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

A Field Manual on Forest Restoration Using Indigenous Species

energy
DEVELOPMENT CORPORATION

VISAYAS STATE UNIVERSITY

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Forest Restoration in Grasslands, Brushlands, and Forest Gaps

This module will guide you on how and where to start forest restoration and which planting strategies to choose in a given site condition. General procedures and techniques in the establishment, maintenance, protection, and monitoring trees in the restoration sites are also mentioned here.

A Field Manual On Forest Restoration Using Indigenous Species

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DEPARTMENT OF ENVIRONMENT
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Visayas Avenue, Diliman Quezon City

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
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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.

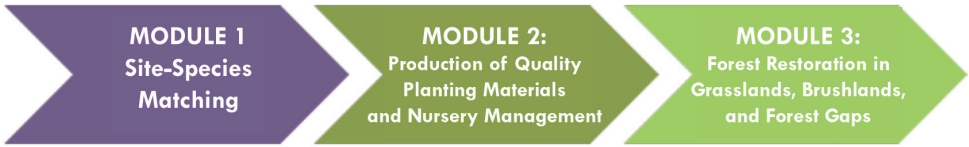
Module 2: Production of Quality Planting Materials and Nursery Management

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.

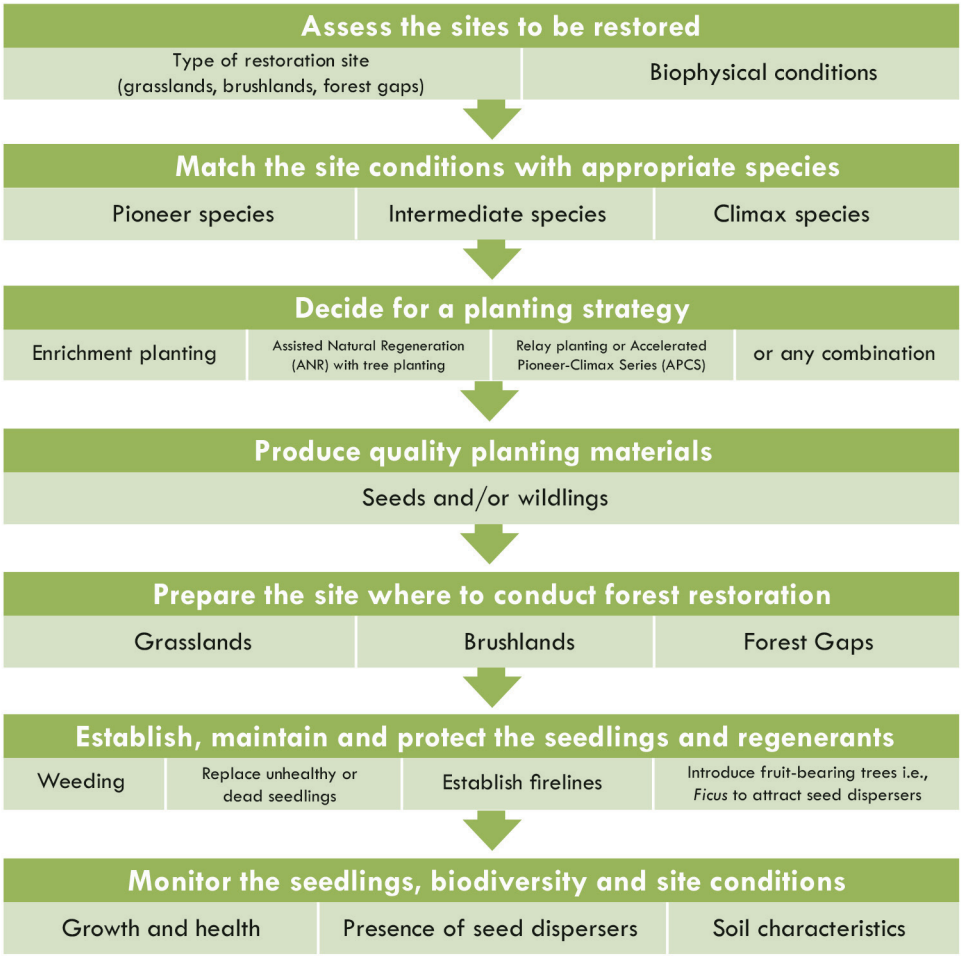
Module 3: Forest Restoration in Grasslands, Brushlands, and Forest Gaps

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 3:

Forest Restoration in Grasslands, Brushlands, and Forest Gaps

This module will guide you on how and where to start forest restoration and which planting strategies to choose in a given site condition. General procedures and techniques in the establishment, maintenance, protection, and monitoring trees in the restoration sites are also mentioned here.

Introduction

Most target areas for reforestation are grassland areas where planting strategies or design are commonly clearing or strip brushing, wide planting spaces, use of fast growing ***exotic species***, and monoculture (i.e. use of single species). This one-size fits all practice is being applied in restoring almost all levels of degradation in the field. But to maximize efforts and minimize costs, planting strategies must vary according to the existing site conditions. For example, degraded areas with plenty of regenerants and seed dispersers would mean less labor in planting the ***seedlings*** and more effort in assisting the growth of existing regenerants. In addition, these areas can be inter-planted with mixed-species of indigenous trees to improve the ecological and economic quality of the stand being restored.

This module is therefore developed to guide field implementers in customizing planting strategy according to 3 different levels of site conditions namely ***grasslands***, ***brushlands***, and ***forest gaps***.

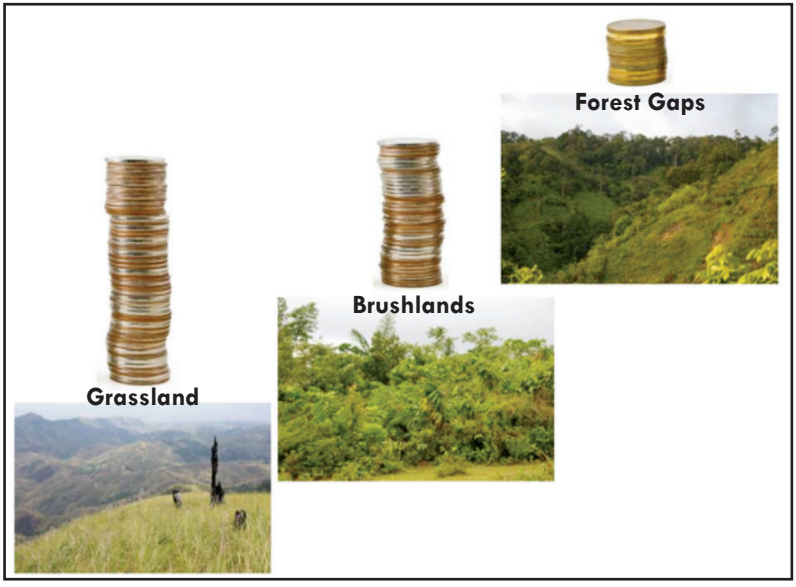


Figure 1. The cost of forest restoration in various degrees of degradation.

Scope of the Module

This module intends to guide the users to:

1. Identify areas where to start the restoration,
2. Establish forests in grasslands or brushlands or forest gaps using appropriate planting strategies,
3. Maintain and protect restoration sites through appropriate silvicultural operations, and
4. Monitor the biodiversity, growth, performance and health of the planted trees and regenerants in the restoration sites.

WHY IS IT IMPORTANT TO APPLY DIFFERENT PLANTING STRATEGIES WHEN CONDUCTING FOREST RESTORATION?

- Because the more degraded the site, the more expensive and labor intensive it is to restore.
- Different planting strategies will maximize the use of:
  - existing trees as shade trees,
  - regenerants,
  - natural ***seed rain process***, and
  - animal ***seed dispersers*** to hasten the restoration.

Which means less labor and inputs on the part of the farmers.

I. Identifying and preparing areas to start restoration.

STEP 1:

Prepare a map of your restoration sites for ease of implementation and monitoring. For large tract of areas to be restored, mark the areas near the forest patches that will be prioritized within the same planting year. Progress to the farther sites on the succeeding planting years. See Figure 2 below for the sample planting map.

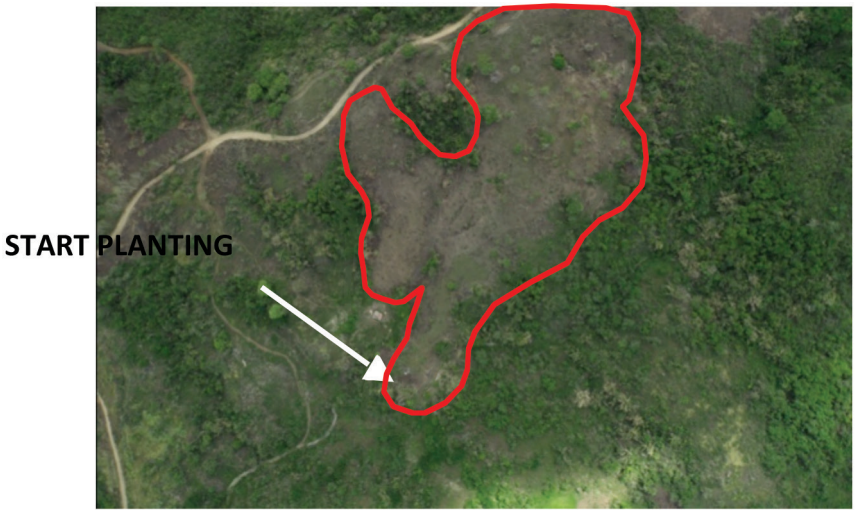


Figure 2. Aerial view of forest gaps (inside the red line) (Source of Photo: DENR, FMB)

If no surrounding forest patches are present, consider starting from the most accessible portion of the restoration site.

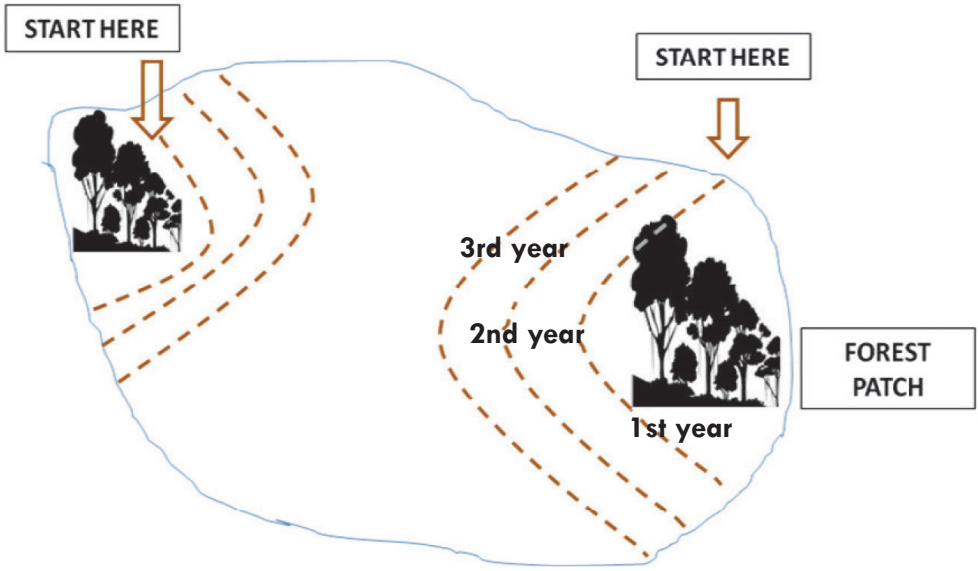


Figure 3. Mapping and planning of areas to be restored.

Some recommendations during site preparations:

- Geotag the sites to be restored.
- Take photos of the site before conducting any forest restoration activities. This is to have proper documentation of the site before planting.
- Take photos in a panoramic view.

STEP 2:

Address possible disturbances, such as fire and grazing animals, through:

- Establishing of firebreaks or strips of land (usually 5 meters wide) which are cleared of vegetation to prevent the spread of fire.
- Planting of bananas or root crops such as gabi, camoteng kahoy or cassava, etc. along strips can also serve as firebreaks in the plantation. See Figure 4.
- fencing of restoration areas frequently disturbed by grazing animals, if possible. See Figure 5.

Figure 4. Establishment of firelines in the restoration sites.

Figure 5. Fencing of plantation areas.

Tips to increase survival of seedlings in highly degraded areas:

- The site should first undergo intensive vegetative remediation if it is in any of the following conditions:
  - heavily degraded
  - too far from the forest remnants, and
  - have no signs of vegetation or regenerants.

- One should not attempt to plant purely climax species directly in these areas. It will only result to high mortality of seedlings.

- Plant nitrogen-fixing pioneer species like kakaute, narra, banuyo, dapdap, or generally pioneer species under Fabaceae family (Refer to Fabaceae species in Appendix 1).

- Prepare the site, 1-2 weeks before the onset of the rainy season.

STEP 3:

Clean the restoration site through spot brushing. Spot brushing is the removal of grasses on the target spot where you intend to plant the seedlings.

The recommended size of spot is 0.5 meter radius.

- During the site preparation, be careful when brushing to avoid any damage to existing regenerants in the restoration site.

Figure 6. Proper brushing.

WHY IS IT IMPORTANT TO PREPARE THE RESTORATION SITE BEFORE TREE PLANTING?

- Saves cost and labor since it reduces seedling mortality.
- Ensures survival of existing regenerants in the restoration site before the planting activity begins.
- Liberates newly-planted seedlings in the restoration sites from competing weeds like grasses, and other undesirable plants.

II. Restoring forests in grasslands, brushlands, and forest gaps

Based from observations, the more degraded a site is, the more expensive and labor intensive it is to restore the said site. To minimize the cost and the effort, different planting strategies are recommended to hasten the forest ecological succession in the area. These strategies will be applied to different sites with different levels of degradation as follows:

A. Grasslands

Grassland areas referred in this module are those that were previously forested but became acidic and became favorable thriving sites for grasses like cogon, talahib, and creeping ferns due to extreme degradation and vegetation clearing.

Below is a step-by-step procedure for restoring indigenous forests in grasslands:

STEP 1:

Retrieve the completed Rapid Site Assessment form (see Module 1) to know the number of regenerants present in the area and the number of seedlings yet to be planted to complete the targeted 2,500 seedlings in 1 hectare.

Figure 7. Grassland areas in Northern Negros being restored into forest by EDC under its BINHI program.

STEP 2:

Mark the existing regenerants in the site using bamboo stakes or poles. One may also use a brightly-colored ribbon and tie it to the regenerants. This activity is important in order to avoid damage to existing trees prior to cleaning the site.

Figure 8. Use bamboo or locally available materials to mark the regenerants anislag *(Flueggea flexousa)*.

STEP 3:

Use Accelerated Pioneer-Climax Series (APCS) or relay planting as main strategy for grasslands. This planting design is useful in restoring forests in open areas such as grasslands and brushlands. It aims to attain close canopy in soonest possible time thus inhibiting the growth of tall grasses.

- Mixed-species is used in APCS or relay planting to attain high diversity which helps minimize pests and disease outbreaks.
- A good tree species combination should also be done to avoid competition on limited resources in the field like nutrients, water and light.

- Fast growing pioneers or ***early successional*** trees and ***mid-successional*** trees are planted during the initial year (see Appendix 1 and 2).
- Shade tolerant or late successional trees can be planted on the second year when the pioneers are already providing shade. (see Appendix 3).
- Fast-growing pioneers are planted at close distance of 2 meters by 2 meters (see Figure 9).
- Shade tolerant species such as Dipterocarps are planted at the center of 4 pioneers. This method of planting trees uses diagonal planting (see Figure 10) which is helpful in sloping areas to reduce soil erosion and to serve as wind breaks.

Figure 9. Three-year old rainforestation farm (Location: Brgy. Liptong, Bacong, Negros Oriental) .

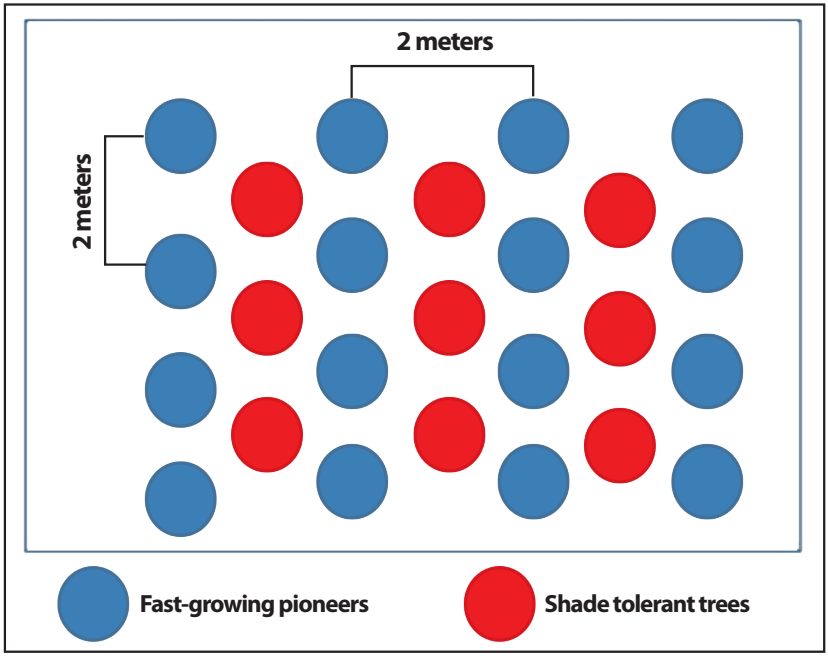
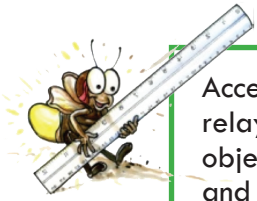


Figure 10. Diagonal planting design used in establishing indigenous forests in grasslands.



Accelerated-Pioneer Climax Species (APCS) strategy or relay planting is commonly used in ***rainforestation*** with the objective of restoring the site for environmental protection and biodiversity conservation.

STEP 4:

Conduct thinning of fast-growing trees once the climax ***species*** have grown to sapling size to reduce competition in the area. This would take around 7-10 years depending on the growth of the climax species planted.

B. Brushlands

Brushlands are areas characterized by patchy ***shrubs***, bushes and herbaceous vegetation. These areas have more existing vegetation including small trees and early successional species that may serve as shade trees to newly planted seedlings.

- There are more existing woody vegetation (regenerants), ***herbs***, and shrubs in brushlands than in grasslands.
- Regenerants in the restoration site could serve as shade trees to newly planted seedlings. Thus, ring weeding should be done instead of strip brushing and clearing.
- During site assessment, existing trees in the area must be included in the count of 2,500 ***density*** that is needed to close the ***canopy*** in one hectare.

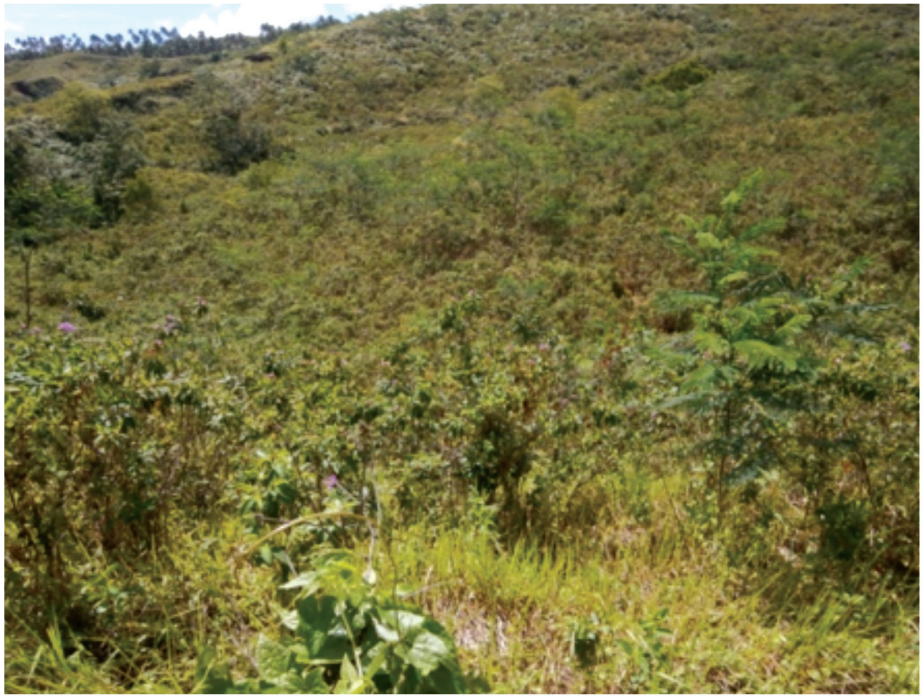


Figure 11. Brushlands in EDC site Northern Negros Geothermal Project (NNGP) site.

Below is a step-by-step procedure for restoring indigenous forests in brushlands:

STEP 1:

- Prepare the site before planting. Remove grasses competing shrubs or climbing vines. Preserve native woody shrubs in the area to provide shade to newly planted seedlings.

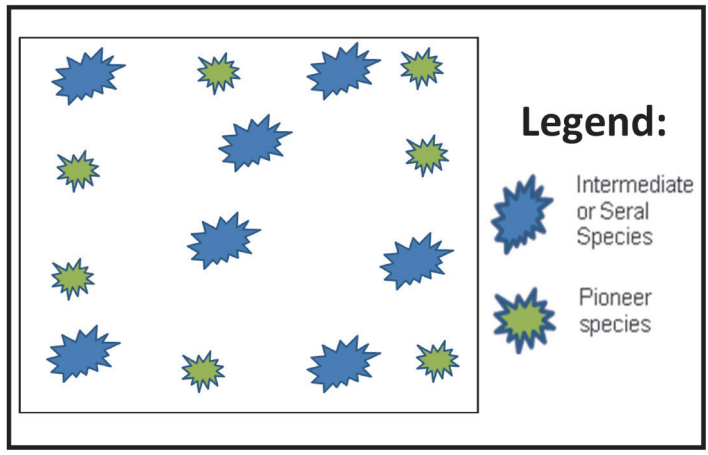


Figure 12. Sample map of the existing regenerants in the restoration site.

STEP 2:

Use Assisted Natural Regeneration (ANR) as major planting strategy for brushlands:

WHAT IS ANR OR ASSISTED NATURAL REGENERATION?

- Assisted or Accelerated Natural Regeneration (ANR) is a "low-cost" reforestation strategy.
- Developed and promoted by the United Nations Food and Agriculture Organization (UN FAO) and pioneered in the Philippines in the 1980s.
- This approach relies on advanced regeneration, live stumps, seed bank and seed rain. Hence, seedling production is not necessary.
- In ANR, costs go to labor in protecting the site (i.e. fire and grazing) and by suppressing weeds or grasses.

Steps in conducting ANR include the following:

1. Locate existing ***regenerants*** in the site such as ***wildlings, saplings, live tree stumps,*** trees (see Figure 13).

Figure 13. Locating regenerants (Photo credit: FMB-DENR).

2. Conduct ring weeding at the base of the existing regenerants. (see Figure 14).

Figure 14. Ring-weeding of regenerants.

3. Press the grasses in the restoration site to reduce the risk of fire and to lessen the competition from weeds.

Suppressing the grasses in the site using a banana pseudostem or wooden board (130 cm length and 15 cm wide; Elliot et.al., 2013) would free the regenerants from the shade of these grasses specifically Imperata. It also helps speed up the growth of trees that are already established in the restoration site.

- ANR is effective when the site is dominated by soft grasses like Imperata or cogon.
- Do the pressing when grasses are more than 1 meter tall in height or 2 months after rains have started.
- In areas where grasses like Saccharum or talahib dominate, slashing is advised and pressing is not recommended because nodes along their stem can easily re-sprout.

Another way to suppress the surrounding grasses in the site is by pressing or lodging using the wooden board.

Photo credit: FMB-DENR

4. Remove grasses at the base of the existing regenerants in the site, about 0.5 meter distance from the tree.

5. Place cut grasses around the base of the regenerants to serve as mulch.

Figure 15. Landscape of ANR area showing regenerants marked with stakes and around flattened grasses (Photo credit: FMB-DENR).

STEP 3:

Conduct Enrichment Planting (EP) in the area using fast growing and light demanding native trees like narra, kalumpit and bagalunga in between regenerants (See Figure 16 below). The purpose of this enrichment planting is to:

- Increase the density,
- Immediately cover the restoration site and,
- Improve the ecological and economic value of the stand (and not end up with a forest consisting only of pioneer tree species).

Keep a distance of 2 meters by 2 meters between newly planted seedlings with existing trees/regenerants in the site to avoid competition.

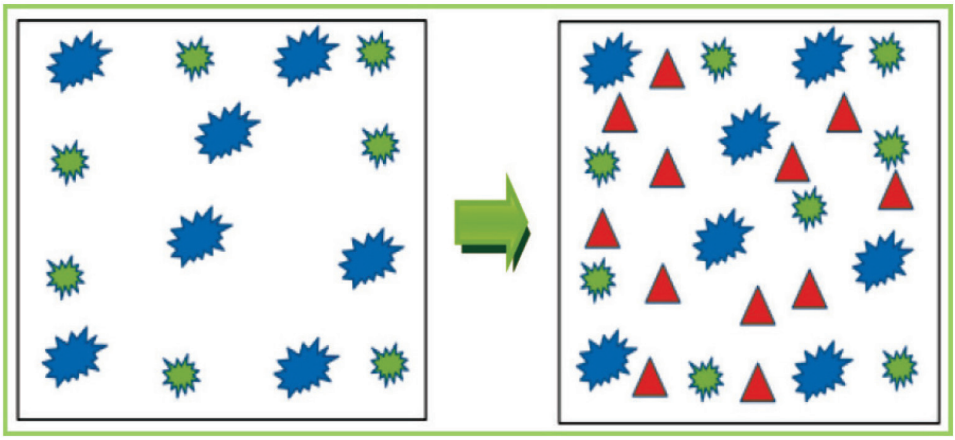


Figure 16. Sample planting configuration in brushlands.

- Look for 600-700 vigorous wildlings per hectare with 15-200 cm height of pioneer species, brush and other woody species relatively well spread on the area.
- If the site has few regenerants or wildlings (less than 600), the area could be utilized for reforestation.
- Areas with more than 700 wildlings can be restored through ***enrichment*** planting. Source: (FMB Technical Bulletin on ANR).

C. Forest Gaps

Forest restoration or planting activities could also be done in forest gaps. Gaps are spaces in forests due to individual tree or group tree mortality. In these areas, trees are more dominant over grasses, herbs and shrubs. In contrast, the small forested areas surrounded by gaps (non-forested land cover) are called **forest patches.**

Figure 17. New BINHI plantation in the forest gaps of Solsona, Ilocos Norte - an EDC reforestation site.

To maximize the restoration effort in a forest gap, the area must be a severely disturbed natural forest, of whatever cause, with a basal area of trees less than five (5) square meters per hectare of all commercial tree species, with dbh/dab of less than 65 centimeters (Based on the definition of degraded residual forest from DENR Administrative Order 99-53).

Below is a step-by-step procedure for restoring indigenous forests in forest gaps:

STEP 1:
Prepare the site before planting by liberating regenerants from climbing vines and weeds.

STEP 2:
Mark naturally existing regenerants i.e. wildlings, saplings, live tree stumps.

STEP 3:
Clean specific spot where to plant seedlings (i.e leguminous and/or dipterocarps). In cleaning, care must be taken not to damage existing regenerants. Also, ***spot brushing*** is recommended to reduce the labor cost.

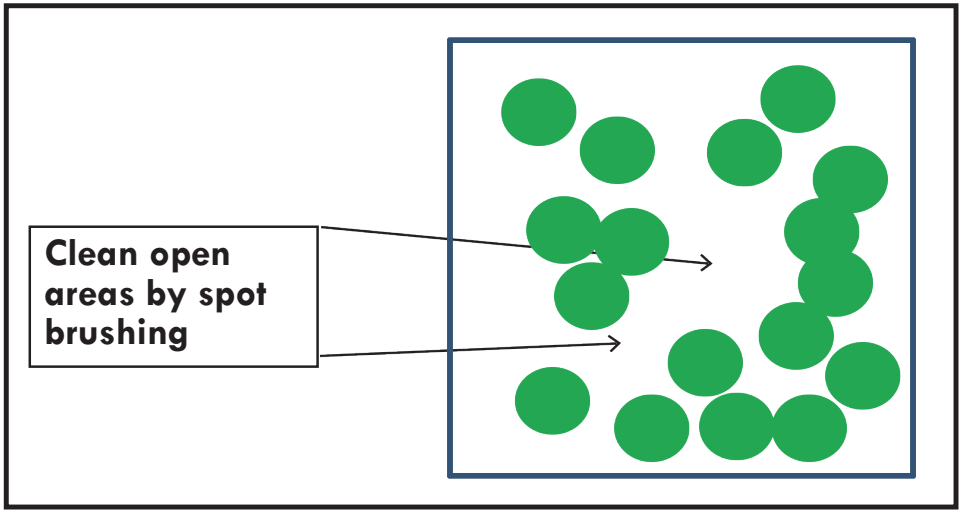


Figure 18. Illustration showing areas to prepare before tree planting in forest gaps (green circles represent woody vegetation).

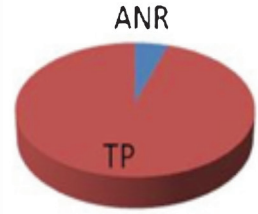
STEP 4:

Use ANR and Enrichment Planting as major planting strategy in forest gaps.

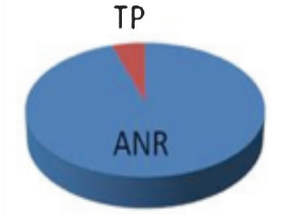
- Depending on the existing woody vegetation and ***canopy*** cover, enrichment planting using native species especially Dipterocarps could be used.
- Enrichment planting aims to add more trees in areas where patches of forests are still present.
- This planting strategy is recommended for small gaps.
- Trees of high ecological and economic importance in the site should be used during enrichment planting.
- This is also called “gap planting”.

Figure 19. Enrichment planting is commonly applied in forest gaps or in areas where a number of trees are still present or with more than 600 wildings.

In enrichment planting, use mixed-species native trees in restoration areas with low species richness.



In grasslands and brushlands, you need to plant more trees and do less ANR.



In forest gaps you only need to plant few trees and do more ANR.

III. Maintenance and protection of trees in forest restoration sites

To increase survival of seedlings planted, the next step would be maintenance and protection. These operations are necessary, especially during the initial years of establishment to ensure that newly planted seedlings would grow well in the site and to reduce mortality caused by agents including fire, stray animals, pests and diseases and human activities i.e cutting and burning.

Some useful tips to maintain the health of the seedlings are as follows:

- Remove grasses around the existing regenerants and planted seedlings regularly.
- Conduct regular patrolling in the restoration site to detect wildfire the earliest time possible;

Figure 20. Ring weeding being conducted as part of maintenance and protection.

Clean the area by taking out grasses and climbers surrounding the seedlings (about 0.5 meter distance from the tree). This activity should be done once a month especially during rainy season.

Figure 21. Dead seedlings.

- Replace seedlings that did not survive in the site.

Figure 22. Farmers planting banana in the firelines.

- Establish firelines to protect protect the restoration site from damage caused by fire. A 5-meter wide fireline around the site is recommended. Firelines should be cleared of grasses or woody vegetation and may be planted with banana or pineapple and vegetables such as sweet potato, taro and eggplant.

- Protect trees from wilting or dying especially during dry spells or prolonged drought by continuous watering. A strategy done in a reforestation area in Nueva Ecija is to place a bamboo culm (more than 1 meter in height, or with 2 to 3 nodes from the bottom) beside the regenerants or newly planted seedlings. Bamboos were filled with water, and the bottom part were liberated from holes or damage (see Figure 23).

Figure 23. An innovative way of watering trees during drought using bamboo filled with water in a reforestation site in Nueva Ecija.

The bottom part of the bamboo has a small hole covered with a small hollow stick. The water is slowly released from the hole to water the seedlings during dry periods (see Figure 24).

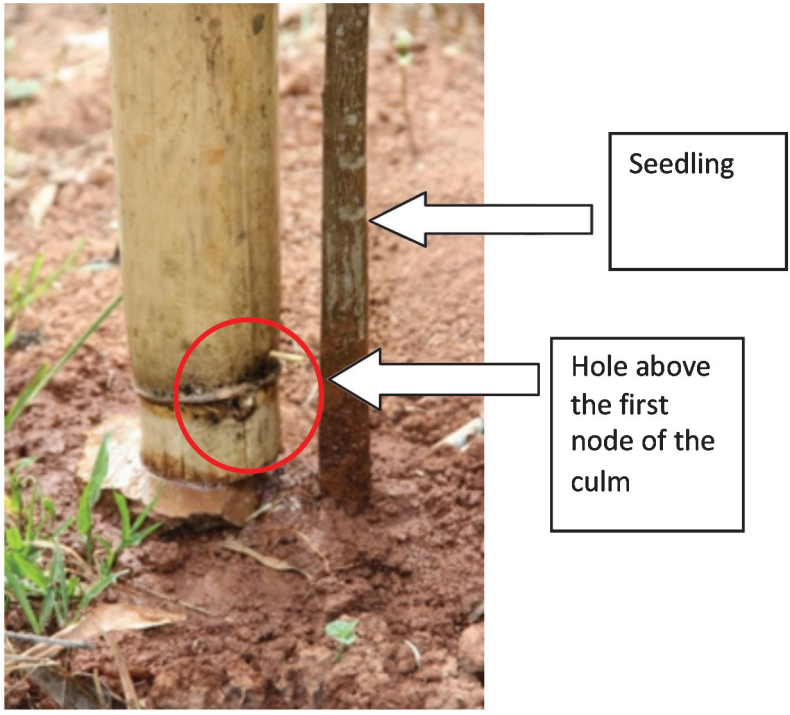


Figure 24. Bottom of the bamboo culm at close angle.

In areas where bamboos are limited, recyclable plastic bottles could also be used using the same principle to rehydrate the trees during dry period.

- Another strategy to water the trees during dry periods is to create a water impounding pond in the restoration site where rainwater will be stored. This strategy is recommended for sites that are located on sloping areas, to ease distribution of water downhill (see Figure 25).

Figure 25. Water impounding pond (Location: Claveria, Misamis Oriental).

IV. Monitoring biodiversity, growth, and health of trees in forest restoration sites

Monitoring the restoration sites regularly is important to ensure success in restoring forests as we detect possible threats including fire, pests, diseases, poor growth due to nutrient deficiency or competition, and other deterrents. It would also help the field implementers to immediately solve these problems in the field. Regular monitoring would also keep track of the positive incidences happening in the field such as the increasing number of birds in the site, presence of other important macro and micro fauna, increasing girth and height of trees, increasing number of leaves of regenerants, and planted seedlings, etc. The efforts one put in monitoring shows the commitment to succeed beyond tree planting.

The following are the simple field strategies that if done properly will provide success to restoration initiatives:

STEP 1:

Make an inventory and keep record of all regenerants and survived seedlings planted in the restoration site. Also, include in the list the animals (big and small) or any droppings found in the restoration site (use Annex A and C in Module 1, or you may also create your own inventory table).

Figure 26. Inventory of survived seedlings.

In monitoring the restoration sites, it is again recommended to do geotagging and take photos in panoramic view of the restoration sites. Photos should be taken in the same location as it was taken before the site preparation.

STEP 2:

Record height and diameter of planted seedlings every 3 months and keep data in record books and computers (if available). Make sure that record books are stored in a safe place, and electronic data are free of virus and protected.

Figure 27. Monitor the heights of regenerants and seedlings in the site using a meter stick.

Figure 28. Root collar diameter of newly planted seedlings are monitored using a vernier caliper.

STEP 3:

Check health status of seedlings in the site.

Take note of insects or pests attacking the stems or leaves of the trees in the site. Immediately remove insects (eggs, caterpillar and pupa) either manually (if not too many) or spray leaves with foliar biodegradable insecticide.

Figure 29. Stems and young shoots of *Artocarpus blancoi* infested by aphids.

Leaves are also good indicators on how healthy your trees are so it is important to keep record of observations like yellowing and desiccation of leaves.

Appropriate and immediate actions are necessary once you see these signs, to insure survival of newly planted trees.

Figure 30. Yellowing of leaves indicates nitrogen deficiency in plants.

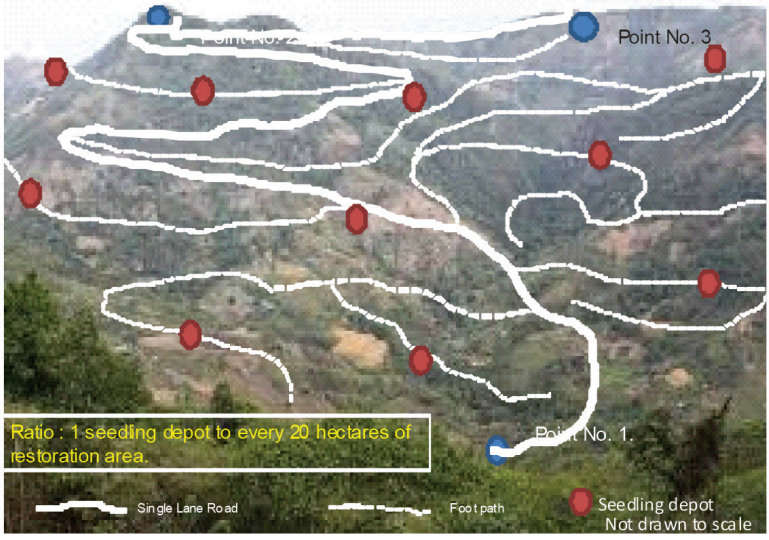
Yellowing of the leaves may indicate poor soil nutrients. To improve the nutrients, you may place10 g NPK and 1 kg vermicast or any organic fertilizer at the base of the tree.

Minced chili with powdered soap mixed in a pail of water is effective in driving away insect pests. Use a backpack sprayer and treat the infested seedlings in the site immediately.

V. Additional Strategies to Attain Success in Restoring Sites

1. Proper transporting of seedlings in the field

- Designate one (1) temporary seedling depot for, at most, every 20 hectares of area to be restored.



(Source: Balangue, T., 2014)

- Carefully haul the planting materials to the site using indigenous material such as “bukag”. “Bukag” are big native baskets made of rattan. Use of synthetic material such as plastic containers might blanch the seedlings because it generates heat.

- Cover seedlings with nets to minimize evapotranspiration during transport.

2. Proper planting of seedlings

- At the site, lay-out and mark planting spots using bamboo stakes, grass stalks or other indigenous materials. Distance from one stake to another is 2 meters.

- Make sure that the area to be planted are free from grasses and other obstructions such as stones, litter and dead branches.

- Dig a hole with a depth of at least 30 cm and a width of at least 25 cm or use the general rule of twice the size of the seedling container. Separate the ***top soil***/darker soil from the ***sub-soil*** as you remove the soil in the hole.

- Apply organic fertilizer in the hole before planting the seedling. About one to two kilos of ***vermicast*** or dried goat manure or ***compost*** is recommended and additional 10 g NPK complete fertilizer.

- Before mounting the seedlings, fill back the hole with a top soil. Put the seedlings then completely fill the hole with a sub-soil. This is to ensure that the nutrient-rich top soil is in good contact with the roots.

• Firmly tamp or press down the soil around the seedlings using both hands.

3. Proper Mulching

- Mulching is done by covering the surface of the soil with biodegradable materials surrounding the plant. This technique is important to minimize loss of moisture in the soil or to reduce evaporation especially during dry season. In addition, mulch serves as organic fertilizer to the soil as it decomposes.

- Aside from cut grasses, chopped coconut husks soaked in water for 24 hours can also be used as mulch (see Figure 31). It is also recommended to use mulch mats cut from recycled cardboard, with 0.5 radius from the center. Also, make a hole at the center of the cardboard with a size that is enough to fit the stem of the seedling (see Figure 32).

- Mulch mats are helpful in drought-prone sites with poor soils. It also reduces the labor cost of weeding since it could last for a year (Elliot et al., 2013).

Figure 31. Gisok-gisok *(Hopea philippinensis)* planted in a marginal upland in Inopacan, Leyte mulched with coconut husks to retain water in the soil.

Figure 32. Cardboard mulch mats are useful in suppressing grasses around the seedlings after planting.

4. Installation of bird feeders

Improvised ***bird perches*** and bird feeders in the restoration site are tall branches of trees that may be used to give resting places for birds in the area (see Figure 33). One may also install customized or bird feeders in the restoration site to encourage coming of birds as seed dispersers (see Figure 34).

Figure 33. Bird perches made up of bamboo.

Figure 34. Bird feeders made up of tin can.

Summary of Procedures

1. Get the site assessment result from the activities conducted following Module 1 (Site-species matching).

2. Check naturally growing trees in the site and trees produced in the nursery. Make it your goal to achieve 2,500 of planted seedlings and regenerants in the restoration site in one hectare.

3. Decide which planting design you will follow. If area is grassland, employ accelerated pioneer-climax species (APCS) strategy. If brushlands, assisted natural regeneration (ANR), and if forest gap, enrichment planting.

4. Use spot brushing in cleaning the specific area where to plant seedlings.

5. Avoid cutting the existing trees and regenerants in the site.

6. Follow standard procedures in tree planting, and recommendations on how to maintain, protect and monitor biodiversity (trees and animals) in the restoration sites.

7. Keep a record of biodiversity and check health status of seedlings regularly.

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Glossary

Assisted Natural Regeneration – management actions to enhance the natural processes of forest restoration, focusing on encouraging the natural establishment and subsequent growth of indigenous forest trees, while preventing any factors that might harm them.

Banana pseudostem – part of a banana plant that looks like a trunk. It is formed by the overlapping leaf sheaths.

Ball of soil/Balled soil – soil that engulfs the roots of a seedling

Biodiversity – the variety of life encompassing genes, species, and ecosystems

Bird perches – artificial place where birds can rest

Brushland – it is an area characterized by discontinuous cover of shrubby and non-wood vegetation including grasses

Canopy – a layer or multiple layers of branches and foliage at the top or crown of a forest's trees

Climbing vines – are plants with tendrils

Conservation – the preservation, management, and care of natural and cultural resources

Compost – is an ingredient in organic farming

Tree Density – number of trees per unit area

Dipterocarpus/Dipterocarps – a genus of resinous trees which yield heavy and valuable timber

Early-successional species – plants that germinate only in full sun or the large gaps. They exhibit high photosynthetic and growth rates, have simple branching patterns, and require high temperature and/or high light intensity for germination. These species are usually short-lived and are characteristics of pioneer forest. These are also known as fast growing pioneer tree species.

Enrichment Planting – the introduction of valuable species in forest areas, where economical species are lacking; or the improvement of the percentage of desirable species or genotypes or increasing biodiversity in a forest by interplanting

Exotic – 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.

Forest Gaps – are defined as spaces in forest stands due to individual or group tree mortality

Forest Patches – see Patch Forest

Forest Restoration – a management strategy applied in degraded primary forest to enhance and accelerate natural processes of forest regeneration in order to regain the elastic capacity of the forest ecosystem; or actions to re-instate ecological processes that accelerate recovery of forest structure, ecological functioning and biodiversity levels towards those typical of climax forest

Indigenous (forest or tree) – native to an area, not introduced; the opposite of exotic

Grassland – areas predominantly vegetated with grasses such as Themada, Saccharum spp., among others

Hauling – bringing of planting materials from the production site to the restoration site

Herbs – a small, non-woody seed-bearing plant in which all the aerial parts die back at the end of each growing season

Invasive alien species – species introduced deliberately or unintentionally outside their natural habitat where they have the ability to establish themselves, invade, or compete with native species and take over the new environment

Late-successional species – are plant species that will remain essentially unchanged in terms of species composition for as long as a site remains undisturbed. They are the most shade-tolerant species of tree to establish in the process of forest succession. The seedlings of climax species can grow in the shade of the parent trees, ensuring their dominance indefinitely.

Live tree stumps – are cut trees which are capable of producing sprouts from the stem

Mid-successional species – are plant species characterized by the need for lots of sunlight and limited amounts of nutrients. These would include grasses, shrubs and herbs first and then replaced by pine trees and other small trees that require abundant sunshine.

Mixed – species – are different species of trees planted together in one area

Natural Regeneration – the recovery of forest following disturbance in the absence of human intervention, resulting in increasing ecosystem functionality, vegetation species diversity, structural complexity, habitat availability and so on

Patch Forest – forest pixels that comprise a small forested area surrounded by non-forested land cover

Organic fertilizer – fertilizers derived from plant and animal matters

Polybags – containers made of polypropene, is a thermoplastic polymer used in a wide variety of applications including packaging and labeling

Rainforestation – a forest restoration technique, developed in the Philippines, that uses indigenous tree species to restore ecological integrity and biodiversity while also producing a diverse range of timbers and other forest products for local people

Regeneration – refers to seedlings and young growth below pole size

Regenerants – refers to naturally existing vegetation such as seedlings, saplings and live stumps in the site. Regenerants are live trees i.e. wildlings, saplings, live tree stumps which are naturally existing in the forest restoration sites.

Relay Planting (Accelerated Pioneer-Climax Series) – is a version of undersowing, in which a second crop is planted while the first is still growing

Sapling – a tree from 5 to less that 15 centimeters in DBH

Seed dispersers – are animals that directly or indirectly distribute seeds or fruits which they consume or come in contact with

Seed rain process – natural deposition of seeds, usually through wind, from its mother tree during its season

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

Shrubs – small to medium-sized woody plant

Site assessment – checking the biophysical characteristics such as vegetation, soil, temperature and rainfall, plants and animals in the site

Species richness – number of individual organisms in a given area

Strip brushing – clearing the area in strips (usually 10-20 meters) prior to planting in grasslands or brushlands

Spot brushing – clearing the spot before tree planting (usually in circular form with 1 Soil erosion - washing or blowing away of the top layer of the soil meter circumference or 0.5 meter radius from the center)

Sub-soil – layer of the soil, usually below 30 cm depth, where nutrients and microorganisms are less

Top soil – upper portion of the soil (0-30 cm depth) characterized to be rich in nutrients

Vermicast – end-product of the breakdown of organic matter by an earthworm

Viable seeds – live seeds capable of germinating

Wildlings – are young trees that have germinated and grown in their natural habitats. A naturally grown seedling transplanted and used in forest planting.

APPENDICES

Appendix 1. List of fast growing pioneers or early successional species for forest restoration in volcanic soils.

Local Name	Scientific Name	Family Name
Agoho	*Casuarina equisetifolia*	Casuarinaceae
Akleng parang	*Albizia procera*	Fabaceae
Amugis	*Koordersiodendron pinnatum*	Anacardiaceae
Anabiong	*Trema orientalis*	Cannabaceae
Anii	*Erythrina fusca*	Fabaceae
Antipolo	*Artocarpus blancoi*	Moraceae
Ayangile	*Acacia confusa*	Fabaceae
Bagalunga	*Melia dubia*	Meliaceae
Bahai	*Ormosia calavensis*	Fabaceae
Baleteng ibon	*Ficus sumatrana*	Moraceae
Banai-banai	*Radermachera pinnata* Seem.	Bignoniaceae
Batino	*Alstonia macrophylla*	Apocynaceae
Bato-bato	*Drypetes littoralis*	Putranjivaceae
Bitanghol	*Calophyllum blancoi*	Clusiaceae
Bogo	*Garuga floribunda*	Burseraceae
Dangula	*Teijsmanniodendron ahernianum*	Lamiaceae
Danupra	*Toona sureni*	Meliaceae
Dao	*Dracontomelon dao*	Anacardiaceae
Dita	*Alstonia scholaris*	Apocynaceae
Dulit	*Canarium hirsutum*	Burseraceae
Dungon	*Heritiera sylvatica*	Malvaceae
Gubas	*Endospermum peltatum*	Euphorbiaceae
Gumihan	*Artocarpus sericarpus*	Moraceae
Igyo	*Dysoxylum gaudichaudianum*	Meliaceae
Ipil	*Intsia bijuga*	Fabaceae
Kalimutain	*Dysoxylum arborescens*	Meliaceae

Local Name	Scientific Name	Family Name
Kalingag	*Cinnamomum mercadoi*	Lauraceae
Kalumpit	*Terminalia microcarpa*	Combretaceae
Kariskis	*Albizia lebbekoides*	Fabaceae
Kubi	*Artocarpus nitidus* Trec.	Moraceae
Kulatingan	*Pterospermum obliquum*	Malvaceae
Lamio	*Dracontomelon edule*	Anacardiaceae
Lanipga	*Toona philippinensis*	Meliaceae
Lingo-lingo	*Viticipremna philippinensis*	Lamiaceae
Liusin	*Maranthes corymbosa*	Chrysobalanaceae
Malabayabas	*Tristaniopsis decorticata*	Myrtaceae
Malakawayan	*Podocarpus rumphii*	Podocarpaceae
Malaruhat	*Cleistocalyx operculatus*	Myrtaceae
Malugai	*Pometia pinnata*	Sapindaceae
Molave	*Vitex parviflora*	Lamiaceae
Mountain agoho	*Gymnostoma rumphianum*	Casuarinaceae
Narra	*Pterocarpus indicus*	Fabaceae
Pagsahingin bulog	*Canarium calophyllum*	Burseraceae
Paguringon	*Cratoxylum sumatranum*	Clusiaceae
Salingkugi	*Albizia saponaria*	Fabaceae
Subiang	*Bridelia insulana* Hance	Phyllanthaceae
Talisai gubat	*Terminalia foetidissima*	Combretaceae
Taluto	*Pterocymbium tinctorium*	Malvaceae
Tamayuan	*Strombosia philippinensis*	Olacaceae
Tangisang bayawak	*Ficus variegata*	Moraceae
Tindalo	*Afzelia rhomboidea*	Fabaceae
Toog	*Petersianthus quadrialatus*	Lecythidaceae
Ulaian	*Lithocarpus celebicus*	Fagaceae
Yellow lanutan	*Polyalthia flava*	Annonaceae

Appendix 2. List of fast growing pioneers or early successional species for forest restoration in limestone.

Local Name	Scientific Name	Family name
Alagao	*Premna odorata*	Lamiaceae
Alagasi	*Leucosyke capitellata*	Urticaeae
Anabiong	*Trema orientalis*	Cannabaceae
Anilao	*Colona serratifolia*	Malvaceae
Anislag	*Flueggea flexuosa*	Euphorbiaceae
Antipolo	*Artocarpus blancoi*	Moraceae
Ayangile	*Acacia confusa*	Fabaceae
Bagalunga	*Melia dubia*	Meliaceae
Bahai	*Ormosia calavensis*	Fabaceae
Balete	*Ficus balete*	Moraceae
Baleting ibon	*Ficus sumatrana*	Moraceae
Baleting pagong	*Ficus forstenii*	Moraceae
Balobo	*Diplodiscus paniculatus*	Malvaceae
Banitlong	*Cleistanthus pilosus*	Phyllanthaceae
Bayag-usa	*Voacanga globosa*	Apocynaceae
Bayanti	*Aglaia rimosa*	Meliaceae
Dao	*Dracontomelon dao*	Anacardiaceae
Dungon	*Heritiera sylvatica*	Malvaceae
Igyo	*Dysoxylum gaudichaudianum*	Meliaceae
Inyam	*Antidesma tomentosum*	Phyllanthaceae
Ipil	*Intsia bijuga*	Fabaceae
Kalumpit	*Terminalia microcarpa*	Combretaceae
Kamagong	*Diospyros blancoi*	Ebenaceae
Kariskis	*Albizia lebbekoides*	Fabaceae
Kubi	*Artocarpus nitidus*	Moraceae
Kulatingan	*Pterospermum obliquum*	Malvaceae
Libas	*Spondias pinnata*	Anacardiaceae
Lingo-lingo	*Viticipremna philippinensis*	Lamiaceae

Local Name	Scientific Name	Family name
Malapapaya	*Polyscias nodosa*	Araliaceae
Malugai	*Pometia pinnata*	Sapindaceae
Molave	*Vitex parviflora*	Lamiaceae
Mountain agoho	*Gymnostoma rumphianum*	Casuarinaceae
Narra	*Pterocarpus indicus*	Fabaceae
Salibotbot	*Tabernaemontana pandacaqui*	Apocynaceae
Salingkugi	*Albizia saponaria*	Fabaceae
Tindalo	*Afzelia rhomboidea*	Fabaceae
Ulaian	*Lithocarpus celebicus*	Fagaceae

Appendix 3. List of shade tolerant or late successional species for forest restoration in volcanic soils.

Local Name	Scientific Name	Family name
Almon	*Shorea almon*	Dipterocarpaceae
Apitong	*Dipterocarpus grandiflorus*	Dipterocarpaceae
Bagtikan	*Parashorea malaanonan*	Dipterocarpaceae
Dao	*Dracontomelon dao*	Anacardiaceae
Gisok-gisok	*Hopea philippinensis*	Dipterocarpaceae
Guijo	*Shorea guiso*	Dipterocarpaceae
Hagakhak	*Dipterocarpus validus*	Dipterocarpaceae
Hairy-leaf apitong	*Dipterocarpus alatus*	Dipterocarpaceae
Kalumpit	*Terminalia microcarpa*	Combretaceae
Malapanaw	*Dipterocarpus kerrii*	Dipterocarpaceae
Manggachapui	*Hopea acuminata*	Dipterocarpaceae
Mayapis	*Shorea palosapis*	Dipterocarpaceae
Narig	*Vatica mangachapoi*	Dipterocarpaceae
Palosapis	*Anisoptera*	Dipterocarpaceae
Red lauan	*Shorea negrosensis.*	Dipterocarpaceae
Tanguile	*Shorea polysperma*	Dipterocarpaceae
White lauan*	*Shorea contorta* S. Vidal	Dipterocarpaceae
Yakal	*Shorea astylosa* Foxw.	Dipterocarpaceae
Yakal kaliot/ Dalingdingan	*Hopea malibato* Foxw.	Dipterocarpaceae
Yakal malibato	*Shorea malibato* Foxw.	Dipterocarpaceae
Yakal saplungan	*Hopea plagata* (Blanco) S. Vidal	Dipterocarpaceae

Note: *can be planted directly in the site even without shade

Appendix 4. List of indigenous tree species and plants growing in wetlands in Ormoc, Leyte.

Local Name	Scientific Name	Family Name
Anubing	*Artocarpus ovatus*	Moraceae
Bayanti	*Aglaia rimosa*	Meliaceae
Cogon	*Imperata cylindrica*	Poaceae
Hagimit	*Ficus minahassae*	Moraceae
Malak-malak	*Palaqquium philippense*	Sapotaceae
Malaputat	*Terminalia darlingii*	Combretaceae
Pandan	*Pandanus spp.*	Pandanaceae
Pototan	*Bruguiera sexangula*	Rhizophoraceae
Saging-saging	*Aegiceras corniculatum*	Myrsinaceae
Talisai	*Terminalia catappa*	Combretaceae
Ulaian	*Lithocarpus celebicus*	Fagaceae

Appendix 5. List of indigenous tree species in coastal areas in Inopacan and Burgos, Leyte.

Local Name	Scientific Name	Family Name
Alagao	*Premna odorata*	Lamiaceae
Antipolo	*Artocarpus blancoi*	Moraceae
Bakawan babae	*Rhizophora mucronata*	Rhizophoraceae
Bakawan lalake	*Rhizophora apiculata*	Rhizophoraceae
Bayok	*Pterospermum diversifolium*	Malvaceae
Bitaog	Calophyllum inophyllum	Clusiaceae
Lino-lino	*Morinda bracteata*	Rubiaceae
Malatangal	*Ceriops zeppeliana*	Rhizophoraceae
Molave	*Vitex parviflora*	Lamiaceae
Pandan	*Pandanus spp.*	Pandanaceae
Pototan	*Bruguiera sexangula*	Rhizophoraceae
Putat	*Barringtonia racemosa*	Lecythidaceae
Talisai	*Terminalia catappa*	Combretaceae
Tangal	*Ceriops tagal*	Rhizophoraceae

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