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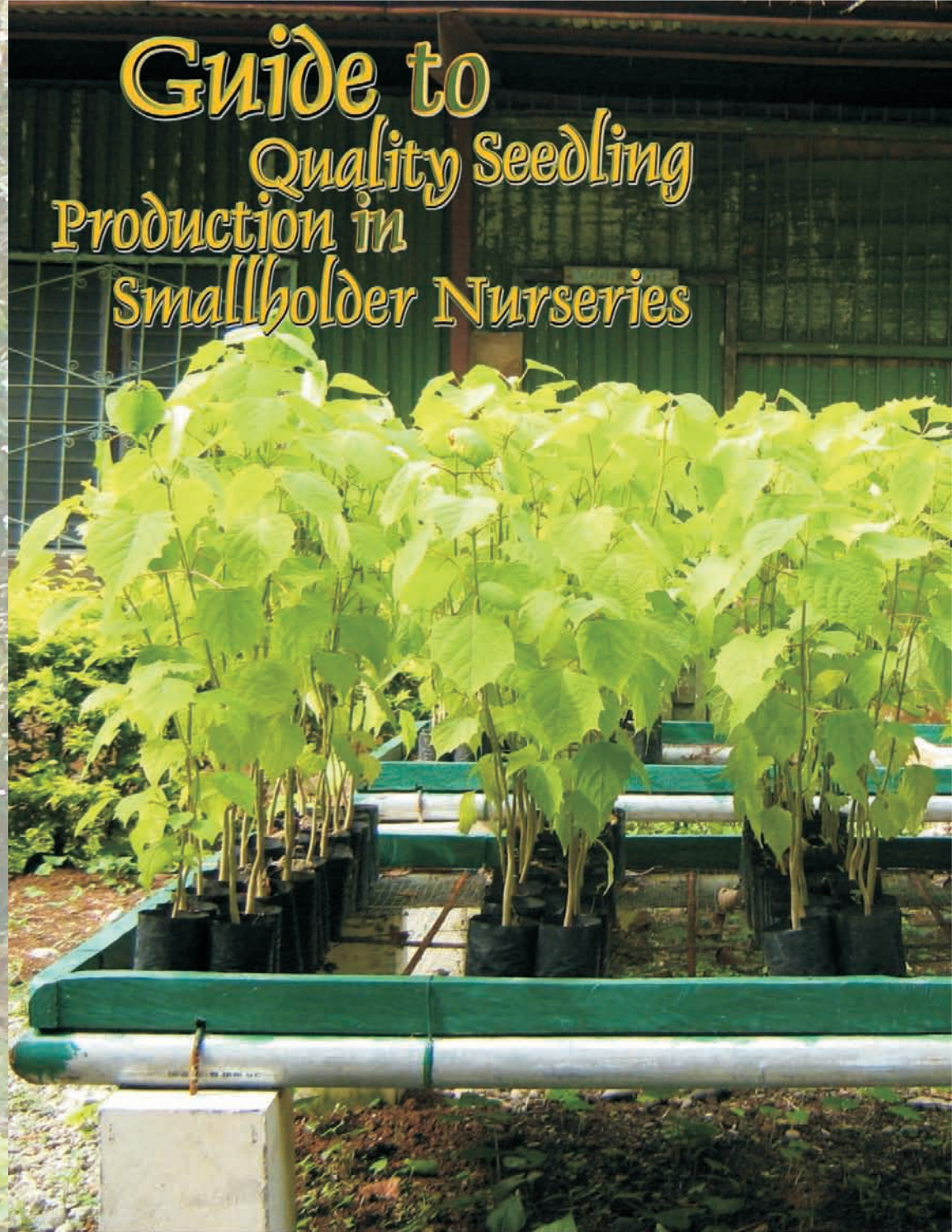
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Guide to Quality Seedling Production in Smallholder Nurseries



Nestor O. Gregorio • John L. Herbohn • Steve R. Harrison

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N.O. Gregorio, J.L. Herbohn and S.R. Harrison

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Enhancing Tree Seedling Supply via Economic
and Policy Changes in the Philippine Nursery Sector (Q-Seedling Project)
Visayas State University
College of Forestry and Natural Resources
Baybay City, Leyte**

2. Do not put much organic matter to the germination medium. Likewise, organic matter should be free from fresh animal waste such as chicken dung, goat dung and cattle manure.
3. When sowing, do not place seeds too close to each other.
4. Sterilize the germination medium and water used for watering the seeds. Otherwise, fungicide should be applied regularly.

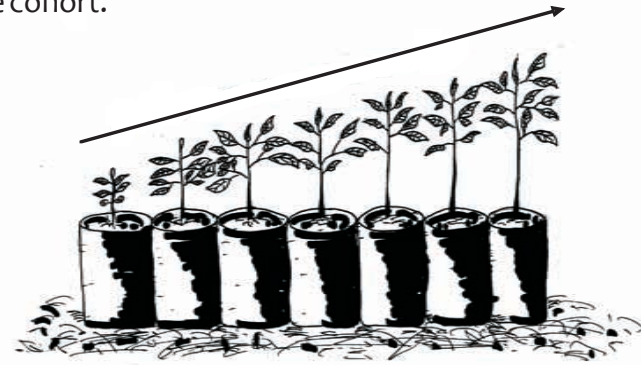
Larvae of insects are the common pests that attack young seedlings while ants and rodents are the usual menace for seeds. Whenever feasible, pick up the larvae, otherwise, spray them with insecticides. Likewise, fence the seedbed and seedboxes with a screen to protect these from rats and other domestic animals.

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◎ Grading and Culling

A batch of seedlings will not grow at the same rate, some will overgrow others. Arranging seedlings according to height or 'grading' will provide sufficient space for smaller seedlings to receive ample sunlight and water to improve their growth. If seedlings on beds are not graded, the shorter seedlings will be overtopped with taller seedlings and become more deprived with sunlight and water, leaving them unsuitable for planting together with the rest of the seedlings in the cohort.



It is inevitable that in a seedling cohort, a few will exhibit very poor growth even though they are given the necessary treatments. These seedlings must be culled from planting. Page 4 of this manual illustrates the seedlings that must be discarded.

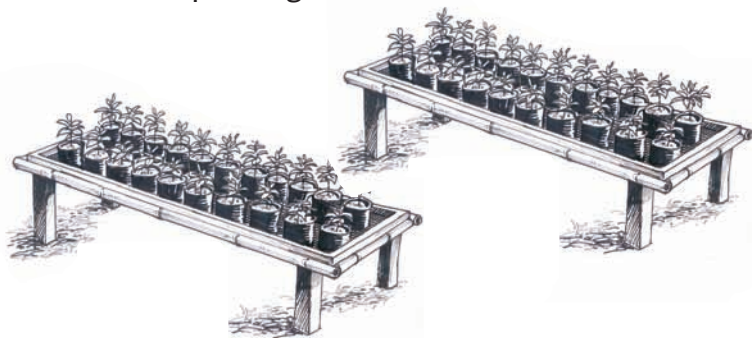
◎ Control of Pests and Diseases

Damping off is the most common disease of seeds and seedlings in the nursery. Seedlings with damping off have rotten portion at the base of the stem causing the seedlings to topple down and die. Seeds with damping off will rot, thus fail to germinate. Damping off is mostly caused by fungi, thus can be treated by applying fungicide. The following are some practices that will minimize the occurrence of damping off:

1. Make sure that the germination medium has good drainage to facilitate the flow of water and movement of air within the medium.

◎ Hardening-Off

Trees are mostly planted in adverse sites characterized by having low soil moisture and fertility, and expose to intense sunlight. To avoid the shock of being exposed to adverse growth conditions, seedlings must undergo the hardening-off process. Hardening-off can be best facilitated when seedlings are raised off the ground. Elevating seedlings prevents absorption of moisture from the ground. It also promotes aerial pruning, thus preventing the development of long taproot that will penetrate into the ground causing severe stress to seedlings when lifted for transplanting.



Hardening-off can be done by controlling:

1. Watering — reduce the frequency of watering and the amount water applied to the seedlings. If possible take the seedling to its wilting point such that shoots will begin to wilt before watering. However, care should be taken not to expose the seedlings to too much wilting that it could not recover anymore and will result to shedding off of leaves. Controlling the watering will accustom the seedlings to limited soil moisture on the field.

2. Shading — shade must be removed a month before planting the seedlings. This will prepare the seedlings from direct exposure to intense sunlight in the planting site. If seedlings are not accustomed to full sunlight, sun scalding of leaves will occur immediately after planting, which will result to mortality.

3. Root pruning — done to prevent the growth of long taproot and encourage the development of young fibrous roots but should be stopped two weeks before planting

4. Fertilizing — the frequency of application and amount of fertilizer applied must be reduced. Fertilizer application must be stopped two to three weeks from planting.

INTRODUCTION

The quality of planting stock is a major factor that determines the success of tree farming. The survival of trees, growth performance, length of rotation period and volume and quality of timber that can be harvested from a plantation are greatly influenced by the quality of seedlings used. Seedlings coming from a nursery should be of high quality and the nursery operator should focus on raising high quality seedlings rather than on the number of seedlings produced. It is better to produce fewer seedlings of high quality rather than to produce many seedlings of low quality. Unfortunately, in the Philippines, private and government nurseries consider the quantity rather than on improving the quality of seedlings.

Seedling quality refers to genetic and physical characteristics. Genetic quality relates to the genetic characteristics of the source of germplasm, while physical quality refers to the physical condition of the seedling as it is raised in the nursery. The physical quality of seedlings can be improved by good practice within the nursery but there is no quick fix to improve seedling genetic quality. Producing seedlings of high physical quality can be carried out when the seedlings are in the nursery, while raising seedlings of high genetic quality requires the application of appropriate technologies prior to the production of seedlings in the nursery. Improving the seedling genetic quality requires a long-term process of mother tree selection and an appropriate germplasm collection procedure.

This “Guide to Quality Seedling Production in Smallholder Nurseries” demonstrates and discusses the simple procedures and smallholder-based technologies for producing high quality seedlings or “Q-seedlings”. This guide is designed to assist nursery managers in improving the quality of seedlings they produce. The technologies included are taken from various sources including the research output of ACIAR assisted project SST 96/110 *Tree Production Technologies for the Philippines and Tropical Australia*, research and development results of the Department of Environment and Natural Resources (DENR), findings of the recent nursery industry surveys in Leyte and Mindanao, and various publications on nursery seedling production.

Why Quality Tree Seedlings?

The quality of seedlings has a profound effect on the growth performance of planted trees. A low quality seedling is not worth planting because it will always produce a low quality tree, even if it is provided with the appropriate silvicultural treatments and planted in an appropriate site. Further, the plantation maintenance cost of low quality seedlings can be high due to high mortality and more intensive management requirement.

On the other hand, a high quality seedling provides minimal plantation cost because of low seedling mortality and the less intensive management needed. Further, the planting of high quality seedlings provide early return on investment because they have more rapid growth, thus rotation age is shortened. If farmers are particular about choosing the best germplasm of agricultural crops such as corn and rice, the more that they should be selective about the quality of tree seedlings to plant. Most agricultural crops can be harvested in a few months such that any mistake in the selection and use of germplasm can be rectified in the next cropping season. Trees, on the other hand, would require several years before they could be harvested. Thus, the mistake of planting low quality seedlings will also take several years before this can be corrected.

The following are examples of advantages of high quality seedlings compared with low quality seedlings:

HIGH QUALITY SEEDLINGS	LOW QUALITY SEEDLINGS
1. Low Mortality	1. High Mortality
2. Low Plantation Maintenance Cost	2. High Plantation Maintenance Cost
3. Shorter Rotation Period	3. Longer Rotation Period
4. High Timber Recovery	4. Low Timber Recovery
5. High Timber Quality	5. Low Timber Quality

The tedious root pruning activity can be avoided if pots are placed on a rack of poles or screen to prevent them from resting on the ground. When roots come out from pots, these will die through air pruning. Elevating the seedlings will also facilitate the hardening process as the availability of water and nutrients to the plants can be controlled.



● Weeding

Weeds compete seedlings with moisture, nutrients and sunlight. Weeding should be done regularly before weeds will outcompete the seedlings. Removing weeds on pots can be done by handpicking or by using hand tools. Weeding should be done carefully not to damage the seedlings as these could be uprooted together with the weeds.



● Fertilizing

The application of inorganic fertilizer may not be necessary if the potting mix contains high amount of nutrients to support the seedling growth. It is easy to scorch the seedlings, thus fertilizer application can damage the seedlings if not done correctly. If it is necessary to apply fertilizer, a cheap material can be Urea. This is a source of nitrogen which is an essential nutrient for the vegetative growth of seedlings. One teaspoon of Urea dissolved in four gallons of water could be applied during watering.



◎ Root Pruning

Cutting of root that are coming out from the seedling container is essential to prevent the roots from penetrating into the ground. If the taproot grows deep into the ground, lifting the seedlings immediately before planting will cause severe stress to the seedlings, which will increase the risk of seedling mortality. Also, taproots penetrating into the ground will hinder the hardening process because even if water and nutrient application is reduced, the roots will continue to absorb moisture and nutrients from the soil.

Root pruning can be done by cutting the roots that come out from the seedling container using a scissor or knife. If the outgrowing roots are still very young, these can be rubbed off by hands.

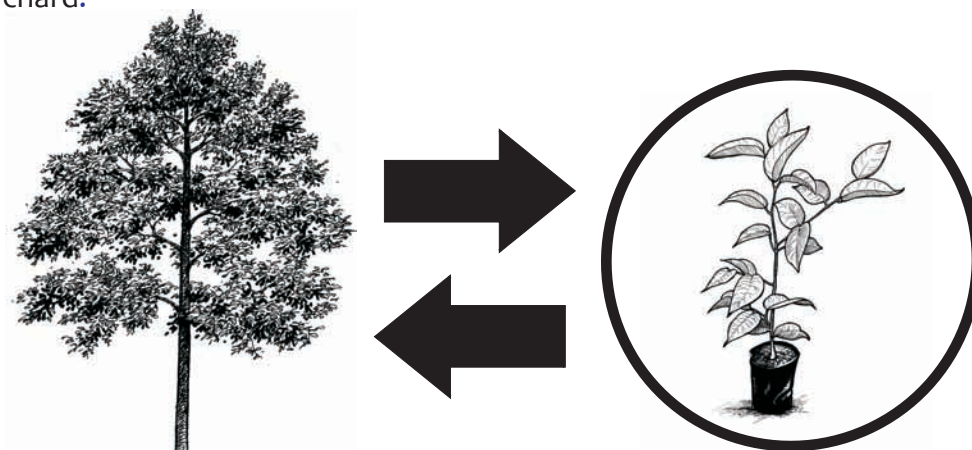


It is necessary to carry out a regular checking so that root pruning can be carried out while the outgrowing roots are still very young. After cutting the roots, the seedlings should be watered as they may be stressed. Root pruning should be avoided two weeks before planting as seedlings may not be able to recover from the stress before they are planted.

WHAT IS SEEDLING QUALITY?

The quality of seedling is based on two aspects, physical and genetic. Physical quality is basically reflective of the nursery seedling cultural practices, and is exhibited by seedling height, root collar diameter, health and root form.

Genetic quality refers to the genetic characteristics of seedlings as a result of practices including the collection of germplasm from selected sources such as phenotypically superior seed trees, a seed production area and seed orchard.

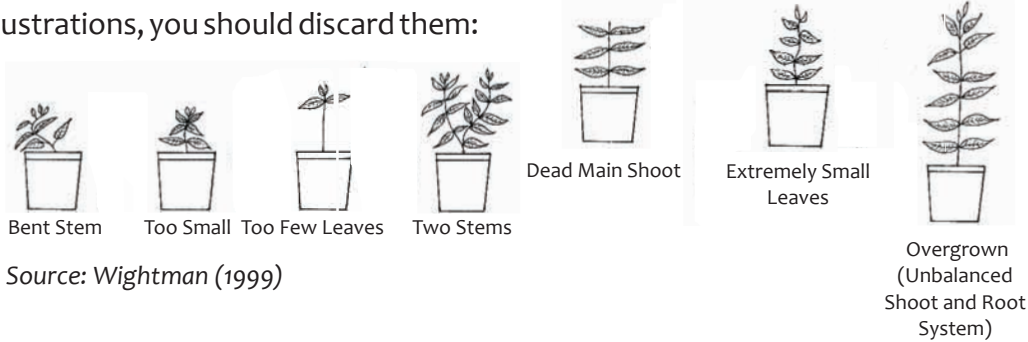


A high quality mother tree will produce high quality seedling. Likewise, a high quality seedling will produce a high quality tree.

A high quality seedling has the following characteristics:

1. Grown from seeds or wildlings collected from genetically and phenotypically superior mother trees or trees from seed production areas or seed orchards.
2. Healthy, free from diseases and with dark green leaves.
3. Sturdy stem and with relatively large root collar diameter.
4. Root system that is free from deformities, dense with many fine fibrous hairs with white root tips.
5. Balanced root and shoot mass.
6. Fully hardened, accustomed to full sunlight and reduced water few weeks prior to outplanting.

If any of the seedlings in your nursery are similar to the following illustrations, you should discard them:



Source: Wightman (1999)

A high quality seedling must have healthy root system with many fibrous roots and be free from deformities.



— A good root system free of deformities with straight taproot. Notice the many fine root hairs that are important for the absorption of water and nutrients.

Seedlings with root system similar to illustrations below should not be planted.



— A deformed root system caused by poor pricking out. Notice that the roots are curled like letter J close to the surface of the container.



— Another deformed root system caused by poor pricking out. Here the main roots were stuffed into a hole too small and the roots were twisted upwards. As the roots began to grow downwards, they formed a complete loop.



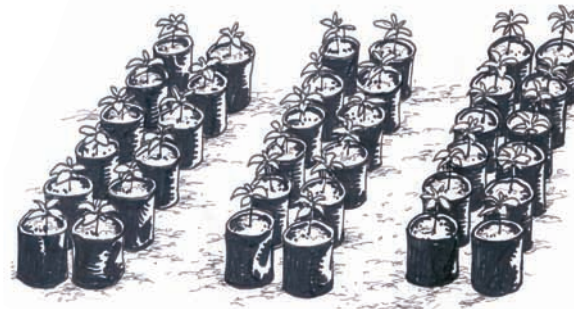
— A spiraled root system caused by the smooth surface of the bag. Notice that the roots are coiled at the bottom of the bag.

Normally, about 20-30% of seedlings raised in the nursery will exhibit poor physical quality. Accordingly, there should be an allowance of 20-30% more seedlings than the quantity of seedlings required. Low quality seedlings must be discarded and should not be used for field planting. It is more expensive to maintain a poor quality seedling in the nursery and it is not worth spending resources for planting low quality seedlings in the field. Poor quality seedlings will not give high net financial returns of investment.

A common practice which is over-watering should be avoided because it will result to etiolated seedlings and promote the spread of diseases caused by fungi and bacteria. The best time to water seedlings is early in the morning and late in the afternoon. If the top of the potting medium is overgrown with moss and weeds, break up the surface using a stick or a hand tool.

◎ Spacing

As seedlings grow approximately 10 cm tall, the shoots will become crowded and prevents most of the leaves to receive sufficient sunlight necessary for growth. Before this happens, seedlings on transplant beds should be spaced. Spacing will not only allow seedlings to receive sufficient sunlight but also facilitates counting and monitoring for seedlings attacked by pests and diseases. Spacing can be done by leaving approximately 5 inches of space in between two or three rows of seedlings in pots. To prevent the pots from toppling down, a piece of wood or a bamboo stem can be placed on the space in between rows.



Seedlings spaced appropriately

Crowded seedlings should be avoided





Natural shade from standing trees in the nursery can also be used. However, if seedlings are placed under standing trees, regular pruning should be done to allow seedlings to receive ample sunlight.

◉ **Watering**

There is no exact regime for watering as this varies according to the species of seedlings, type of potting mix, seedling age, size of pots and the weather. Watering can be done by overhead application using hose, cans and sprinkler. For tender and small seedlings, water can be applied using sprayers/or a very small hose.



To produce high quality tree seedlings, a forest nursery is needed. A forest nursery is a place where seedlings are raised either from seed or from any other part of the mother plant.

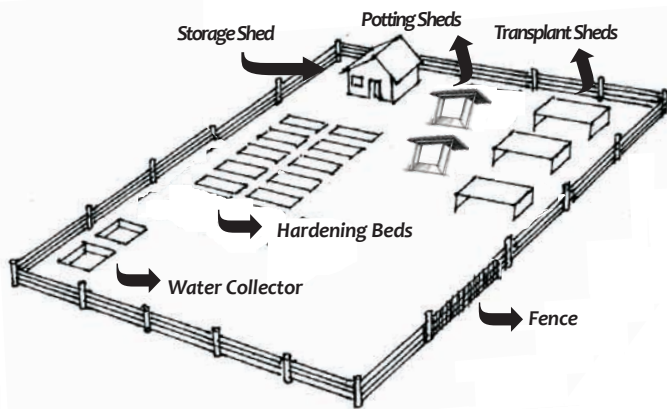
Why is there a need to establish a forest nursery?

1. Flowering and subsequent seed production of most species are irregular.
2. Inapplicability of direct seeding.
3. Nurseries provide maximum care of the planting stock.
4. Take advantage of the abundance of germplasm during seed year.
5. Best and vigorous seedlings are produced in nurseries especially when best seeds are used.

Factors to consider in selecting a nursery site

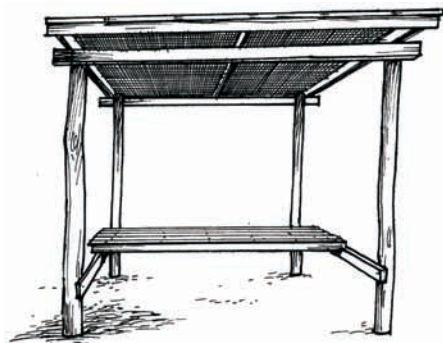
1. Soil — choose a site that has a light sandy loam or loamy sand foundation and rich in organic matter.
2. Freedom from weeds — put up nursery in a weed-free area or remove weeds before constructing the nursery. Weeds serve as home for pests and diseases that may attack your tree seedlings.
3. Exposure and aspect — nursery should be fully exposed to sunlight; should have a gentle slope (5%); should not be exposed to strong winds; and seed beds and transplant beds should be aligned in the East-West direction to maximize exposure to sunlight.
4. Accessibility — it should be centrally located to avoid long distance for transport of seedlings; with accessible by foot or by vehicle.
5. Water supply — the nursery should be near a water source.
6. Size of the area — the nursery should be large enough to accommodate the necessary structures in the nursery.

A nursery could be established following this layout. A nursery should have structures including the potting shed, transplant shed, germination shed and hardening beds. A bunkhouse may be needed for storing nursery equipment and fence could be established to protect the seedlings from stray animals.



Example of a Nursery Layout

Structures Needed in a Small-Scale Nursery



● Germination Shed

Seed boxes with newly sown seeds are placed in the germination shed to protect the seeds from too much sunlight, damage from raindrops, stray animals and insects. Ideally, a germination shed must have a plastic roofing to allow some sunlight to penetrate yet protect the seeds from being dislodged by rain.



● Potting Shed

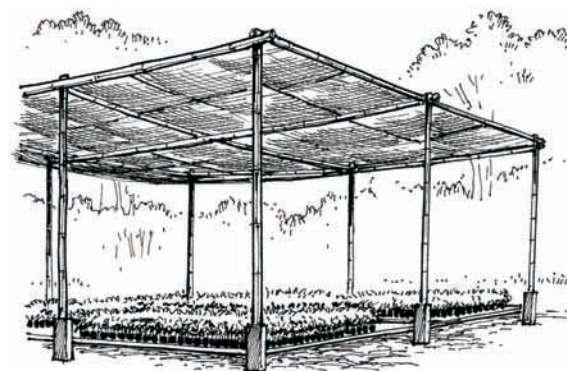
Seedling containers are filled with potting media in the potting shed. A potting shed should have a roof to prevent the potting medium from getting persistently waterlogged. The floor should be dry, free of weeds and flat for the pots to stand after filling. The area of the shed should be sufficient enough to allow piling of the filled pots and stocking of the potting materials.

SEEDLING MAINTENANCE ACTIVITIES

Appropriate care of seedlings in the nursery is crucial for seedling survival and growth after outplanting. Important maintenance activities for seedlings in the nursery include shading, watering, spacing, root pruning, weeding, fertilizing, hardening off, grading, culling and control of pests and diseases.

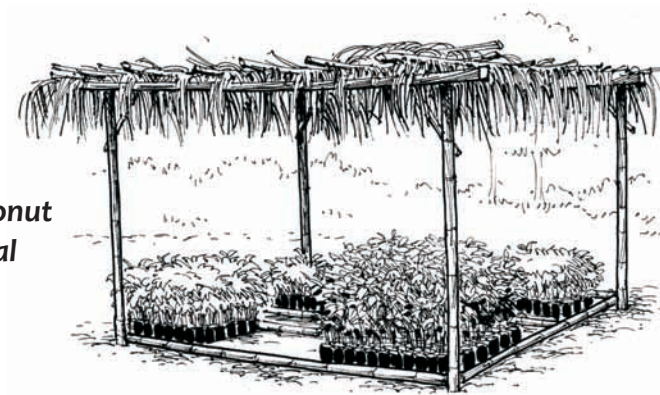
● Shading

Shading is essential for newly potted seedlings. During the first week from potting, it is essential that seedlings will be under 70% shade. When new leaves develop, shade should be removed gradually. Fish nets, plastic sheets or coconut leaves can be used as artificial shade materials.

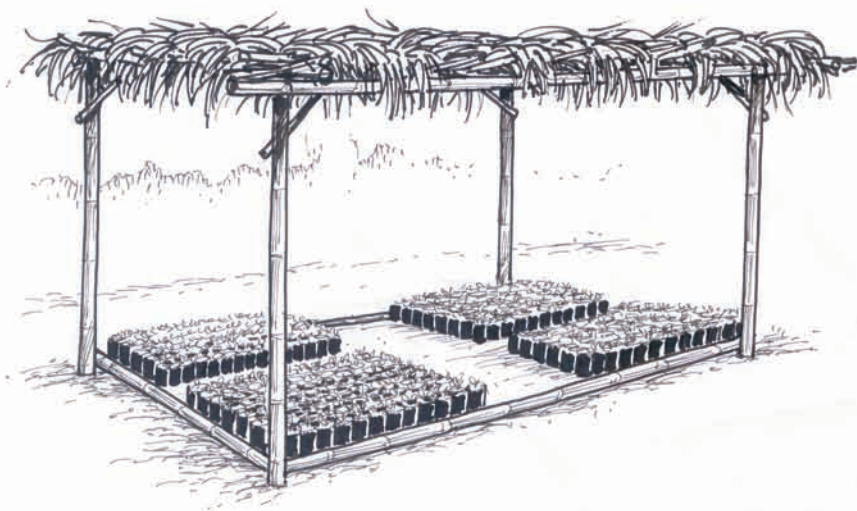


Transplant shed with fish net as shade material

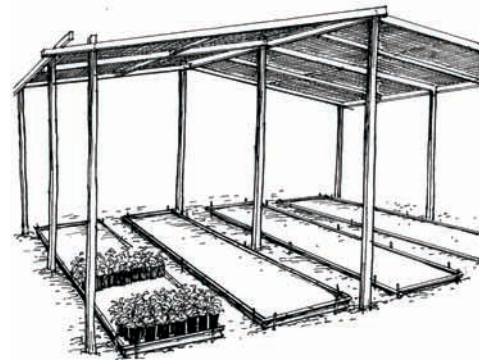
Transplant shed with coconut leaves as shade material



8. Water the seedlings immediately after planting and keep the medium moist for the next three days but take care not to overwater to prevent waterlogging and damping-off outbreak.
9. Place the newly potted seedlings on the transplant bed under a shade (about 70%) for few days. When new leaves have developed, the shade must be removed gradually.



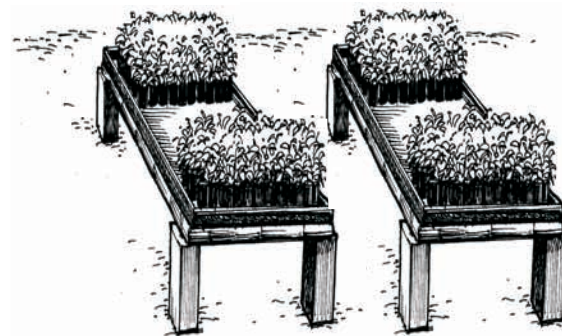
☉ **Transplant Shed**



After transplanting the seedlings from germination boxes or seedbeds to individual containers, seedlings are placed in the transplant shed. A transplant shed should have a cover to protect the young transplants from intense sunlight but with sufficient transparency to allow some sunlight to reach the seedlings. The cover must also allow rain to pass through.

However, for species with very small seedlings like bagras (*Eucalyptus deglupta*), transplant shed should have a plastic roof to prevent the seedlings from dislodging due to raindrop action.

☉ **Hardening Bed**



Seedlings must be made ready for adverse conditions of the planting site prior to planting to make them sturdy and hardened. Hardening includes exposing the seedlings to full sunlight, reduction of the frequency of watering and fertilizer application, and root pruning. In the nursery, the

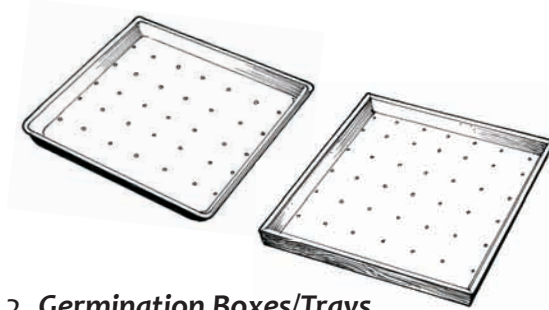
hardening area therefore should be free from shade to provide the seedlings full exposure to sunlight. To control the moisture available to plants, it is ideal to elevate the seedlings by placing them on a structure that prevents the pots from resting on the ground. A screen or a bed with bamboo slat floor will serve this purpose. Aside from regulating the moisture available for seedlings, elevating seedlings will promote aerial root pruning. Root pruning will prevent the taproot from penetrating into the ground, which is detrimental when seedlings are lifted for transplanting. Preventing the growth of long taproot will enhance the development of root hairs, which are essential for the early stage of seedling development when outplanted.

Common Tools and Materials Needed in the Nursery



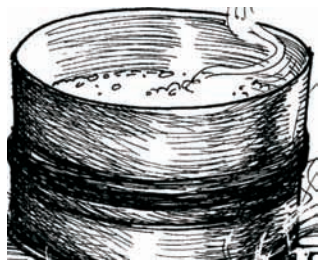
1. Pruning Shears

— for pruning long taproots that grow outside the seedling pot



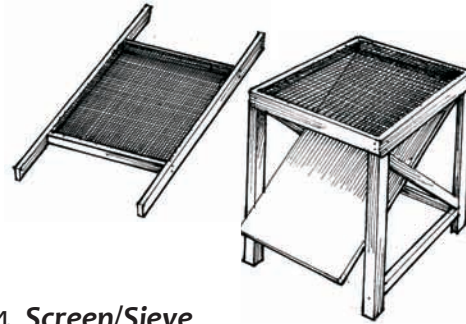
2. Germination Boxes/Trays

— for sowing small to medium-sized seeds



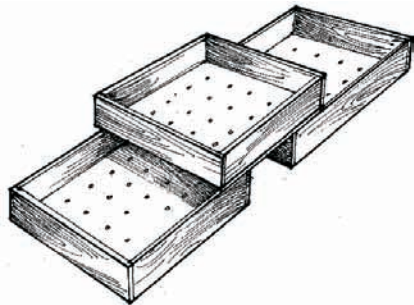
3. Sterilization Pan

— for pasteurizing Germination media



4. Screen/Sieve

— for sieving germination and potting media



5. Boxes

— for carrying seedlings within the nursery

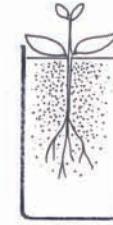


6. Hose/Sprinkler

— for watering seedlings

The following are common mistakes in potting and must be avoided:

- Hole too deep, resulting in the plant being half buried.



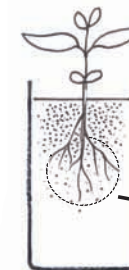
- Hole too shallow, the plant will desiccate rapidly.



- Hole too shallow, resulting in the roots being bent. The growth of the plant will be permanently retarded. Furthermore, plants with this defect will be prone to windthrow when planted out in the field.



- Air pockets left around the roots; this will cause rapid desiccation of the plant.



Air pockets

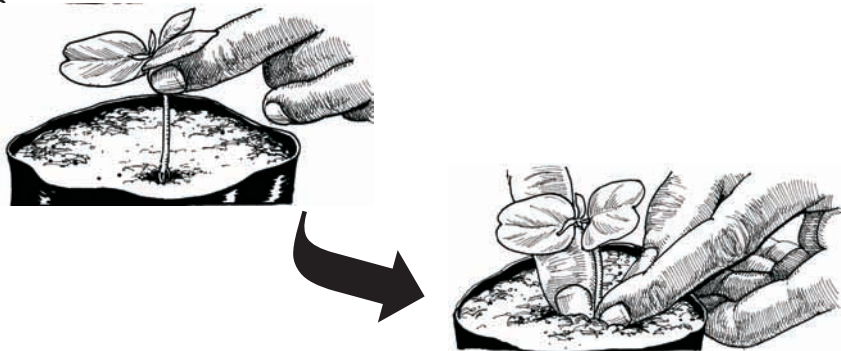
- The volume of seedlings to be lifted at one time should be enough to be planted within 15 minutes. Otherwise, seedlings will die due to desiccation.
- When lifting, seedlings should be held at the terminal leaf, not at the stem.



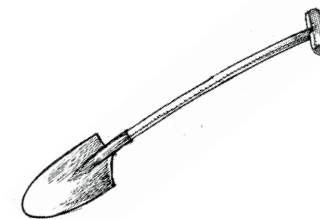
- Using a small stick, make a hole in the potting medium. The hole in the potting medium should be enough to accommodate the root system without bending the taproot to avoid root deformation particularly J-rooting. If necessary, the taproot must be cut. Root pruning is particularly necessary when wildlings are used.



- While holding the seedlings at its terminal leaf, insert the root system into the hole and cover the hole gently with the potting medium and carefully firm the potting mix to prevent air pockets left around the roots



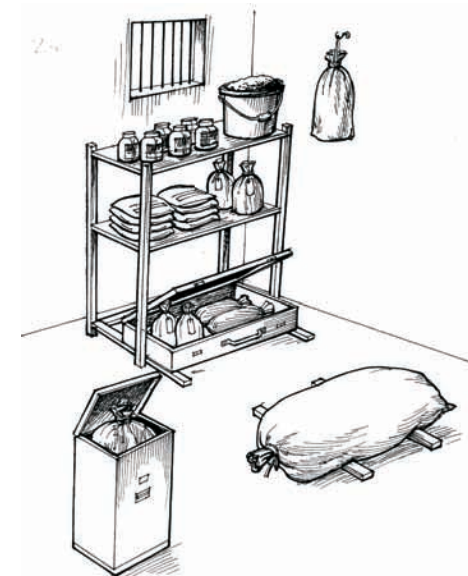
- Sprayer**
— for spraying chemical controls to pests and pathogens



- Shovel**
— for mixing potting media



- Hand Spade**
— for mixing germination media



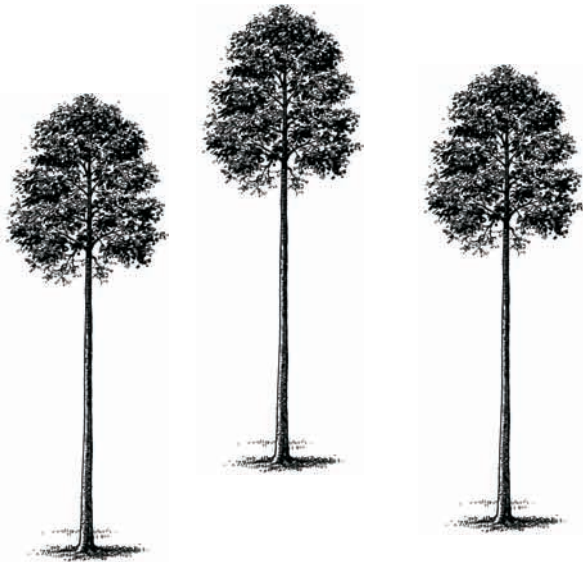
- Seed Jars and Seed Sacks**
— for storing seeds

The source of germplasm and collection methods greatly affect the seedling quality. Germplasm used in private and public nurseries in the Philippines comes from sources including seed trees, seed stands, seed production areas and seed orchards.

Sources of Germplasm

◎ Seed Trees

These are individual trees from which a seed or a wildling is collected. This is regarded as the most common source of germplasm for smallholder seedling production. Seed trees may be in natural forest or plantations and must have superior physical characteristics including straight and single stem, few branches, mature to produce an ample quantity of seeds and belong to the dominant or co-dominant trees in the site. Below is an illustration of ideal seed trees for timber species.

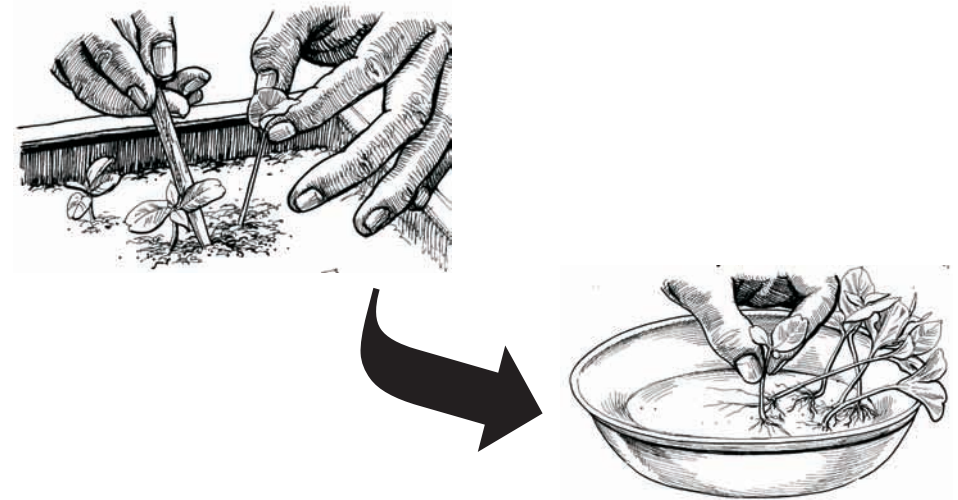


Seed trees with ideal physical characteristics

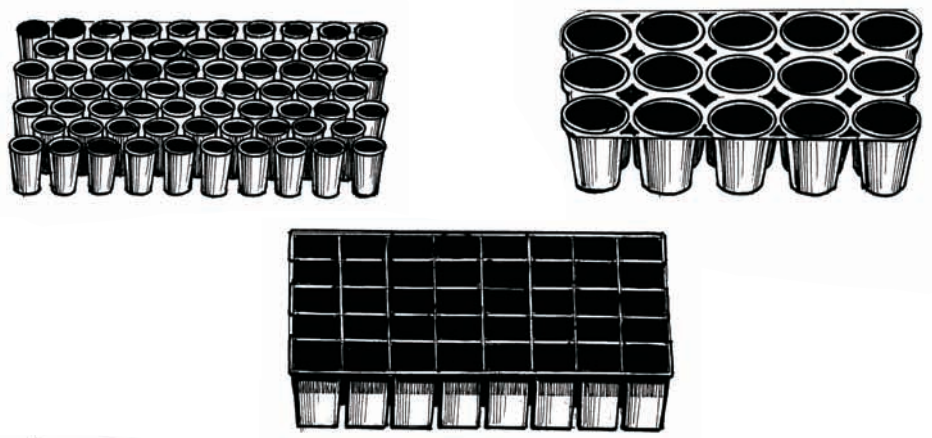
Potting

Potting or pricking out is transplanting seedlings from germination boxes and seedbeds to individual pots. This is considered as the most delicate operation of seedling production because very young seedlings are tender and improper potting will damage the root system. The following conditions should be observed during pricking out:

1. Water the pots and germination trays/seedbeds before lifting and planting the seedlings.
2. Prick early in the morning and late afternoon as the solar radiation is not so intense to damage the young seedlings
3. Lift seedlings from germination media with a flat stick and place them in a shallow bowl of water to prevent wilting.



Materials that can be used as seedling containers include polybags and waste materials such as juice tetrapacks and cans. Indigenous materials such as bamboo stem sections and abaca sheath can also be used. For best result, containers with root trainers such as hiko tray is recommended. The ridge lines on the inside wall of the hiko tray prevents the roots from curling.



Examples of hiko trays

If a polybag is used, it should have at least six holes on the bottom. During filling, press the two bottom corners of the bag towards the inside to circle and flatten the bottom. This facilitates the bag to stand in an upright position.



The size of the container depends on the species and the length of time the seedlings will stay in the nursery. As a general rule, larger containers are used for bigger seeds. For most timber species, a 4 inches by 6 inches or 3 inches by 7 inches bag is usually used.

◎ **Seed Stand**

These are groups of trees in plantations or natural forest. Trees are identified to have superior physical characteristics similar to individual seed trees. Seed stands are managed for seed production but the management practices are not geared towards improving the quality of germplasm from the stand. Rouging or removal of inferior trees in the stand are not done.

◎ **Seed Production Areas (SPA)**

These are groups of trees in plantation or natural forest that are improved for seed production. Rouging is done by removing low quality trees and those attacked by pests and diseases. Thinning is also carried out so that trees are uniformly spaced. The stand is isolated from possible pollination by poor quality trees of the same species from adjacent stand by cutting the adjacent trees within 200 meters radius from the SPA.

◎ **Seed Orchard**

These are stands established for a specific purpose of seed production. Trees are obtained from families of superior genetic quality and planted at regular spacing to provide sufficient space for seed production. Selective thinning is done to maintain the superior quality of trees in the stand. The stand is isolated from adjacent trees of the same species with those at the seed orchard to maintain the superior genetic quality of the germplasm. Isolation is done by cutting trees of similar species in the orchard within 200 meters from the orchard.

◎ **Unselected Plantations and Individual Trees**

This is the common source of germplasm used for private and government seedling production in the Philippines. Germplasm is collected from individual trees of poor physical characteristics and plantations of trees of unknown genetic quality. Germplasm collected from these sources is of low quality and should not be used for seedling production.

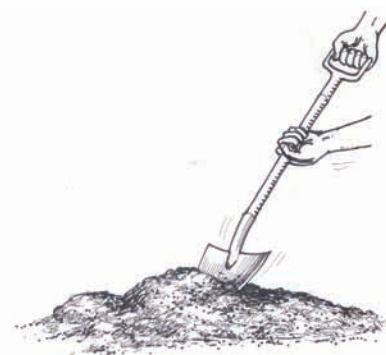
Among the various sources of germplasm, seed orchard produces the highest quality seed, followed by seed production area, seed stands and individual seed trees. Germplasm from unselected sources should not in any way be considered acceptable for the production of seedlings of timber species.

Characteristics of various germplasm sources

CHARACTERS	SEED SOURCES				
	Seed Orchards	Seed Production Areas	Seed Stands	Seed Trees	Unselected Seed Areas
Planting Purpose	Seed Production	Not for Seed Production	Not for Seed Production	Not for Seed Production	Not for Seed Production
Seed Origin	Identified	Identified and Unidentified	Unidentified	Unidentified	Unidentified
Quality of Mother Trees	Selected and Tested Trees	Selected Stands, Thinned, Untested	Selected Stands, Unthinned (or Thinned) Untested	Selected Trees from Unselected Stands	Unselected Trees from Unselected Stands
Seed Quality	Very Good	Good	Fairly Good	Intermediate	Poor

Source: Mulawarman et al. (2003)

Once sieved, mix the potting medium thoroughly before bagging.



Bagging

Bagging is filling the pots with potting mix. To facilitate pot filling, a funnel or a scoop could be used. The potting mix must be dry during potting and pots should be shaken during filling to avoid large air pockets within the potting medium.



The pot should be filled right to the top and let to stand upright on the transplant bed.



Potting Mixture

A good potting mix should be:

1. Free of particles larger than 5mm diameter.
2. Firm enough not to disintegrate around the root ball of the seedlings when it is handled.
3. Friable enough to allow the ready movement of water and air and will not impede the growth of roots.

A good potting mixture is a combination of three parts soil, one part mudpress and one part rice hulls.



Soil

Rice Hulls

Mudpress

The soil supplies nutrients, holds moisture and medium for plant anchorage. The mudpress supplies bulk of the nutrients for the seedlings and rice hulls promote good drainage. If the supply of mudpress is not available, compost, vermicast and other thoroughly decomposed organic materials can be used. A fresh organic matter such as animal manure **should not** be used as part of the potting mix.

The potting medium should be sieved through a 5mm mesh to remove large clods and irregularities including roots and twigs of trees. Screening will also pulverize the medium thereby promoting good aeration and drainage.



Sieving potting medium using a 5 mm mesh screen

Germplasm Collection

Seeds and wildlings are the common types of germplasm used for forest tree seedling production. Planning the germplasm collection is very important. The **purpose** of collecting germplasm should be defined, the **sources** should be identified and the **timing of collection** must be known. Germplasm must be collected from several trees, not from just a single tree to ensure genetic variability.

Seed Collection

Harvesting of seeds is done when most of the seeds or fruits are mature. Most fruits change color upon maturity for example, from green to brown, yellow and black. There are two general methods of collecting seeds — from the tree and on the ground.



Collecting seeds from the ground



Collecting seeds from the tree

Adapted from: Mulawarman et al. (2003)

Seeds of trees producing fine fruits and those with fruits that open at maturity should be collected when the fruit is still attached to the tree. For some species, nets and mats are used to collect the seeds. For large seeded trees, seeds can be collected on the forest floor. Ideally, it is best to collect seeds before they fall from the tree because seeds on the ground are already contaminated with bacteria and fungi that may damage the seeds. Also, when seeds are on the ground, it is difficult to identify the tree where it comes from especially if there are several trees of the same species in the area.

Seed Processing

Processing of seeds is necessary immediately after the seed collection. Seed processing includes extraction from fruit, cleaning and drying.

After the collection, separate the seeds from the fruit. If left unextracted, the sap of thick and fleshy pulp of some fruits ferment and damage the seeds. Seed extraction procedure varies according to species.

- A. Fruits that are sown as seeds itself (e.g. Dipterocarps)
No seed extraction is necessary



Seeds of White Lauan

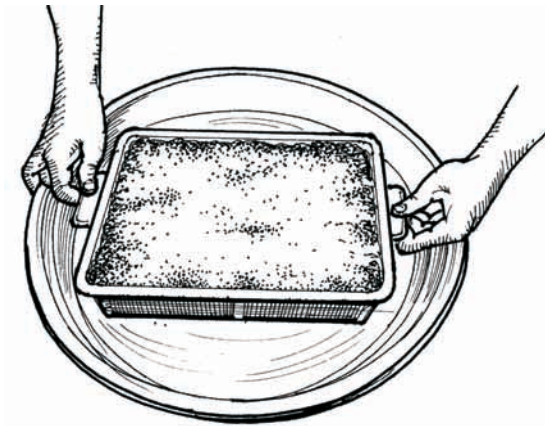
- B. Fruits that open when mature (e.g. mangium, eucalyptus, mahogany, falcata)

Fruits are air dried and spread over a mat, plastic or any material that will collect the seeds once released from the fruit. This is particularly true for fruits with very fine seeds such as eucalyptus. Avoid placing the fruits under direct and intense sunlight and occasionally stir the layer of fruits to facilitate drying.



Fruits and seeds of Mahogany, Mangium, and Bagras

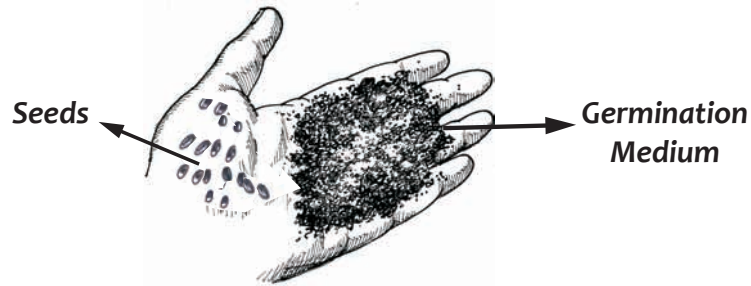
Sub-irrigation method is the most ideal means of watering but is only applicable for seeds sown in seedboxes and seedbeds.



Seeds sown directly in pots should be watered using hose or sprinkler.



As a rule of thumb, the size of the germination medium particles should be smaller than the size of the seed.



When sieved, mix the medium following the appropriate proportion. Fill the germination box and level the medium carefully.



Use the germination medium immediately after the preparation otherwise, place it in a container or cover the filled germination boxes with plastic sheets or cloth to protect the medium from being contaminated with pathogens.

Maintenance of Sown Seeds

• Watering

Watering is the most crucial maintenance activity for sown seeds. It is necessary that seeds will receive adequate moisture all the time. Watering should be done carefully not to dislodge the seeds.

C. Fruits that do not open at maturity (e.g. gmelina, narra, molave, dao)

Extract the seeds by threshing and by using scissors or knife. Fleshy pulp of seeds of gmelina, molave and dao can be removed by placing them in a sack and threshing or placed on a screen and macerating. Threshing and macerating can be facilitated when fruits are soaked in water for overnight.

Seeds of fruits like narra can only be removed by manually cutting the edge of the fruit using scissors or knife.



Gmelina seeds being trampled



Narra fruit cut on the edge

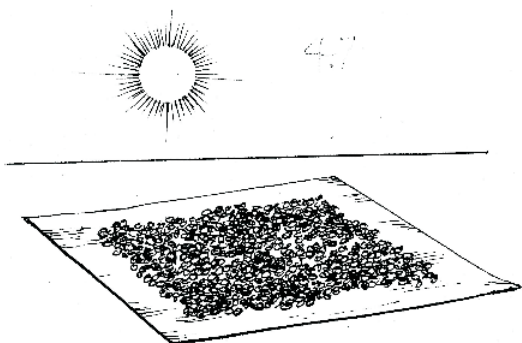
Seed Drying

Seed drying is necessary to maintain viability if seeds will be stored, even just for a short period. The drying process will depend on the type of seed, whether recalcitrant or orthodox.

Recalcitrant seeds must retain high moisture during storage and should not be stored for a longer period, only few days or weeks. Recalcitrant seeds must be wrapped in moist cloth or paper and stored in a moist environment. The seed will lose its viability when it dries completely. Examples of recalcitrant species are jackfruit, neem tree, rattan, dipterocarps, and mahogany.

Orthodox seeds must be dried to a low moisture content before they are stored. These seeds will retain its viability for several years when stored in a cold place or even in a room temperature because drying will let them enter to a state of dormancy. Before sowing, these seeds usually require pre-sowing treatments to break the dormancy. Examples of orthodox species are eucalyptus, kakawate, teak, mangium, narra, falcata, molave, and kalumpit.

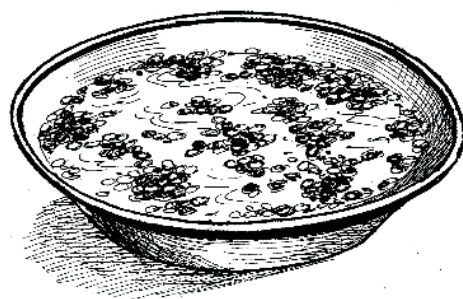
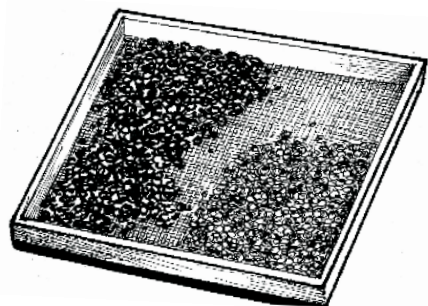
Many orthodox seeds can be sun-dried to reduce the moisture content to the minimum. Seeds are appropriately dry if they are easy to bite, crack or cut and will produce a sharp snapping sound, will make a rustling sound when mixed or shaken and will have a constant weight.



Seeds of Mangium spread on mat and dried under the sun

Seed Cleaning

Before storing, collected seeds must be cleaned to remove irregularities including debris and defective seeds. Seed cleaning can be done either before or after drying. When done after drying, seed cleaning is usually carried out by winnowing and sieving. For some species, defective seeds are removed by immersing seeds in a pale of water. Viable seeds usually sink to the bottom of the container while defective ones will float. Seeds that will float are discarded.



Seeds being sieved and soaked in water



60% Soil



40% Sand

Sterilize the germination medium by heating over fire at 60 degrees for full 30 minutes.

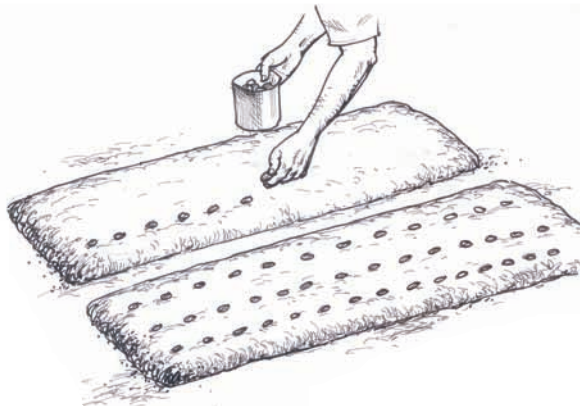


The medium must be dampened (but not sodden) before heating. After heating, let it stand to cool down. Sieve the medium by passing through a screen to remove large clods.



Sowing Seeds in Seedbeds

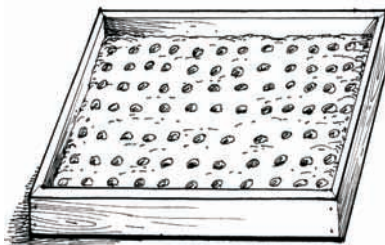
1. Moisten the seed bed.
2. Make straight furrows across the seed bed.
3. Place the seeds into the furrows.
4. Cover the seeds with a thin layer of soil.
5. Cover the seedbed with shading material.



Sowing Seeds in Seed Boxes

The advantage of sowing seeds in boxes over seed bed and direct seeding is that the germination medium can be sterilized. Sowing seeds in seed boxes involves the following steps:

1. Place the appropriate germination medium inside the seedbox and level it. The box should have holes at the bottom to prevent waterlogging.
2. Spread the seeds evenly over the medium and cover them with a thin layer of the medium.
3. Water the seed box through the sub-irrigation method (page 27) so as not to dislodge the seeds and destroy the physical structure of the medium.
4. Place the seed box under a well-ventilated shelter.



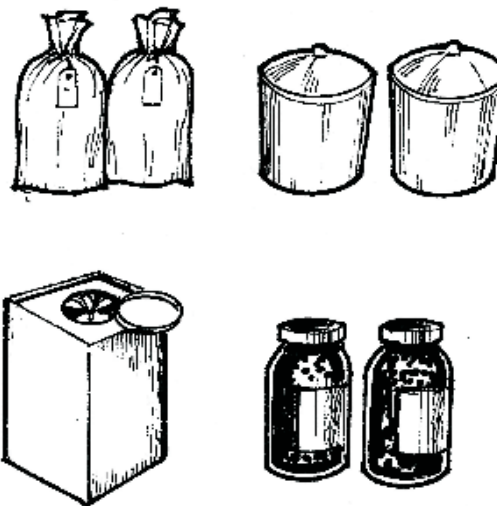
Preparation of Germination Media

Water holding capacity, good drainage and free from pathogens are the most important requisites of a germination medium. A mixture of 60% soil and 40% riversand is a good germination medium. The soil holds moisture while the sand promotes aeration and good drainage.

Seed Storage

Seed storage is important in seedling production scheduling. Sometimes, seeds are not available throughout the year so it is best to take advantage by collecting as many seeds as possible and store them for subsequent use. Factors that should be considered in storing seeds include temperature, humidity, moisture content, light, and insects and diseases. Of these, the two most important are temperature and humidity. Seeds will retain its viability for longer period when these are stored at low temperature and low relative humidity, placed in an airtight container and kept in a dry and dark storage compartment.

Containers appropriate for storing seeds include sacks, plastic bags, cans, glass jars and empty bottles of softdrinks and mineral water. The containers must be filled to avoid empty space in the container that will lead to increase the air humidity. Whenever containers could not be filled with seeds, empty space can be filled with charcoal or any materials that will absorb air moisture.

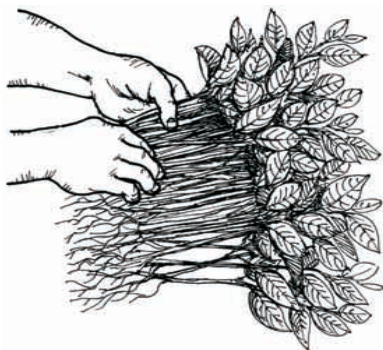


Examples of seeds containers (sacks, cans and jars)

Bottles and jars must be covered air-tight, plastic bags must be sealed and sacks must be tied tightly. Containers must be clearly labeled to indicate the species, date of collection, collector and the source.

Collection of Wildlings

Wildlings should be collected while they are still very young. Collecting old wildlings will cause severe root damage which will result to high seedling mortality. Also, potting old wildlings will usually result to deformed root system such as J-rooting especially when root pruning is not carried out prior to potting.



Young Wildlings

The best time to collect wildling is early in the morning and late afternoon. If collection is done during a sunny day, wildlings should be covered to protect them from wilting. Mud packing of roots is ideal and fresh banana sheath will serve as a good packing material.



Wildlings packed in banana sheath during the collection process

SEED GERMINATION AND GERMINATION MEDIA

Seed germination is the production of new plant from seed. Seed germination occurs when the seed embryo is viable. It begins when water and oxygen enter the seed.

The method of germinating seeds depends on the size of the seed. For large seeds such as pili, ipil, lauan and akle, these can be sown directly to pots. For medium-sized seeds such as gmelina, mahogany and dao, seeds can be sown in seedbeds. For seeds of bagras, mangium, auri, kalumpit, molave and other small seeds, these are best sown in seed boxes. If the viability of the seeds is unknown, it is best to sow the seeds in seedbeds and seed boxes instead of sowing them directly to pots.

Sowing Seeds Directly in Pots

1. Water the pots filled with the potting medium thoroughly.
2. With the use of a dibbling stick, loosen the medium and make a small hole at the center. The size and depth of the hole should just be enough to bury the seed with a thin cover of the medium. Burying the seeds too deep will likely result to low germination rate.
3. Place one seed in each pot and cover it with the medium.
4. Water the pots carefully after sowing so as not to dislodge the seeds and keep the medium moist all the time.
5. Protect the newly sown seeds by covering the pots with plastic or any protective material.
6. If possible, spray the pots with insecticide to ward off insects that might consume the seeds.





SEED DORMANCY AND PRE-SOWING TREATMENTS

<i>Intsia bijuga</i>	Ipil; Moluccan, Ironwood	Cut or scratch through the seed coat opposite the hilum.
<i>Leucaena leucocephala</i>	Ipil-ipil	Soak seed in hot water for 2-5 minutes and then in cool water for 12-24 hours.
<i>Palaquium sp.</i>	Nato	No Treatment.
<i>Paraserianthes falcataria</i>	Falcata; Falcataria	Soak seed in hot water for 2-5 minutes and then in cool water for 1 day.
<i>Pinus merkusii</i>	Merkus pine; Mindoro pine; Sumatran pine	No Treatment.
<i>Santalum album</i>	Sandalwood	Soak seed in cool water for 1 day.
<i>Shorea javanica</i>		No Treatment.
<i>Swietenia macrophylla</i>	Mahogany	No Treatment.
<i>Tamarindus indica</i>	Tamarind	Soak seed in cool water for 1 day.
<i>Tectonagrandis</i>	Teak	Burning Method. Spread fruits evenly on the soil surface or in a bed of sand and cover with a 2-cm layer of dry straw. Burn the straw. The surface of the fruits should be slightly burnt. Collect seeds and soak in cool water for 1 day. Roasting Method. Place fruits in a pan and heat until the hair on the surface of the fruit is burnt off. Stir the fruit during the heating process. Soak fruits in cool water for 1 day. Soaking Method. Soak fruits in water for 2 days. Then wrap the fruits in a moist cloth and store in a humid place for 5 days.

Source: Mulawarman et al. (2003)

Seed dormancy is a physiological state in which viable seeds will never germinate even if subjected to favorable conditions. This is a seed mechanism to maintain the viability over a long period usually by preventing moisture absorption and some physiological processes. For a germination to proceed, the state of dormancy must be overcome. Methods of breaking seed dormancy varies according to species.

1. Cold Water Treatment

This involves soaking of seeds in tap water until they become bloated. Seeds of ipil soaked in tap water for 10 days obtained high germination. Ipil and langil seeds soaked in tap water for 15 hours resulted in 80% and 89% germination, respectively.



2. Chemical Treatment

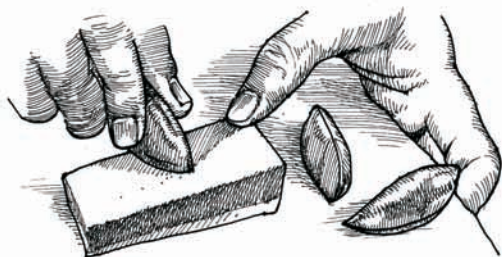
This is applicable to seeds with very hard seed coat like molave and kalumpit. Seeds are soaked in acid and constantly stirred to abrade the seed coat. The soaking time depends on the thickness of the seed coat. Sulfuric acid is the common chemical used for chemical treatment.

3. Hot Water Treatment



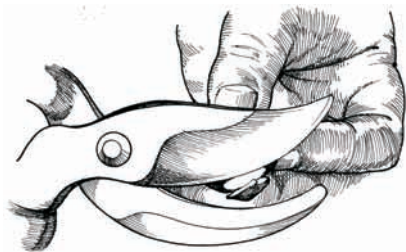
Seeds are immersed in boiling water for few seconds or pouring them with hot water in a container. The volume of water should be 5 to 10 times the volume of the seed. When seeds are immersed in boiling water, these should be placed in a cloth before dipping. Hot water treatment is effective for molave and most of the legume species including mangium, auri and falcata.

4. Scarification



This technique is usually used for large seeds and aims to thin down the stony seed coat to facilitate water absorption and exchange of gases. Seeds are rubbed against hard and rough surface to remove a layer of the seed coat.

5. Nicking



This involves cutting the seed coat just enough to expose a small portion of the cotyledon. The cut should be made farthest from the embryo so as to ensure that the embryo will not be damaged. This is applicable for seeds of ipil, ake, tindalo and other large seeds with stony coat.

6. Fire Treatment



Seeds are placed on the ground and covered with a thin layer (about 3 cm) of dry cogon grass and set on fire. As soon as the grass is completely burned, the seeds are placed in cold water. The quick change of temperature will cause the seed coat to crack.

The following are some of the pre-sowing treatments for common tree species.

BOTANICAL NAME	LOCAL NAME	PRE-SOWING TREATMENT
<i>Acacia mangium</i>	Mangium	Soak seed in hot water for 2-5 minutes and then in cool water for 1 day.
<i>Aleurites moluccana</i>	Candlenut (Lumbang)	Burning Method. Spread fruits evenly on the soil surface or in a bed of sand and cover with a 2-cm layer of dry straw. Burn the straw. Pour cool water over the fruits immediately after the straw burns. Soak fruits in cool water for 1 day. Sun-Dry Method. Place wet fruits under direct, hot sunshine. When the fruits become hot, spray them with cool water. Repeat this process until the skin of the fruits crack.
<i>Alstonia scholaris</i>	Pulai, Dita; Milkwood	No Treatment.
<i>Azadirachta indica</i>	Neem Tree	No Treatment.
<i>Calamus</i> sp.	Rattan	No Treatment.
<i>Calliandra calothyrsus</i>	Red Calliandra	Soak seed in hot water for 2-5 minutes and then in cool water for 1 day.
<i>Canarium ovatum</i>	Pilinut	Place wet fruits under direct, hot sunshine. When the fruits become hot, spray them with cool water. Repeat this process until the skin of the fruits crack.
<i>Eucalyptus</i> species	Bagras, Red Gum, White Gum	No Treatment.
<i>Gliricidia sepium</i>	Gliricidia	No Treatment necessary, but soaking seed in cool water for 1 day will hasten and improve germination.
<i>Gmelina arborea</i>	Gmelina; Melina	Soak seed in cool water for 2 days.