SEEDLING NURSERY
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1. NURSERY BED PREPARATION FOR SEEDLING GERMINATION

1.1. Selection of bed location

There are two types of nursery bed for seedling germination: the permanent nursery bed and the temporary nursery bed.

1.1.1 The permanent nursery bed: is a large bed with capacity to germinate a large amount of multiple species, including long, medium, and short-term species, and fruit. The bed is prepared with an irrigation system and tools to ensure long-term use.

Therefore, the bed location shall be selected with the following characteristics: upland area with enough sunlight and sufficient water supply, accessible by road and close to the reforestation area. If the location has no water supply, we must dig a pond or well for irrigation.
1.1.2 **Temporary nursery bed**: is small scale, used for short periods of time and is suitable for germinating small amounts of seedlings. Therefore, the location of this kind of nursery is based on the following: upland area with sunlight and water supply, accessible by road and close to the reforestation area.
1.2. Fence building - this relates to types of nursery bed
1.2.1 Bed for sowing seeds: there are 3 types of bed as described below.

- Bed built on the ground:
  - earth-mound bed used for sowing small seeds such as *Eucalyptus*, which requires the bed to be well drained
  - dug beds that are used for sowing *Hopea odorata* that need a high rate of moisture

- Bed made of bricks and cement: this is durable in the permanent nursery for germinating special seeds, such as fruit trees.

- Trough-shaped bed: made of wood and is used to germinate small seeds such as *Eucalyptus* which are vulnerable to damage by ants or fungi when sown in heavily dampened soil.
1.2.2 Bed for preparing bagged seedlings: A kind of bed using rope, plywood, bamboo, or earth mounds to prevent the plastic bagged seedlings from falling. This type of bed is used in an area with hard soil, or soil which is heavily dampened. It can be used for both temporary and permanent nursery beds. During bed preparation, we shall:

- Clear the grass stubble or vines from the bed base before building the fence so that it does not absorb nutrients from the bagged seedling;
- Build a small channel to drain the water out of the nursery bed; and
- Prepare the seedling bed in rows along the direction of the sun, in order to allow the soil to dry quickly.
1.3. Shelter of each nursery bed

In the permanent nursery, the shelter shall be made of net materials, high, stiff, strong and durable. Shelters for temporary or farmer nurseries can be built in a simple way by using poles, with a roof of coconut leaves or other available materials.
1.4. Building a fence around the seedling nursery bed
There are two types of fence: the fence and live hedge.

- Fence: the posts are of poles, cement, *krak*, or bamboo, with cross sections of barbed wire, small poles or split bamboo. It is used for temporary nursery beds, or for the preparation of a new permanent nursery bed before starting to plant a live hedge.

- Live hedge: is a fence that is also planted with trees to protect the nursery from storms or strong winds which can destroy the seedlings. This kind of fence is built with the aim to protect a large number of seedlings and to maintain the nursery bed for long-term use.
1.5. Water sources
Sources of water for seedling irrigation are:

- Ground water, such as water pumped or taken from a river, stream, pond or lake.
- Underground water, taken from a manual or pump well, but water from these sources often effect the seedlings because it contains a lot of lime.
1.6. Compost
1.6.1. How to make compost
Compost is a natural fertilizer produced by mixing together decayed leaves, residues, tree bark, saw dust, waste vegetables, rotten fruit, live or dead grass, hay, water hyacinth, *Pistia stratiotes*, *Chromolaena odorata*, cattle, buffalo, pig, chicken or duck manure, kitchen ash and other organic matter that is easy to rot. The use of compost results in loose soil, good crop and plant quality, and is better than chemical fertilizer. To produce good compost we shall first build a store for dumping the wastes into.

1.6.1.1 Building a store for composting
This can be built in many ways according to area and affordability, using woven palm leaves, split bamboo, or ply bamboo, which requires little expenditure. We combine together the woven bamboo or leaves, or bamboo pieces into a square or circular shape. We shall install poles at each corner of the square to be bound tightly with the bamboo board. Finally, we have a store for making compost.
1.6.1.2 How to produce compost

Once the store is built, we have to collect waste from around the house or elsewhere, by selecting types of waste that are easy to rot for compost. Larger waste needs to be cut into smaller pieces that can quickly decay. Waste has to be put into the store every day until it is full, and then covered with old sacks or ripe banana leaves and crushed soil from the mound. In the dry season, water needs to be poured into the store frequently so that the waste rots quickly. In the wet season, we do not need to pour water onto the store. The waste inside the store will become compost within 4 to 6 months depending on the raw materials mixed, and whether they are quick to rot or not.

Note: Water hyacinth is the best raw material for producing compost.
1.6.1.3 Collecting compost

When the waste sinks down it means that the compost is beginning to decay. Once it has sunk to half the level of the store, the compost is mature enough for use.

Black residues are screened, those which are not rotten are separated and put into a new store to produce the next compost. Raw materials that do not decay shall be kept out.

If the materials used to build the compost store are in good condition, they can be removed and used to build a new one nearby.

Note: When screening the compost, it is good if there are many insects within it because they speed the rate of decay and keep moisture inside. If you find earthworms, take them out before the compost is applied to crops. You should keep earthworms in the compost store because they are helpful in the residue-decaying process.
1.6.2. Use of compost and its advantages

- 30% of compost mixed with 70% of simple soil can be used in a plastic bag or container made from banana leaves to germinate seedlings or crops;
- Application of compost around the base of seedlings or crops such as flowers, papaya, lemon, cabbage, tomato, chili, ginger and others (soil around the base should be loosened when applying compost);
- Mix compost with chemical fertilizer to apply in rice fields to loosen the soil, maintain the quality of the chemical fertilizer for a longer period, and increase the rice yield and its flavour;
- Use compost in fishing ponds to increase the amount of insects available for feeding fish;
- The production of compost is helpful for society, providing a clean environment, and savings otherwise spent on chemical fertilizer, that can be used in other aspects of their daily life.
2. PREPARATION FOR GERMINATION
2.1. Preparing plastic bags for soil
2.1.1 Type of soil and soil treatment
Soil used in plastic bags for germinating seedlings can be alluvial soil from the river or lake, silt from the lakebed, earth from mounds or surface soil from the forest. However, if these types of soil are not available, we can use simple earth mixed with burned chaff, cow manure, or compost, using 6 portions of simple earth with one portion of cow manure or burned chaff, but with 3 portions of compost.

The earth must be beaten into small pieces and mixed thoroughly with the above-mentioned fertilizer, then the mixture should be dried in the sun, leveled on the ground to a depth of 4 index finger lengths (tnot), sprinkled slightly with water. We should dry it for one whole day, then collect together and cover with plastic sheet.
2.1.2 Selecting plastic bags and punching

- Plastic bags are selected according to the type of seedlings to be germinated: short-term seedlings require 9 x 16 cm., medium and long term seedlings need 15 x 25 cm. Long-term seedlings need to have the plastic bag changed once or twice during maintenance in the nursery. For tree species found in the sandy jungle forest, we need to use long plastic bags so that the seedlings will have long roots and have good protective capacity during the dry season.
- Farmers can be innovative, using plastic bags used to pack goods from the market, or other items such as old palm juice containers, for germinating seedlings.
- Plastic bags or other containers used for seedling germination should be punched so that soil will not be waterlogged, which can spoil the seedling.
2.1.3 Filling plastic bags with soil

- Slightly dampen the soil;
- Put the prepared soil into the punched plastic bags by shovel or hand;
- Place the bag in the nursery bed in a vertical position and in specific rows; and
- Water the soil in the plastic bags thoroughly using a watering can.
2.2. Seed treatment

Seed treatment is a way to:
- Enable seeds to grow quickly;
- Enable seedlings to grow simultaneously and develop quickly; and
- Minimize the chance of infection from diseases or seed problems.

Seed treatment can be done in many ways depending on the type of seed, for example, whether they can be kept for a long time, or whether they rot quickly. It also depends on other conditions such as the thickness of the pods, hardness of the pods, and whether they can easily be dampened with water.

The treatment of various species is listed in Annex 1. Some methods of seed treatment and examples are outlined below.

2.2.1 Treatment using normal water for seeds that can be kept for a long period and quickly soaked with water, and seeds that rot quickly

- Dry the seeds in the sun (cut the wing off the fast rotting seeds before drying);
- Soak the seeds in normal water for 12-48 hours depending on the thickness of the pod;
- Clean the seeds with water and place them in a damped hemp sack;
- Check and clean them each day, keeping in the dampened sack, until they begin to sprout, and then they can be planted in a prepared bag or sown in the nursery bed.
Treatment process of long term seeds

1. Dry seeds
2. Soak seeds
3. Wash seeds
4. Store seeds
5. Control and clean the seeds
6. Plant the seeds with sprout in the plastic bag
Treatment process of quickly-decaying seeds

- Soak in water
- Wash
- Hemp bag
- Store seeds
- Germinated seed
Note:
- We can use this method only for certain long lasting seeds, but also for quickly rotting seeds.
- We shall pick the seeds carefully and put them into plastic bags using tweezers, which will not touch the root of the emerging sprout.
- We shall frequently check the treated seeds when they germinate to prevent the root from becoming too long.

- We shall store the treated seeds carefully in a place out of the reach of children, rodents or insects.
2.2.2 Treatment using hot water for seeds that can be kept for a long period

- Dry the seeds under the sun;
- Parboil or soak the seeds in hot water (temperature dependent on the seed type, as indicated in Annex 1);
- Other activities include cleaning, and preserving in the damped sack as described in treatment by normal water.

Treatment by hot water is necessary for species such as *Afzelia xylocarpa*, *Sindora siamensis*, *Peltophorum dasyrrhachis*, *Cassia siamea*, and *Acacia*. 

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2.2.3 Treatment with frequent dampening and drying of the seeds

- Soak the seeds in water for one night and clean them the following morning. We soak seeds of *Tectona grandis* in flowing water such as stream, canal or lake.
- Dry the seeds in the sun for 8 to 12 hours *Tectona grandis* seeds mostly grow when dried in the hot sun, particularly on a cement floor, then put them into a hemp sack for further soaking, and again in the morning, we need to clean and dry them and then soak them.
- We conduct the process 2 or 3 times until you can see that the seeds start to grow, then you stop the drying and soaking, but keep the seeds in the dampened hemp sack so that they will have enough moisture for good growth.
2.2.4 Treatment by filing the seed pods

- Trim or file using a knife or nail cutter, sandpaper or other rough surface material, such as sandstone. File carefully so as not to touch the sprout. You should cut the seed flesh slightly.

- Soak the seeds with their cut pods in normal water for one night and clean them in the morning, then preserve them and control by following the process outlined above in treatment with normal water.

We can use this method of treatment for durable seeds which have a large, thick pod, easy for handling for filing or cutting such as *Afzelia xylocarpa*, and *Sindora siamensis*.
2.3. Planting seeds into plastic bags

- Sprinkle the plastic bag thoroughly with water;
- Use treated seeds with emerging sprouts;
- Use a stick (as in picture) or finger to make a hole of the size of the seed;
- Place the seed into the hole (seed like *Dipterocarpus alatus* with a wing shall be placed horizontally) then sprinkle slightly with soil;
- Use hay or dead grass to cover the plastic bag transplanted with seed; and
- Slightly water using a watering can.

**Note:**
- Mark the row that has already been planted to avoid repetition;
- Record the germination date;
- Attach labels describing the number of the plastic bag, the species and date of germination in the nursery bed.
2.4 Transplanting seedlings into plastic bags

Seedling transplantation into plastic bags is mostly for species such as *Eucalyptus, Hopea odorata, Melaleuca cajeputi, Dalbergia cochinchinensis*, and *Peltophorum dysyrrhachis*. This work is done in two stages: broadcasting and transplanting.

2.4.1 Broadcasting

- Seed of *Hopea odorata* and *Dipterocarpus intricatus* are broadcast onto the nursery bed (earth mound) immediately after harvest. We shall cover the bed with hay, sprinkle with water, and cover with a roof of coconut leaves.
- For Eucalyptus, we shall thoroughly mix one portion of seed with 3 portions of sand in a pepper pot, then sprinkle evenly on the bed (either on the ground or in a trough, already irrigated with water) broadcasting between 20-25 grains per square metre. Sprinkle fine sand on the top, and spray the bed frequently with water to keep the soil wet. We shall use insecticide against ants, and will cover the bed when rain is forecast. We continue this treatment until the seedlings are 3 weeks old.

2.4.2 Transplanting

- Water the seed bed thoroughly, then dig up the seedlings and soak in water filled trays;
- We shall keep the earth in the plastic bags damp, and make a hole in the bags, using a stick. When the seedling is placed into the hole, we must take care not to bend the root. Finally, the hole is filled with earth and some water added.
### 2.5 Grafting

Grafting is a method to produce seedlings from a large branch, through the following process:

- Select a narrow branch the size of a finger, not too short, but without an existing graft.
- Remove the leaves and then cut the branch into pieces (about 8-10 cm. long) leaving a sloped surface
- Transplant the cut branch into the trough or a plastic bag filled with earth (sometimes a root germinating substance is used), then place in the shade with good moisture, such as a cover-sealed box.

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**Ways to cut stem and trim leaves before planting**

- Planting branch in the trough bed
- Transplanting stem in the bag
3. SEEDLING CARE IN THE NURSERY BED

3.1. Watering
While the seedlings are still young we shall water them twice a day (morning and afternoon). On average, we need 2-3 liters of water per square meter. When the seedlings grow bigger, we shall water them once a day, or every two days, with between 4 to 5 liters per square meter each time. The seedlings are carefully watered, by sprinkling them with small drops of water, so that they do not break or decay.

3.2. Weeding
- Water thoroughly before weeding;
- Weed carefully with your hands; and
- Water again after weeding.
3.3. Selective picking and replacement planting
When the seedlings in plastic bags become mature and stop receiving reserve nutrients, we can pick them out. For this work, we shall follow the procedure below:

- Thoroughly water the seedling in the plastic bag;
- Pick seedlings from plastic bags containing multiple seedlings (2-3 seedlings);
- Soak the picked seedlings in a tray of water;
- Transplant healthy seedlings into individual plastic bags; and
- Water them and keep covered in the daytime but uncover at nighttime (for two days).
3.4. Insect control
- Control insects or worms by hand, or use botanical pesticides produced from bitter plants which is considered the best method;
- If a chemical pesticide is used (Cabaris or Metaphos), we shall be careful to apply only in the afternoon, and with appropriate protective clothes.

3.5. Fertilizer application
- When the seedlings have grown for 4 – 5 weeks, fertilizer is applied once a week. Two or three weeks before planting the seedlings, we shall apply Urea fertilizer to make them healthier and stronger.
- Immediately after applying chemical fertilizer, we shall water to clean the leaves of the seedlings.
3.6. Cutting the seedling’s roots that grow outside the plastic bag

Cutting the roots outside the plastic bag prevents the seedling from rooting into the ground, which would otherwise result in difficulties in picking them for planting. Therefore:

- Start to control the root when the seedlings are three months old. This can be done by taking the seedling bags away from the nursery so that you can clearly see the roots which come out of the bag;
- For long and medium term seedlings, we shall remove them from the nursery bed and cut off the outside roots. After cutting, we shall return them to the nursery and water them.

3.7. Changing seedling bags

We need to change the plastic bags holding long-term seedlings when they are 6 – 7 months old, so that their root systems can develop at full capacity when they are planted in the open field.
3.8. Exposure to sunlight of seedlings in the nursery bed
Seedling exposure is done in the short-term nursery beds. It allows sufficient sunlight
to kill fungi and bacteria, and enables the seedlings to become healthier with large,
strong stems.

To expose the seedlings, we must remove them from the nursery bed, then return
them but with wider spacing between the bags. We shall use bamboo sheets or palm
stems to prevent the seedling bags from falling down.

3.9. Increasing sunlight and decreasing moisture
Seedlings kept in the nursery bed shall be made accustomed to sunlight and dryness
so that they will adapt to the outside atmosphere. We shall gradually increase the
rate of sunlight and decrease the moisture so that the seedlings can more easily
adapt.