nick/nicking. A small cut or notch made on the seed coat that can allow entrance of water inside and start germination process

Orthodox seeds. Usually small to medium-sized seeds, often with a hard seed coat that can be stored for a long time and it can tolerate drying and storage in low temperatures

Outplanting. Moving planting materials from a nursery bed to the field or farm

Pathogen. An organism that causes disease or illness

Pericarp. The layer of the fruit that act as the walls of a matured fruit

Plantation. For this manual, this is a relatively large tree stands of roughly the same age consisting of carefully selected one to two tree species that are actively managed to produce a high volume of the desired forestry product (seeds or wood) in the shortest possible time

Planting material. Seedlings, transplants, cuttings, and wildlings that will be planted out in the field/farm

Pollination. The process where pollen grains from the male parts of a plant goes into the female parts of the plant and triggers fertilization and eventual formation of the seed

Potting media. Organic and inorganic materials mixed in soil in prescribed ratios to maximize its ability to support plants

Progeny testing. A long-term study where the offspring of selected trees that manifest desired characteristics are tested to see if the said characteristics endure through generations

Propagation. The act of producing new plants from parent plants

Propagules. Plant parts where new plants are produced, it can either be seeds or plant cuttings

Provenance. Original source of trees or crops

Ramet. An individual in a group of organisms, trees in this instance, that originated vegetatively from a single ancestor and thus have the same genes

Recalcitrant seeds. Seeds that cannot tolerate drying and storage at low temperatures, therefore can only be stored for a very short period before it loses viability

Roguing. The act of identifying and removing plants with undesirable characteristics from the field/farm

Root collar. The area where the root meets the main stem or the trunk

Root hairs. Hair-like projections on the secondary roots that emerge from the tap root, facilitates absorption of water and nutrients from the soil

Root pruning. The process of cutting long roots to encourage new roots and reduce transplant shock when moving seedlings to new locations

Rootstock. Part of a grafted plant that makes up the stem or trunk down to the roots

Scarification. The process of deliberately inducing openings on the seed coat through mechanical, thermal, or chemical means to encourage germination

Scion. The top part of the grafted plant that consists of the middle the middle of the stem to the leaves, flowers, and other aerial parts. It contains the shoot buds from parent plants that have the desired characteristics for propagation.

Seed coat. The outer protective covering of a seed

Seed dormancy. A state where favorable conditions (adequate moisture, light, space, and air) for seed germination are prevented until treatments are applied to break it

Seed extraction. The process of carefully removing the seeds from its fruits through manual or mechanical means

Seed orchards. Tree plantations consisting of clones or seedlings from rigorously tested and selected trees for early abundant production of seed and to promote balanced, random mating. Seed orchards supply certified seeds by seed certifying bodies (e.g. Bureau of Plant Industry, etc)

Seedling height to stem diameter ratio. A unitless ratio that indicates the sturdiness of a seedling. A ratio higher than 6 is undesirable as it indicates a spindly seedling

Seedlot. A batch of seeds of the same species often collected from the same location

Sun-dry. Reducing moisture of seeds by spreading it under the sun to allow drying by prolonged exposure to the sun's heat

Surfaced-sterilized. Spraying, dipping, and other forms of contact of a seed to a chemicals that can kill disease causing microorganisms such as hypochlorite solutions

Syncarp. A fruit formed when many ovaries of flowers fuse together and become one fruit; also called multiple fruit

Tap root. The root that extends from the main stem of the seedling. It is where the fine root hairs emerge

Timber. Wood material which include standing trees in a form suitable for construction, carpentry, joinery, or reconversion for manufacturing purposes.

Turgor pressure. The pressure exerted by the plant's cell content against its cell wall. Loss of this pressure will lead to plant wilting (also called hydrostatic pressure)

Unclassified seeds. Seeds sourced from uncontrolled general collection areas that have little to no records on the information needed to ascertain its quality

Vegetative parts. Plant parts that are not directly involved in sexual reproduction of plants such as include roots, stems, shoot buds, and leaves. These parts are used in forms of vegetative propagation such as grafting and marcotting.

Vegetative propagation. The method where vegetative parts of a plant with desirable characteristics are cut and nurtured to produce new plants that carry the same characteristics

Viability test. Set of tests that measure the percentage of seeds that are alive and could develop into plants which could reproduce, given proper conditions

Wildling. Planting stocks that grew within the forest without any human intervention

Wood density. The amount of wood in a unit. A tall timber tree with a straight trunk with a big diameter that is free of pest, disease, and growth defects will have a higher wood density.

Further Reading

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