MODULE 2: Production of Quality Planting Materials

A Field Manual on Forest Restoration Using Indigenous Species

energy DEVELOPMENT CORPORATION

VISAYAS STATE UNIVERSITY

MODULE 2:
Production of Quality Planting Materials

A simple step-by-step guide to produce sustainable and good quality planting materials in a well-managed nursery

A Field Manual On Forest Restoration Using Indigenous Species

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DEPARTMENT OF ENVIRONMENT
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Foreword

The National Greening Program (NGP) of the Department of Environment and Natural Resources (DENR) is by far the largest reforestation program funded by the Government of the Philippines. With a staggering target of 1.5 billion trees covering 1.5 million hectares for a period of six years from 2011 to 2016, the program aims to reduce poverty, promote food security, environmental stability and biodiversity conservation, and enhance climate change mitigation and adaptation function of our forests.

In its fifth year of implementation, NGP has already planted 916.76 million seedlings in 1.35 million hectares of degraded lands as of the 4th quarter of 2015. This would not be possible without the support of various agencies such as the Energy Development Corporation (EDC). As one of our major partners, we would like to commend EDC for their remarkable contribution to NGP goals through their BINHI program.

This Forest Restoration Manual will be very useful as we implement the remaining years of NGP. In this regard, we would like to thank the College of Forestry and Environmental Science of the Visayas State University (VSU) for sharing their expertise and vast field experience on forest restoration as reflected in this manual.

We would also like to extend our gratitude to EDC for spearheading the production of this Manual. This Manual is not only relevant but also timely in the light of growing initiatives in forest restoration. May this manual equip your farmers and Forest Development Rangers to successfully restore the forests in your project sites.

HON. RAMON J.P. PAJE
Secretary

ENERGY DEVELOPMENT CORPORATION
Ortigas Center, Pasig City

Foreword

Energy Development Corporation (EDC) is the largest producer of geothermal energy in the Philippines with business operations in Bicol, Leyte, Negros Island and Mount Apo. With close to 40 years in the geothermal industry, the company provides clean, indigenous and renewable energy to support the country's growth prospects.

BINHI, our flagship reforestation program, helps sustain our geothermal operations. Six years into this 10-year program, we have managed to exceed our annual target of 1,000 hectares every year. From 2009 to 2015, we have reforested 7,937 hectares using indigenous and native trees. We have rescued 96 of 96 priority species of premium endangered trees in the country. We have also organized 117 farmer associations as partners in the BINHI program who help us protect the watershed areas in our project sites.

To enhance the implementation of the BINHI program and to further improve knowledge management in the field of forest restoration, EDC, in partnership with the DENR's Forest Management Bureau and the Visayas State University, has come up with the "Field Manual on Forest Restoration Using Indigenous Species". The Manual will guide EDC staff and partners in the implementation of forest restoration activities in watershed areas. The Manual draws from our experience in implementing BINHI, as well as from national and international best practices in forest restoration.

The Manual consists of three modules that lay down the technical procedures on forest restoration using indigenous tree species. While the Manual may seem too technical, we took great effort to simplify the technical terms and make it more understandable to readers.

It is our hope that this Manual will contribute to the improvement of forest restoration projects and activities that will translate into better seedlings and greener forests.

RICHARD B. TANTOCO
President

VISAYAS STATE UNIVERSITY
Visca, Baybay City, Leyte
6521 Philippines

Foreword

As I browsed the pages of this "Field Manual on Forest Restoration Using Indigenous Species", I am certain that this would really benefit not only those who are directly involved in forest restoration but as well as other stakeholders who are concerned of bringing back the dwindling remaining forest that we have. I commend the people behind the completion of this scholarly manual who devoted much of their time in order to come up with this output. This piece of work is a clear manifestation of how they love the environment, thus putting their best foot forward to educate everyone on the necessary steps to preserve this God-given resource — the forest.

It took several years to experiment and explore ways by which we can technically help our government in the restoration and preservation of our existing forests. Now that we have completed and documented all the initiatives in addressing this profound problem faced by the government, the VSU pool of experts was able to come up with this manual. We have high hopes to reach out those who need this information in resolving issues related to forest restoration using indigenous tree species.

This manual would guide every reader to the different modules adopted by the researchers in coming up with concrete solution to the forestry problem besetting our country. These modules include: site-species matching; production of quality planting materials; and forest restoration and best practices in grasslands, brushlands, and forest gaps.

Through the concerted efforts of our active partners in this endeavor, such as the Energy Development Corporation and the Department of Environment and Natural Resources, I am very optimistic that we can help each other in implementing the rules and regulations stipulated in Executive Order No. 26 "Declaring an Interdepartmental Convergence Initiative for a National Greening Program."

Let's join hands in addressing P-Noy's Matuwid na Daan through the National Greening Program.

JOSE L. BACUSMO, Ph.D.
University President IV

Acknowledgement

Special thanks goes to the faculty and staff of Visayas State University especially to Prof. Renezita Sales–Come, Mr. Marlito M. Bande, Ms. Angelica P. Baldos, Mr. Jimmy O. Pogosa, Mr. Hernando L. Mondal, Mr. Mizael B. Cerna and Ms. Elvira Gorre for sharing their skills, expertise, and field experiences to make this manual possible. Also thanks to Atty. Allan Barcena, Forester Liezel Salagubang, Forester Jimson Solatre, and Ms. Monette Evangelista of the Watershed Management Department of EDC for reviewing and for providing valuable comments to improve the contents of the manual.

We would also like to acknowledge important recommendations and standards on reforestation provided by the Technical Working Group of the Forest Management Bureau (FMB) headed by Dir. Ricardo Calderon and Forester Ma. Teresa Aquino and their technical staff Forester Bert Lansigan. Also to Dr. Tonie Balangue for his valuable technical contribution during the initial phase of this manual.

Preface

For decades conventional reforestation strategy in the country has been considering use of fast-growing tree species like gmelina, mangium, and mahogany; vast clearing of open areas in preparation for the 4 meters by 4 meters standard planting density; use of fewer species to simplify planting design; and weak consideration in the forest formation type and ecological succession as inputs to the site-species matching.

This could be due to limited technical references to guide reforestation initiatives in the country using indigenous species. Available data and references were mostly from western countries that are more applicable to temperate forests that are simpler in structure, compared to the complex design of a tropical rainforest.

Fortunately, there are already current initiatives in the country that use indigenous species in reforestation activities. This include the National Greening Program (NGP) of the Department of Environment and Natural Resources (DENR), the BINHI Program of the Energy Development Corporation (EDC) and other private and NGO forest restoration initiatives in the country. Most of these initiatives have promoted the concept of rainforestation technology pioneered by the Visayas State University (VSU). The said technology not only encourages the use of native species in restoration, it also emphasizes the importance of social preparation and environmental education during forest restoration activities, promotion of community volunteerism to sustain the initiatives, and realization of the concept of payment for environmental services (PES) to show communities the economic benefits of restoration initiatives.

However, there are several challenges that lead to high mortality of indigenous species in the field - most especially in highly degraded areas. This include mismatch of species used in a particular planting site, inappropriate planting design, poor quality of seedlings, and others. This manual was therefore developed to bridge the knowledge gaps and to assist the field implementers in restoring our degraded tropical rainforests using appropriate and good quality indigenous species to ensure survival and growth of the seedlings. This is based on over two decades of experience in forest restoration by the VSU, with inputs from the EDC experiences from its BINHI program.

This manual is an evolving document with plenty of rooms for innovations and technical improvements. In the adoption of this manual, field implementers are also encouraged to identify and develop new strategies that are more applicable to their respective site conditions. In the end, these initiatives aim to broaden the lessons in restoring our degraded forestlands by following the nature's process on forest succession.

How to Use this Field Manual

This Field Manual on Forest Restoration using Indigenous Species has the following modules:

Module 1: Site-Species Matching

The first module aims to guide its users on the procedures to characterize the forest restoration sites, match the site conditions to suitable indigenous forest species, and identify the appropriate planting strategy to be used.

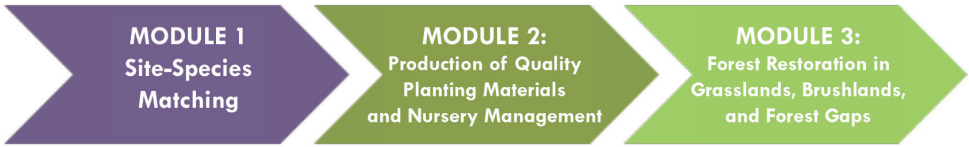
Module 2: Production of Quality Planting Materials and Nursery Management

The second module aims to guide the users to further improve the processes and standards of producing quality planting materials. It is expected that a good quality planting material will produce a robust forest stand. It also provides the users recommended standards for effective monitoring and management of their nurseries.

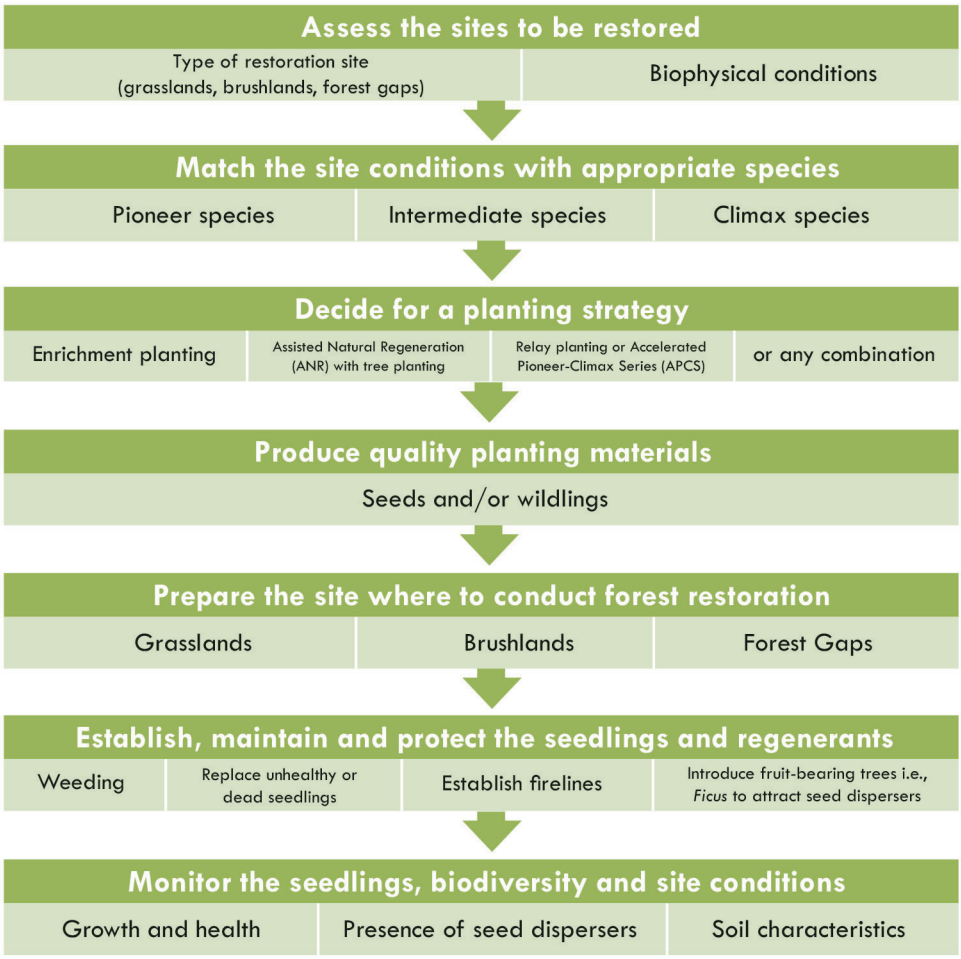
Module 3: Forest Restoration in Grasslands, Brushlands, and Forest Gaps

The third module aims to guide and to train the users on the step-by-step procedures on how to establish, protect and monitor indigenous forests in grasslands, brushlands, and forest gaps. The module aims to attain high survival rates and better growth performance of trees in the restoration sites.

The relationship of the above manuals is shown in the following framework:



General Flow of Procedures for Forest Restoration Using Indigenous Species



Scope of the restoration activities under Module 1

Meet Ali

This module will share additional information or highlights in green boxes through "Ali". Ali is a firefly and an indicator of a healthy forest ecosystem. Be reminded of the following when you see Ali:

Queries with answers

Standards and facts in forest restoration activities

Reminders and Suggestions

Other useful references and guide

You would also find a Glossary at the end of the module where you can find the meanings of some words or phrases written in bold italics. Most definitions used in this manual are based on the compilation of terms from the Philippine Official Reference for Forest-Related Terms and Definitions published by the Department of Environment and Natural Resources - Forest Management Bureau and International Tropical Timber Organization (DENR FMB-ITTO, 2006)

All forms or templates needed in this Field Manual can be found in ANNEXES while supplemental information can be found in APPENDICES.

MODULE 2:
Production of Quality Planting Materials

A simple step-by-step guide to produce sustainable and good quality planting materials in a well-managed nursery

Introduction

In restoring our forests we need to plant trees that naturally grow in the area. Hence, the mass production of native species has gained much attention. The challenge, however, is on how to manage a nursery that produces different kinds of native species of good quality. Therefore, there is a need to improve and innovate on nursery management practices to produce quality indigenous planting materials.

The raising of ***seedlings*** of ***indigenous forest species*** is challenging for three reasons: a) seedling production technologies for indigenous forest species are limited to few popular species, thus, limiting the choices suitable to varied site conditions; b) there are very few known good quality seed sources in the existing indigenous forest and their fruiting seasons or seed years are yet to be established ; and c) lack of innovative but affordable technologies to grow, tend, and take care of the seedlings. As such, this module was prepared to guide foresters and farmers to address these challenges.

Scope of the Module

This module intends to guide its users to

1. Identify sources of planting materials,
2. Produce quality planting materials based on site-species matching, and
3. Improve the nursery management practices to produce quality planting materials.

I. Identify Sources of Planting Materials

Propagation of high ***quality seedlings*** is an important factor in the success of any forest restoration activities. Poor quality seedlings have low survival in the field. Since quality planting materials come from good mother trees, proper selection of mother trees is very crucial. Below are the steps for selecting and protecting a good mother tree:

Figure 1. Ideal features of a good mother tree. *Shorea almon* (Location: Tres Marias, Brgy. Imelda Silago, Southern Leyte)

STEP 1:

Consider the following traits in selecting a mother tree:

1. At least 4 meters in height,
2. Straight and clear bole of trunk,
3. Balanced branching, and
4. Dense crown

STEP 2:

Observe and record the ***phenology*** (flowering and fruiting cycle) of the mother trees. See ANNEX A for the sample form to be used in recording the time when the identified mother trees bear flowers and fruits.

Record the months or years when a mother tree bears flower or fruits. This will serve as a guide in the appropriate timing to collect ***wildlings*** and ***seeds***.

STEP 3: Map the exact location of the mother trees. GPS readings can be taken to mark the location of the mother trees. Record the information in ANNEX A.

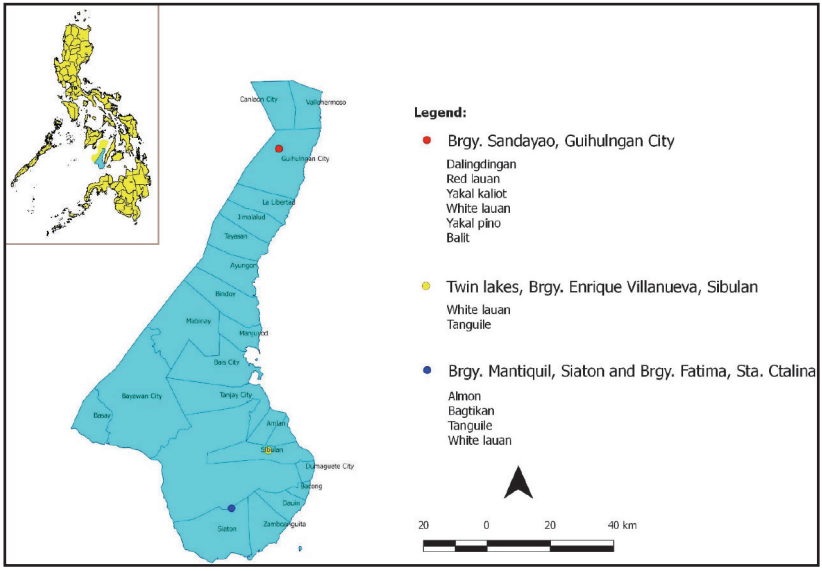


Figure 2. Location Map of the remaining dipterocarp mother trees in Negros Oriental

STEP 4: Protect the ***mother trees*** by regularly patrolling the areas and putting up signages where they are located. Give information such as the location (i.e. ***GPS*** readings) of the mother trees to authorized persons only.

Prioritize seedlings to be raised based on the result of the site assessment.

II. Production of Quality Planting Materials

In producing seedlings, consider the conditions of the restoration site and the species that the site needs. Species whose ecological requirements are closest to the biophysical characteristics of the restoration site (based on site-species matching) have higher chances of survival. These planting materials can be produced in two ways - through seeds or through wildlings.

1. Production of Quality Planting Materials Through Seeds

FRUIT COLLECTION AND SEED EXTRACTION

STEP 1: Collect fruits from the ground or from standing trees. Collecting fruits from the ground is appropriate for large and fleshy fruits such as Dipterocarp species, Antipolo, Pangi, Mabolo, etc . Collection of seeds from trees is appropriate for small seeds such as Molave, Alagao, Alim, etc.

Figure 3. Collection of the fruit of apitong *(Dipterocarpus grandiflorus)* (Location: Salcedo, Eastern Samar)

You need timing in seed collection. Most tropical tree species have short viability.

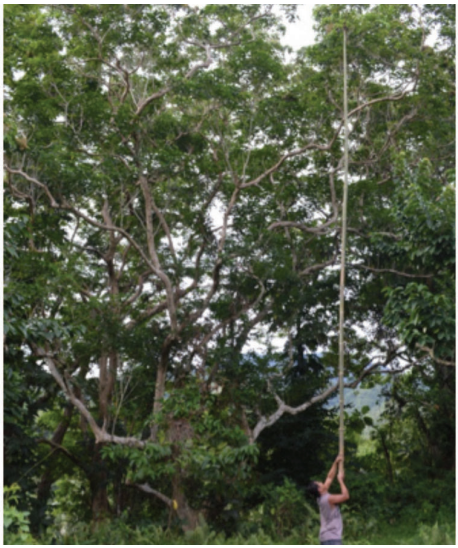


Figure 4. Collection of seeds of Molave *(Vitex parviflora)* (Location: Visayas State University, Leyte)

STEP 2: Remove seeds from fruits.

STEP 3: Clean the seeds by removing fleshy tissues and other debris. Remove the fleshy tissues by rubbing seeds in between your hands. It is important to remove the fleshy tissues coating the seeds for better water imbibition during germination. Seeds are clean when the ***seed coat*** is smooth and clear.

STEP 4: Test viable seeds either through:

a. flotation test - put seeds in a basin of water after cleaning. Generally, seeds are viable when they do not float. Take note that there are some seeds such as anislag *(Flueggea flexousa)* that naturally float in water.

b. physical test - randomly choose few sample seeds. Cut them, smell if they do not have foul odor, and check if the ***cotyledon*** is still intact.

Figure 5a. Perform a physical test to determine seed viability.

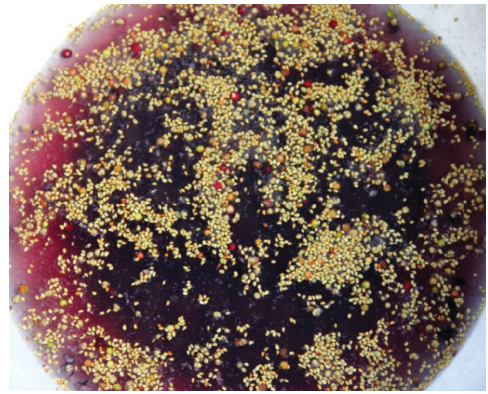


Figure 5b. Anislag seeds (*Flueggea flexousa*) naturally float in water even if still viable.

STEP 5: Air-dry ***viable seeds*** for two hours to drain excess water. Make a final check on the cleanliness and viability of seeds before seed treatment.

SEED TREATMENT

Seed treatments are done to facilitate the germination process. Refer to APPENDIX 1 for information on the recommended methods of seed treatments for several indigenous tree species.

Seed treatment or germination treatment varies among species. For dipterocarp species, seeds should be sown immediately after collection because seeds germinate easily during seed off (i.e. ***recalcitrant***). For non-dipterocarp species, the following are the different types of seed treatment:

- Alternate soaking and drying (e.g. Lamio, Dao)
- Hot water treatment (e.g. Molave and Kalumpit)
- Cold water treatment (e.g. Tindalo)
- Scarification (e.g. Milipili and Pagsahingin)
- Nicking (e.g. Ipil)
- Breaking using nails (e.g. Bagalunga)
- Complete removal of the seed coat (e.g. Narra and Banuyo)

SEED SOWING

STEP 1: For fine seeds, prepare seedboxes (24 inches in length x 12 inches in width x 6 inches in depth) with a perforated bottom. Fill the seed-boxes with river sand. For medium to large seeds, seedbeds or polybags can be used.

STEP 2: Sprinkle water on the seedboxes, seedbeds, or polybags before sowing.

Figure 6. Broadcast sowing of fine seeds like anislag *(Flueggea flexousa)*.

STEP 3: For fine seeds, broadcast the seeds on the seedbox just enough to cover the area (not too dense and not too sparse). Cover the broadcasted seeds with a very thin layer of river sand.

Figure 7. Sowing of large seeds like pili *(Canarium ovatum)* using the drill method.

For medium to large seeds, sow the seeds using the drill method. The seeds should be buried up to a depth that is equivalent to about 2/3 of the seed diameter in centimeters.

STEP 4: Water the sown seeds regularly using a sprinkler to keep the soil moist.

POTTING BEDS AND MEDIA

While waiting for the seeds to germinate, prepare the potting medium and potbeds to be used in potting. This can be done through the following steps:

STEP 1: Prepare the following materials for potting.

- Use longer-sized polybags (4" x 10") to minimize root-coiling.
- Ensure there are small holes in the polybags before filling them with the ***potting medium***.

STEP 2: Mix the forest soil, river sand, and rice hull in the recommended ratio.

The soil used for filling the bags should have:

1) good moisture and nutrient retention capacity,
2) promote root development, and
3) bind the roots firmly to prevent damage during transport. Soils with clay-loam texture, good structure and friability are ideal for this purpose.

Forest Soil (2 parts)

River Sand (1 part)

Rice Hull (1 part)

STEP 3:

Construct a 1 meter wide and 4 meters long ***potting bed***. Place this in a partially shaded area. This size of ***potting bed*** can accommodate 1, 300 seedlings.

An elevation potting bed can also be constructed to address root pruning. See Appendix 2 for the procedures.

Figure 8. Sample potting bed.

Figure 9. Proper filing of soil in polybags.

STEP 4:

Fill the polybags with the mixed potting medium. Gently tap or shake the bag to ensure compact filling of soil without leaving air spaces. Heavy compaction should be avoided at the top of pots because it will inhibit root penetration

The bag should be filled up to about 1-2 cm below the brim.

Figure 10. Farmers digging a canal around the potting bed.

STEP 5:

Place the filled polybags inside the potting beds. Dig a canal around the potting bed to avoid water logging.

PRICKING OUT

This is the process of transferring young and tender seedlings from seedbeds into containers (pots). Pricking out should be carried out when the seedlings reach a height of 2 cm. This is usually about two weeks after sowing but depends on the species.

This will be done as follows:

STEP 1:

Prick out the seedlings when the first 2 leaves (not yet expanded) come out (see seedling encircled in red in Figure 11). This is the best time to prick the seedlings because:

- they are not yet dependent on photosynthesis, and
- secondary roots have not yet formed.

Figure 11. Seedling encircled in red is the best size for pricking.

- Pricking out should be carried out when the seedlings reach a height of 2 cm. or about two weeks after sowing although this would still depend on the species (Mboroa,et.al., 2008).
- If seeds have been sown directly in polybags, there is no need to prick out.

STEP 2: Water the seedlings before pricking out to soften the soil.

STEP 3: Water the polybags filled with the potting medium before transplanting the seedlings.

STEP 4: Dig a small hole in each filled polybag using a stick. Make sure that the hole is wide and deep enough to accommodate the roots of the seedling.

Figure 12. Preparation of the polybag for newly pricked seedlings.

STEP 5:
Carefully lift each seedling from the seedbox or the seedbed. Hold the seedling just below the newly developed leaves. Take care not to press or damage the stem when lifting.

Figure 13. Proper pricking of sprouts.

STEP 6:
Plant the seedling in the polybag. Pack the soil firmly around the base of the seedling.

Figure 14. Proper transplanting of sprouts.

STEP 7: Regularly water the transplanted seedlings.

2. Production of Quality Planting Materials Through Wildlings

WILDLING COLLECTION

STEP 1: Prepare the following materials for wildling collection.

Bolo

Sako Bag

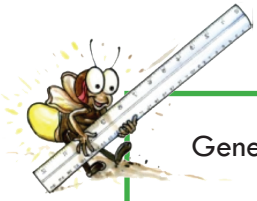
Rattan Basket

Tying Materials

Banana Bracts

STEP 2: Go to the forest and collect wildlings shortly after heavy rains to make sure that soil is soft. Carefully lift each wildling to ensure minimum damage to the roots.

Figure 15. Proper lifting of seedlings means inclusion of top soil.



General characteristics of wildlings to collect:

- 10 - 20 cm in height
- 2 - 3 leaves
- healthy and have no signs of disease

THE HEIGHT STANDARD VARIES AMONG SPECIES.

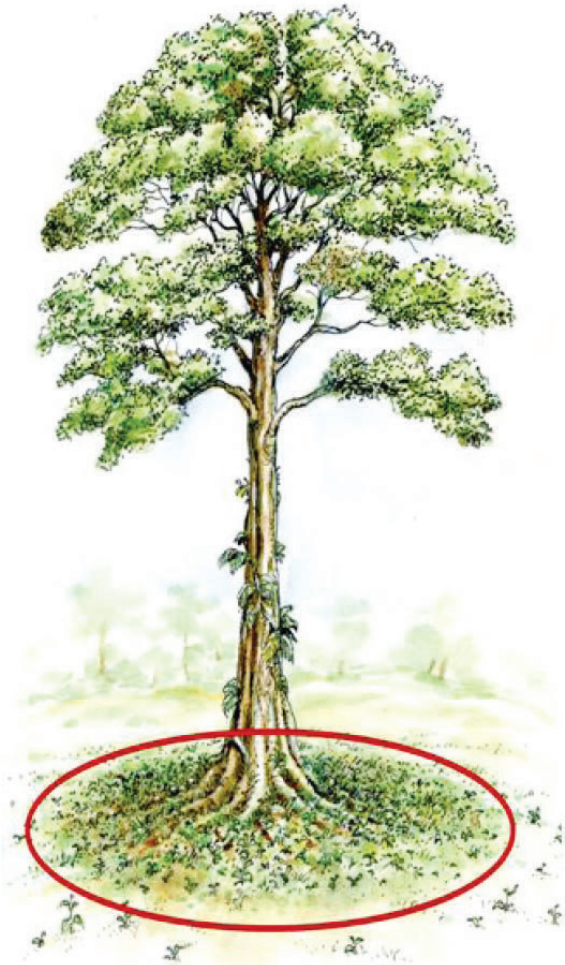
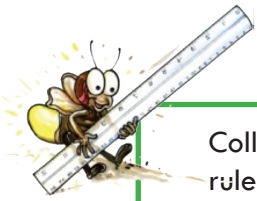


Figure 16. Collect wildlings located underneath the crowns of mother trees.

Only collect wildlings that are under the crown of the mother tree (inside the red circle).

Figure 17. Collection of seedlings under the mother tree.

Figure 18. Wildings collected in Bacon-Manito Geothermal Project (BMGP).



Collect wildlings that are less than the half-size of a ruler or less than 6 inches.

STEP 3:

Roll the wildlings in topsoil and place them in fresh banana bracts. A bract can accommodate a maximum of 30 wildlings.

Figure 19. Fresh banana bract with seedlings.

STEP 4:

Collect top soil from the vicinity of the mother tree. The top soil can be added to the potting medium.

The top soil contains microorganisms that are beneficial for the survival of the wildlings the nursery.

Figure 20. Proper collection of topsoil.

STEP 5:

Sort and grade the collected wildings by species.

Cull-out wildlings with:

- coiled root formation,
- sign of infestation, and
- more than 6 inches long.

Figure 21. Cull-out coiled root formation.

Figure 22. Cull-out wildlings more than 6 inches long.

STEP 6: Cut the leaves and prune the roots to minimize water loss from wildlings.

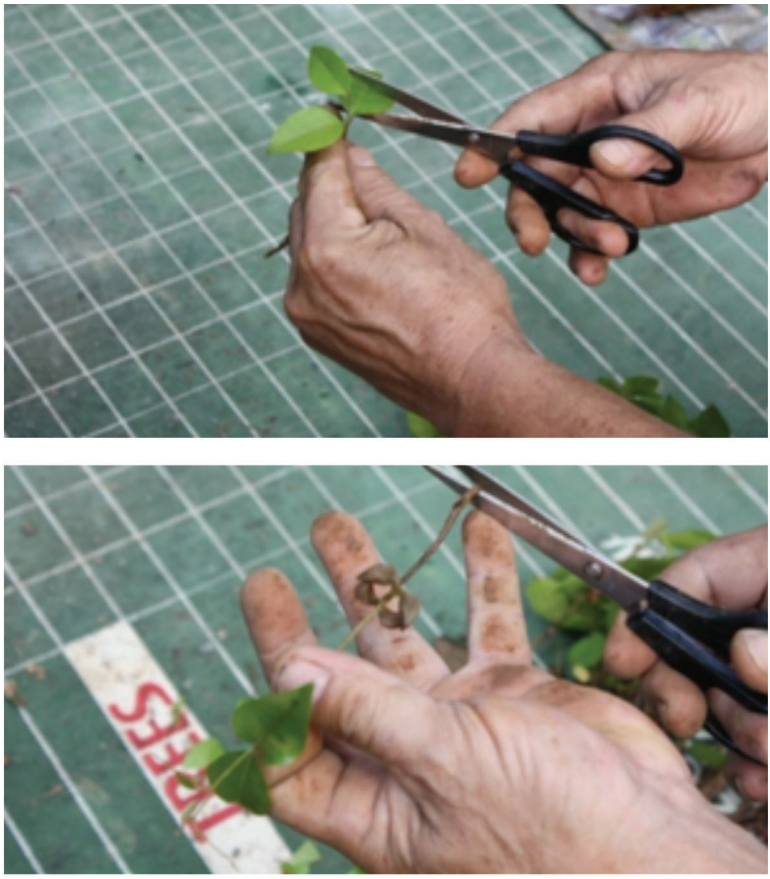


Figure 23. Proper pruning of leaves and roots.

HOW TO MINIMIZE LOSS OF WATER FROM THE WILDLINGS?

- Cut 2/3 of the surface of the leaves
- Prune the roots to the length that it will be accommodated in the polybag

STEP 7:

Transplant the wildlings to the potbeds. Add the collected topsoil from the forest to the potted wildlings.

Figure 24. Transplanting of collected wildlings.

INSTALLATION OF THE RECOVERY CHAMBER

STEP 1:

Curve the bamboo slats to form 5 domes along the 4-meter length of the potting bed. Overlay and tie the 7 pieces of 4-meter-long bamboo slats on top of the domes to strengthen the chamber.

Figure 25. Bamboo slats over the potting bed.

Figure 26. Filled up recovery chamber with transplanted seedlings.

STEP 2:

Transplant the seedlings to the polybags inside the ***recovery chamber***. Water the potbeds with seedlings afterwards.

Figure 27. Preparation of the plastic cover.

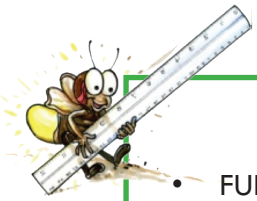
STEP 3:

Prepare a transparent plastic cover. Join the ends along the length with a packaging tape.

Figure 28. Proper sealing of the recovery chamber.

STEP 4:

- Cover the recovery chamber with the transparent plastic.
- Dig a shallow canal around the chamber for the ends of the plastic cover to be inserted and sealed in.

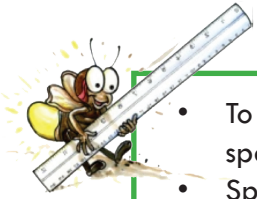


WHEN SHOULD THE CHAMBER BE OPENED?

- FULLY OPENED: after 2 months

➤ SIDE COVER: 1st month
➤ GRADUAL OPENING: On the 2nd month, chamber is opened gradually in one-week intervals for a period of one month

Figure 29. Wildling recovery chamber opened in segments of one-week intervals for a month



- To ensure high survival rate, place wildlings of pioneer species in chamber after collection.
- Species of this kind may only be placed in the chamber for one to two weeks.
- Climax species is advised to be chambered from 4 to 6 weeks.

Figure 30. Wildling recovery chamber fully opened after two months

On each recovery chamber, record the following date:

- When it was covered,
- When the chamber was gradually opened at weekly intervals, and
- When it was fully opened (use ANNEX B to record the dates).

III. Improvement of Nursery Management Practices

One of the conventional practices in nurseries is mass production of seedlings with very little attention being given to the quality of the planting materials. This is crucial since the quality of planting materials significantly affects the survival of seedlings in the restoration site. Hence, there is a need to improve and innovate current nursery management practices to produce quality indigenous planting materials. In the following sections, some techniques to improve the nursery practices are presented.

Figure 31. Satellite nursery managed by EDC in Ayungon, Southern Negros.

Whether you choose to build a ***permanent*** or ***temporary nursery***, an ideal nursery has to have the following:

- Good water supply,
- Natural shade in the area, and
- Good drainage.

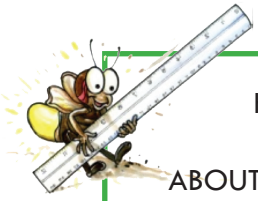
HARDENING

Hardening is the gradual preparation of seedlings to harsh climatic and site conditions in the field. This is being done as follows:

STEP 1:

Pre-harden the seedlings by partially exposing them to sunlight. Water the seedlings twice a week in 4 weeks, and gradually reduce to once a week for the remaining 4 weeks.

Figure 32. Pre-hardening of seedlings with partial exposure to sunlight.



HOW LONG ARE THE SEEDLINGS PRE-HARDENED?

ABOUT 2 MONTHS

This period varies depending on the species, age and the speed of recovery of the seedlings.

STEP 2:

Harden the seedlings by placing them under full sunlight with gradual reduction of watering - this time once every two weeks. Place 2-3 seedlings in a row to prevent light competition. Record the date when the seedlings are placed in the hardening area. Record all other information in Annex B.

Figure 33. Proper spacing to harden seedlings.

THE SEEDLINGS ARE HARDENED WHEN THEY ARE:

- at least 60-80 cm or knee-length in Height
- with Root Collar Diameter 5 – 7 mm or size of a mongol pencil
- with Number of Leaves at least 3-5 leaves

THESE ARE THE DESIRED CHARACTERISTICS OF SEEDLINGS THAT ARE READY FOR OUTPLANTING. THIS USUALLY TAKES ABOUT 3 MONTHS DEPENDING ON THE SPECIES.

ROOT PRUNING

Before out planting of seedlings, root pruning should be carried out. This can be done through:

- re-arrangement of pots at least 2-3 weeks to avoid roots penetrating the soil at the bottom;
- use of pruning shears or garden scissors (See Figure 34); or
- place seedlings in an elevated potting bed presented in Appendix 2.

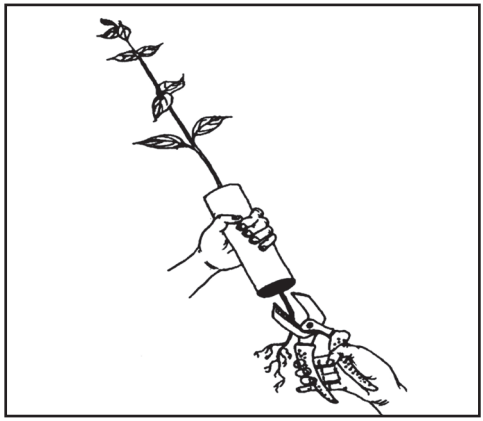


Figure 34. Pruning of roots through a pruning shear.

According to Mbora, et.al., (2008, p. 14) "If it's not possible to plant when the seedlings are ready for planting out (that means seedlings reached right size for planting-1.5 ft) or the seedling are not bought, cut the tips of the plant to suppress further growth so that they will not be overgrown during next season planting".

SORTING AND GRADING

STEP 1:

- After hardening, check if the seedlings are ready for outplanting.
- Randomly choose 10% of the total number of seedlings placed inside each chamber.

Seedlings are ready for outplanting when they meet the characteristics of hardened seedlings.

Culled seedlings are those that do not meet the standards of hardened seedlings and are not recommended to be used in outplanting.

STEP 2:

Measure the root collar diameter 0.5 – 1.0 cm from the top of soil. In the absence of caliper, pencil size (yellow mongol) seedlings would pass the sorting and grading.

STEP 3:

Measure the height of the seedling.

Figure 35. Measuring of hardened seedlings using a caliper.

STEP 4:
Count the number of leaves on each seedling.

Figure 36. Sorting and grading.

STEP 6: Cull-out seedlings with bent stems (right) and those with double stems (left). Record all information on Annex C.

Figure 37. Seedlings for culling out.

OTHER GOOD NURSERY MANAGEMENT PRACTICES

REGULAR WATERING

- The seedlings should be watered regularly.
- Optimal watering depends on temperature, air humidity, wind velocity, potential evaporation, tree species, seedling size and substrate.

Figure 38. Regular watering.

WEEDING AND MAINTENANCE OF NURSERY CLEANLINESS

- Regularly conduct weeding to prevent competition for light, water, nutrients and to prevent any possible spread of pests and diseases.
- Regularly maintain overall cleanliness of the nursery (such as removal of litter).

MONITORING OF PESTS AND DISEASES

- The most common pests and diseases observed in the nursery are the leaf-sucking and leaf-eating insects and bacterial wilt. (See Figures 39a-d)
- Manually remove the pests or the infected parts of the seedlings as soon as these are noticed to prevent spreading.
- If the damage on the seedlings reaches critical level, foliar biodegradable chemicals can be applied.

Figure 39a. Scale insects on mayapis

Figure 39b. Leaf-sucking insect on molave seedlings.

Figure 39c. Leaf eating caterpillar on white lauan seedling.

Figure 39d. Bacterial wilt on narra seedlings

HAULING AND TRANSPORT OF SEEDLINGS

- Hauling or transporting of seedlings from the nursery to the planting site is also crucial in handling the plants.
- Use closed vehicles for longer period and distance of hauling.
- To prevent further damaged of the plant, place the seedlings in a plastic or wooden crate.
- For shorter distances, the seedlings can be carried by animals or human.
- It is also suggested to use the rattan basket during hauling.

Figure 40. Seedlings can be hauled using closed vehicles like trucks.

Figure 41. Seedlings can be carried on big baskets.

Seedlings should be watered thoroughly before hauling.

Summary of Procedures

1. Locate good mother trees of those species that have been identified based on the site assessment.

2. Produce good quality planting materials either from seeds or wildlings using
    a. Standards in nursery operations, and
    b. Improved techniques in nursery management.

3. Check the seedlings if they are ready for outplanting.

4. Keep a record of the important seedling measurements since these will serve as basis for the monitoring of the health and quality of the seedlings.

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Glossary

Abaca tuxy – an outer strip of abaca that can be used for tying as rope

Banana bract – an outer part of the banana pseudo stem

Cotyledon – seed leaf within an embryo of a seed

Exotic species – species that have been transported by human activity, intentional or accidental, into a region where it does not naturally occur. Also called introduced, or non-native species.

Enrichment planting – the introduction of valuable species in forest areas, where economical species are lacking

GPS – Global Positioning System

Indigenous species – species or genotypes that have evolved in the same area, region or biotope and are adapted to the specific predominant ecological conditions at the time of establishment

Imbibition – the process with which seeds take up water during germination

Mycorrhizae – a mutually beneficial association of a fungus and the roots of a plant

Mother trees – a tree that is a source of seeds or wildlings

Native species – species that is normally found as part of a particular ecosystem

Nursery – a place where planting materials are raised

Permanent nursery – a type of nursery that is fixed and lasts for several years

Phenology – the fruiting and flowering cycles of a plant

Potting bed – also called nursery bed; a place where pots filled with soil are kept

Potting medium – the material in which seedlings are grown, usually a combination of soil and other organic materials

Quality seedlings – young plant with vigorous performance resistant to pest and diseases

Recalcitrant – refers to seeds with short viability

Recovery chamber – an enclosure wherein wildlings are kept after collection from the field to ensure their recovery and survival

Seed – embryonic plant enclosed in a protective outer covering called the seed coat

Seed coat – the protective outer covering of a seed

Seedling – nursery grown planting material smaller than 5 centimeters in diameter developed out of a seed

Temporary nursery – nurseries that are often used for a short period of time

Viable seeds – seeds that have the ability to germinate

Wildling – a young plant that grows in the wild or those plants that have not been cultivated

ANNEXES

Annex A. Record of phenology of identified mother trees

SPECIES		LOCATION		PHENOLOGY			REMARKS
Common Name	Local Name	GPS Reading	Site	Period of Flowering	Period of Fruiting	Period of Seed-Off	

Annex B. Monitoring form for hardening

RECOVERY CHAMBER No.	**Number of Seedlings Survived**
Date Chamber Was Closed:	
Dates Of Gradual Opening ***week 1:***	
week 2:	
week 3:	
Date Of Removal Of Plastic Cover From Chamber:	
Date Hardened:	

Annex C. Seedling evaluation form

SPECIES	ROOT COLLAR DIAMETER (mm)	HEIGHT (cm)	NO. OF LEAVES	ROOT FORMATION ☑ where applicable		REMARKS ☑ where applicable	
				straight	coiled	culled	for outplanting

APPENDIX

Appendix 1. Compilation of different indigenous species and their respective seed processing techniques.

Local Name	Scientific name	Site requirements	Seed collection	Seed extraction	Germination treatment	Germination period	Ecological Function	Successional Guild	Source
Alagao	*Premna odorata* Blanco	Sandy, clay and calcareous soil Lower elevation	September-October (Leyte)	Collect the ripe fruits, macerate, and depulp	Soak the seeds in water for 24 hrs, sundry for 8-16 hrs., and soak again for another 24 hrs.	17-21 DAS	Food for frugivores	Long-lived early successional	VSU
Almon	*Shorea almon* Foxw.	Volcanic soils	August-September (Leyte)	Collect the ripe fruits	Remove the wings and pot	Usually seeds germinate during seed off		Long-lived late successional	VSU
Amugis	*Koordersiodendron pinnatum*	Forest at low and medium altitudes	July – September (Leyte)	Collect the ripe fruits, macerate, and depulp	Scarification	18-20 DAS	Food for frugivores	Late-successional	VSU
Anii	*Erythrina fusca* Lour.	Low to medium altitude	July-August (Leyte)	Collect and split the pods	Soak the seeds in water for 24 hrs	7-10 DAS	Shade tree and nitrogen fixing tree	Short-lived early successional	VSU
Anislag	*Flueggea flexuosa*Müll. Arg.	At low elevation and grows well along the riverbanks. Can grow in swamp area.	September-October (Leyte)	Collect the ripe fruits, macerate, and depulp	Sow the seeds in seedboxes filled with sand	15-22 DAS	Food for frugivores	Mid-successional	VSU
Antipolo	*Artocarpus blancoi* (Elmer) Merr.	Sandy and limestone soil Valley bottoms and stream bank	June-July (Leyte)	Collect the ripe fruits, macerate, and depulp	Soak the seeds in water for 24 hrs and sealed in a sack for 2-3 days	5-7 DAS	Serves as shade tree and food for frugivores	Long-lived early successional	VSU
Apitong	*Dipterocarpus grandiflorus* Blanco	Semi-evergreen rain forest; on small islands and on coastal hills in less seasonal areas	August-October (Leyte)	Collect the ripe fruits	Remove the wings and pot	Usually seeds germinate during seed off		Long-lived late successional	VSU

(Continuation of Appendix 1)

Local Name	Scientific name	Site requirements	Seed collection	Seed extraction	Germination treatment	Germination period	Ecological Function	Successional Guild	Source
Bago	***Gnetum gnemon***	Dry and humid area, low and medium altitude Annual rainfall 750 to 1000 mm Clay to clay loam and calcareous	June to July (Philippines) Sept. to Oct. (Leyte and Southern Leyte)			45 to 360 DAS		Mid-successional	VSU and RISE
Bagtikan	*Parashorea malaanonan* (Blanco) Merr.	Lowlands up to 1300 m	August-September (Leyte)	Collect the ripe fruits	Remove the wings and pot	Usually seeds germinate during seed off		Long-lived late successional	VSU
Bahai	*Ormosia calavensis* Azaola	At low elevation and grows well along the ridge. Clay to clayloam soil	August to October (Leyte)	Collect and split the pods	Soak the seeds in water for 24 hrs	20-25 DAS	Nitrogen fixing tree	Long-lived early successional	VSU
Bakan	*Litsea philippinensis Merr.*	Sandy to clay loam soil	October – November (Laguna)	Soak the fruit overnight then depulp.	Air-dry before sowing	120 DAS	Food for frugivores	Long-lived early successional	VSU, DENR Recommends
Bangkal	*Nauclea orientalis* (L.)	Usually grows in streams and swampy areas	December-January (Laguna)	Soak the fruit in tap water to soften the pericarp. Macerate to separate the seeds and strain to remove the fruit debris	Sow the seeds in seedboxes filled with sand	15 to 18 DAS	Food for frugivores	Late successional in swamp forests	VSU, DENR Recommends
Bani	*Pongamia pinnata (L.)Pierre*	Occurs naturally in beach forests and thickets						Short-lived early successional	Fernando et. al. 2004

(Continuation of Appendix 1)

Local Name	Scientific name	Site requirements	Seed collection	Seed extraction	Germination treatment	Germination period	Ecological Function	Successional Guild	Source
Batete	*Kingiodendron alternifolium*	Mid elevation and occurs in primary forest. Sandy and clayloam soil	August to September (Leyte)	Collect the fruits and depulp	Direct potting	18-23 DAS		Mid-successional	VSU
Batino	*Alstonia macrophylla*	Clay and sandy soils	July-November (Laguna)	Extract the seeds manually	Air-dry the seeds for 5 days	10-14 DAS	Serves as shade tree	Short-lived early successional	VSU, DENR Recommends
Binucao or Batuan	*Garcinia binucao*	Well drain at low altitude	July (Laguna) June (Eastern Visayas)				Food for bats, turtles	Mid-successional	
Bitanghol	*Callophylum blancoi*	Sandy soil 400 to 500 elevation calcareous	January (Ilocos Norte) February to March (Laguna) July (Cebu)	Ripen the fruits and depulp	Remove the shell completely and soak tap water overnight, air dry the seeds do not sun dry	8-12 DAS	Serves as shade, shelterbelt and windbreaker, Food plant for frugivores	Long-lived early successional	
Bitaog	*Callophylum inophyllum*	Beach tree species, growing in sandy soils	January (Ilocos Norte) February to March (Laguna) July (Cebu)	Ripen the fruits and depulp	Remove the shell completely and soak tap water overnight Air dry the seeds do not sun dry	8-12 DAS	Shade, shelter and windbreaker, Food plants for frugivores	Late successional in beach forest	
Bitongol	*Flacourtia rukam* Zoll. & Mor.	low and medium altitudes	October-November (Luzon)	Soak the fruit in tap water to soften the pulp, then extract the seeds manually.		15 DAS	Food plant for frugivores	Long-lived mid-successional	DENR Recommends

(Continuation of Appendix 1)

Local Name	Scientific name	Site requirements	Seed collection	Seed extraction	Germination treatment	Germination period	Ecological Function	Successional Guild	Source
Dalingdingan	*Hopea foxworthyi*	Semi-evergreen rainforest; volcanic and calcareous soils	July-August (Leyte)	Collect the ripe fruits	Remove the wings and pot	Usually seeds germinate during seed off		Long-lived late successional	VSU
Dao	*Dracontomelon dao* (Blanco) Merr.	At low elevation and grows well along the riverbanks. In primary and secondary forest	August-September (Leyte)	Ripen the fruits, macerate, and depulp	Soak the seeds in water for 24 hrs, sundry for 8-16 hrs., and soak again for another 24 hrs.	14-21 DAS	Food for frugivores Serves as shade tree and erosion control	Long-lived early successional	VSU
Dita	*Alstonia scholaris* (L.) R. Br. Var.	at low and medium altitudes	May-July (Luzon)	Sun-dry or air-dry the follicle to split. Then extract the seeds manually.		6 to 30 DAS	Wind breaker Nesting tree for Philippine squirrel	Long-lived early successional	DENR Recommends
Dungon	*Heritiera sylvatica* S. Vidal	Forest at low and medium altitudes	July – September (Leyte)	Collect the fruits and depulp	Remove the wings and pot	16-18 DAS		Mid-successional	VSU
Guijo	*Shorea guiso (Blanco) Blume*	Lowland forest' volcanic soils	August-September (Leyte)	Collect the ripe fruits	Remove the wings and pot	Usually seeds germinate during seed off		Long-lived late successional	VSU
Guisok-gisok	*Hopea philippinensis* Dyer	Volcanic soils	June-July (Leyte)	Collect the ripe fruits	Remove the wings and pot	Usually seeds germinate during seed off		Long-lived late successional	VSU
Hagakhak	*Dipterocarpus validus* Blume	Flat land, freshwater swamps, riverine sites and occasionally in hills to 300 m.	August-October (Leyte)	Collect the ripe fruits	Remove the wings and pot	Usually seeds germinate during seed off		Long-lived late successional	VSU
Igyo	*Dysoxylum gaudichaudianum* (A. Juss)	well-drained habitats in the lowland on clayey to sandy soils	October-December (Laguna)	Ripen fruits and depulp	Remove the seed coat	7 DAS	Serves as shade tree and food for frugivores	Short-lived early successional	VSU, DENR Recommends

(Continuation of Appendix 1)

Local Name	Scientific name	Site requirements	Seed collection	Seed extraction	Germination treatment	Germination period	Ecological Function	Successional Guild	Source
Kalantas	*Toona calantas* Merr. & Rolfe	Grows in low and medium altitudes. It prefers deep and well-drained soils	February-March (Laguna)	Extract the seeds manually	Remove the wings before sowing	7 DAS in dried humus 3 DAS in filter paper		Long-lived early successional	
Kalukoi	*Ficus callosa*	Sandy, clayloam and moist soil	March to April July to August (Cebu)	Soak the fruit and macerate. Strain the seeds to separate from the pulp.	Sow the seeds in the seedbox filled with sand	15 to 20 DAS	Food plant for bats (frugivore)	Short-lived early successional	VSU,RISE
Kalumpit	*Terminalia microcarpa* Decne.	Sandy and limestone soil Valley bottoms and stream bank	July-August(Leyte)	Ripen the fruits, macerate, and depulp	Soak the seeds in water for 24 hrs, sundry for 8-16 hrs., and soak again for another 24 hrs.	14-21 DAS	Serves as shade tree and food for frugivores	Long-lived early successional	VSU
Kaningning	*Guioa bicolor Merr*	ultrabasic soils, up to 1,000 m altitude	March-April (Laguna)	Remove the fleshy orange aril and wash the seeds in running water to completely remove the pericarp.		2 DAS (black seeds) 7 DAS (light brown seeds)		Long-lived mid-successional	DENR Recommends
Kulatingan	*Pterospermum obliquum*Blanco	On forest edges at low elevation	July-September (Leyte)	Collect the fruits and split	Remove the wings and pot	16-18 DAS		Mid-successional	VSU

(Continuation of Appendix 1)

Local Name	Scientific name	Site requirements	Seed collection	Seed extraction	Germination treatment	Germination period	Ecological Function	Successional Guild	Source
Laneteng gubat	Kibatalia gitingensis	Sandy loam Thrive up to 1000m elevation	January to February November to December (Laguna)	None		1 to 3 months		Germination medium: Coconut coir dust, dried humus and garden soil 1:1:1	
Lanipga	*Toona philippinensis* Elmer	Sandy, clay or clayloam	August-September (Leyte)	Ripen the fruits, macerate, and depulp	Soak the seeds in water for 24 hrs, sundry for 8-16 hrs.	17-21 DAS	Serves as shade tree and food for frugivores	Long-lived early successional	VSU
Libas	*Spondia pinnata*	Limestone Tidal forest Lowland to 500m elevation	June to October (Luzon)	Ripen the fruits and depulp	Pot seeds directly	15 to 21 DAS	Food plant for ruminants	Short-lived early successional	
Lingo-lingo	*Viticipremna philippinensis* (Turcz.)H.J. Lam.	Limestone Lower elevation	July-August (Leyte)	Collect the ripe fruits, macerate, and depulp	Soak the seeds in water for 24 hrs, sundry for 8-16 hrs., and soak again for another 24 hrs.	17-21 DAS	Food for frugivores	Long-lived early successional	VSU
Lipote or Igang	*Syzygium polycephaloides*	Low to medium elevation	December and July (Luzon)	Ripen the fruits and depulp	Pot seeds directly		Food for frugivores Serves as shade tree and wind breaker	Long lived early successional	
Magkuno/ Mancono	*Xanthostemon fruticosus*	At low and medium altitudes. Ultramafic forest.	July-August (Leyte)	Collect and split the pods	Soak the seeds in water for 24 hrs	17-25 DAS		Late successional	VSU
Magtalisay	*Terminalia spp.*	Karst forest. Sandy loam/Clay loam, calcareous soil. Inland and near the coasts.	July-October (Pilar, Camotes)	Collect the ripe fruits and depulp	Direct potting	18-20 DAS	Serves as shade tree and food for frugivores	Long-lived successional	VSU

(Continuation of Appendix 1)

Local Name	Scientific name	Site requirements	Seed collection	Seed extraction	Germination treatment	Germination period	Ecological Function	Successional Guild	Source
Malakauayan	*Podocarpus rumphii* Blume	Usually to 200m alt.	August – October (Leyte)	Collect the fruits and macerate	Sow the seeds in seedboxes filled with sand	15-18 DAS	Nitrogen fixing tree	Mid-successional	VSU
Malambingan	*Broussenitia luzonica*	Sandy soil Low to medium altitude		Crash fruits in fine screen wire	Sun-dry for 1 day or air-dry for 2 days	8-10 DAS	Food plant for frugivores		RISE
Malapapaya	***Polyscias nodosa***	Moist along gullys and creeks Low to medium altitude	January (Surigao), February (Rizal), April (Bataan) and September and October (Laguna) November (Benguet)	Remove seeds from fruits	Soak in water for 24 hours, macerate and sun-dry for 2 to 3 days	25 to 30 DAS	Fast growing pioneer shade tree	Short-lived early successional	VSU and RISE
Malayakal	*Shorea seminis* (de Vriese) Slooten	Alluvial soils on sluggish rivers, below 100 m	August-September (Leyte)	Collect the ripe fruits	Direct potting	Usually seeds germinate during seed off		Long-lived late successional	VSU
Mangalingau	*Melia azedarach*	All type of soil 18^{O}C mean annual temperature Elev. 200m Rainfall 600 to 1000mm per annum			Soak in tap water and air dry	20 to 60 DAS	Windbreaker		RISE
Manggachapui	*Hopea acuminata* Merr.	Semi-evergreen and evergreen rain forests, (100-)300-800 m	July-August (Leyte)	Collect the ripe fruits	Remove the wings and pot	Usually seeds germinate during seed off		Long-lived late successional	VSU
Manggasinoro	*Shorea assamica* Dyer	Fertile soil in semi-evergreen rain forest	August-September (Leyte)	Collect the ripe fruits	Remove the wings and pot	Usually seeds germinate during seed off		Long-lived late successional	VSU

(Continuation of Appendix 1)

Local Name	Scientific name	Site requirements	Seed collection	Seed extraction	Germination treatment	Germination period	Ecological Function	Successional Guild	Source
Mayapis	*Shorea palosapis*(Blanco) Merr.	Evergreen rain forest below 300 m; fertile and well drained sites	August-September (Leyte)	Collect the ripe fruits	Remove the wings and pot	Usually seeds germinate during seed off		Long-lived late successional	VSU
Milipili	*Canarium hirsutum*	Forest at low and medium altitudes	June-July (Leyte)	Collect the ripe fruits, macerate, and depulp	Scarification	12-15 DAS		Short-lived early successional	VSU
Molave	Vitex parviflora	Sandy, clay and calcareous soil Lower elevation	September to October (Eastern Visayas) January (Mindoro) February (Pangasinan) March (Cagayan, Cebu) April (Surigao) May (Bohol)	Ripen the fruits and removal of pericarps	Soak the seeds in the solution (HCl with water) Soak the seeds in water for 24 hrs and sundry for 8 hrs., soak again for another 24 hrs.	7 to 15 DAS 17 to 21 DAS	Food plant for birds (Fruigivore)	Late successional species in Karst forest	VSU, RISE
Narig	*Vatica mangachapoi* Blanco	Evergreen and semi-evergreen rain forest	June-July (Leyte)	Collect the ripe fruits	Remove the wings and pot	Usually seeds germinate during seed off		Long-lived late successional	
Pagsahingin	*Canarium asperum*	Forest at low and medium altitudes	June-July (Leyte)	Collect the ripe fruits, macerate, and depulp	Scarification	12-15 DAS		Short-lived early successional	VSU
Paguringon	*Cratoxylum sumatranum* (Jack)	sometimes in open places at low and medium altitudes	May-June; August-September (Laguna)	Shake the fruits to dislodge the seeds	Sow seeds right after extraction to attain high germination			Long-lived early successional	DENR Recommends

(Continuation of Appendix 1)

Local Name	Scientific name	Site requirements	Seed collection	Seed extraction	Germination treatment	Germination period	Ecological Function	Successional Guild	Source
Pili	*Canarium ovatum*	Low to medium altitude Limestone and volcanic soil	All year round (Leyte)	Collect the ripe fruits and depulp	Scarification	15-21 DAS		Long-lived early successional	VSU
Red lauan	*Shorea negrosensis*Fox w.	Evergreen and semi-evergreen rain forests; volcanic soils	August-September (Leyte)	Collect the ripe fruits	Remove the wings and pot	Usually seeds germinate during seed off		Long-lived late successional	VSU
Sibukao	*Caesalpinia sappan*	Clayey soil or Calcareous Low and medium altitude	January to February (Luzon)	Sun dry seeds for 3 to 7 days	Nick the seed coat		Food plants for butterflies	Short-lived early successional	
Talisay	*Terminalia catappa*L.	Occurs naturally along sandy and rocky beaches or tidal river banks	All year round(Leyte)	Collect the ripe fruits and depulp	Direct potting	18-25 DAS	Serves as shade tree and food for frugivores	Long-lived early successional	VSU and Fernando et. al. 2004
Tamayuan	*Strombosia philippinensis*	At low and medium altitudes	July-August (Leyte)	Collect the ripe fruits, macerate, and depulp	Soak the seeds in water for 24 hrs,	15-20 DAS		Short-lived early successional	VSU and Fernando et. al. 2004
Tanguile	*Shorea polysperma* (Blanco) Merr.	Evergreen rainforest on hills; volcanic soils	August-September (Leyte)	Collect the ripe fruits	Remove the wings and pot	Usually seeds germinate during seed off		Long-lived late successional	VSU
Local Name	**Scientific name**	**Site requirements**	**Seed collection**	**Seed extraction**	**Germination treatment**	**Germination period**	**Ecological Function**	**Successional Guild**	**Source**
Toog	*Peterianthus quadrialatus*	At low to medium altitudes, on well-drained soils near riverbanks or on hillsides	March and May (Luzon)	Extract the seeds manually	Pot seeds directly	7 DAS	Soil erosion Windbreaker Nesting tree for Philippine Cockatoo	Long-lived early successional	
White lauan	*Shorea contorta* S. Vidal	Semi-evergreen lowland rain forest; volcanic soils	August-September (Leyte)	Collect the ripe fruits	Remove the wings and pot	Usually seeds germinate during seed off		Long-lived late successional	VSU

(Continuation of Appendix 1)

Local Name	Scientific name	Site requirements	Seed collection	Seed extraction	Germination treatment	Germination period	Ecological Function	Successional Guild	Source
Yakal kaliot	*Hopea malibato*Foxw.	Volcanic soils	July-August (Leyte)	Collect the ripe fruits	Remove the wings and pot	Usually seeds germinate during seed off		Long-lived late successional	VSU
Yakal saplungan	*Hopea plagata* (Blanco) S. Vidal	Semi-evergreen rainforest; volcanic soils	July-August (Leyte)	Collect the ripe fruits	Remove the wings and pot	Usually seeds germinate during seed off		Long-lived late successional	VSU
Yakal yamban	*Shorea falciferoides* Foxw. *ssp.*	Rain forest to 1000 m	August-September (Leyte)	Collect the ripe fruits	Remove the wings and pot	Usually seeds germinate during seed off		Long-lived late successional	VSU

Appendix 2. Construction of elevated nursery beds

The use of elevated nursery beds aims to address root pruning. Below are the step-by-step procedures in constructing an elevated nursery bed.

STEP 1: Prepare the following materials:

- 2 pcs lumber (2" x 2"; 1 meter in length)
- 2 pcs lumber (2" x 2"; 3 meters in length)
- 2 pcs wood slats (1" x 2"; 3 meters in length; to be used for flooring and to tuck the mesh net)
- 24 pcs wood slats (1" x 2"; 1 meter in length; to be used for flooring and tucking
  the mesh net)
- 4 pcs lumber (2" x 2"; 0.2 meter in length; to elevate the nursery beds)
- 3.2 meters green plastic mesh net nails

STEP 2: Construct the frame of the elevated nursery bed with a dimension of 1 meter in width, 3 meters in length, and with a height of 0.2 meter from the ground.

STEP 3: For the flooring, tuck the green plastic mesh net on the frame and secure by nailing wood slats. The distance between the 1-meter wood slats is about 7 inches from each other.

STEP 4: Place the 32 seedlings by two's for every interval between wood slats with similar height to avoid competition.

(Continuation of Appendix 2)

Elevate the nursery bed 0.2 meter from the ground.

Tuck the mesh net in between 2 pieces of wood.

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