Papua New Guinea Forest Authority
Japan International Cooperation Agency

User Manual for Assisted Natural Regeneration after Logging

Capacity Development Project for Reducing Carbon Emissions from Forest Degradation through Commercial Logging in PNG by Improving Monitoring System of Forest Logging Operations

March 2025

Co-funded by
The European Union-funded Forestry-Climate Change-Biodiversity (EU-FCCB) Programme

Co-funded by the European Union

EU- FCCB
PAPUA NEW GUINEA

All rights reserved

This document was developed by Papua New Guinea Forest Authority and Japan International Cooperation Agency under Capacity Development Project for Reducing Carbon Emissions from Forest Degradation through Commercial Logging in PNG by Improving Monitoring System of Forest Logging Operations.

This document was co-funded by the European Union through the national component of the European Union-funded Forestry-Climate Change-Biodiversity (EU-FCCB) Programme for Papua New Guinea, implemented by Expertise France. In no way should it be construed as representing the official views of the European Union.

Preface

The Independent State of Papua New Guinea (PNG) is one of the world's largest tropical forest nations. Forests provide essential environmental, economic, and social benefits to its people.

Logging operations are one of the most important industries in the country. However, forest degradation caused by commercial logging has posed significant challenges to sustainable forest resource management. Recognizing the urgent need for action on these issues, the PNG Forest Authority (PNGFA) and the Japan International Cooperation Agency (JICA) launched the Capacity Development Project for Reducing Carbon Emissions from Forest Degradation through Commercial Logging in PNG in 2022.

As part of this project, the User Manual for Assisted Natural Regeneration (ANR) after Logging was developed to serve as a practical guideline for implementing ANR projects, contributing to the restoration and rehabilitation of logged-over forests.

The potential users of this manual include PNGFA officers, logging company employees, and landowners involved in ANR projects. The manual outlines the key activities for implementing ANR projects across five essential phases: the Preliminary Survey Phase, Consensus Building Phase, Planning Phase, Implementation Phase, and Monitoring Phase.

The development of this manual was also supported with the support of the European Union through the national component of the European Union-funded Forestry-Climate Change-Biodiversity (EU-FCCB) Programme for Papua New Guinea implemented by Expertise France. In particular, the national component of the EU-FCCB Programme hosted working sessions to discuss and finalise the writing of this user manual.

This is the first comprehensive manual to promote ANR projects. It should be applied by potential users in actual project operations and will need updates in the future. The revisions will be discussed based on practical application and lessons learned.

Contents

List of Tables

List of Figuires

List of Pictures

List of Abbreviations

ANR	Assisted Natural Regeneration
FAO	Food and Agriculture Organization
FMA	Forest Management Agreement
FRI	Forest Research Institute
ILG	Incorporated Landowner Group
JICA	Japan International Cooperation Agency
KGIDP	Kandrian Gloucester Integrated Development Program
LFA	Local Forest Area
MOU	Memorandum of Understanding
PNGFA	Papua New Guinea Forest Authority
PNG-FRIMS	PNG Forest Resource Information Management System
REDD+	Reducing emissions from deforestation and forest degradation in developing countries. The '+' stands for additional forest-related activities that protect the climate
TRP	Timber Right Purchase
UNDP	United Nations Development Programme

Chapter 1. Background

The Independent State of Papua New Guinea (PNG) is one of the world's largest tropical forest nations, with approximately 35 million hectares of forest. Forests are vital not only for environmental sustainability but also play a crucial role in PNG's economy, creating jobs and generating income for local communities. The PNG constitution mandates the sustainable conservation and utilization of natural resources, supported by key legislation such as the National Forest Policy, the Forestry Act, and related laws.

Despite the importance of forests, PNG has faced significant challenges related to forest degradation. Greenhouse gas emissions in 2015 increased by about 29 million tons of CO2 compared to the year 2000, with approximately 80% of this increase (around 23 million tons) attributed to commercial logging and agricultural land use. Addressing deforestation and forest degradation has become essential in the fight against climate change and for promoting sustainable forest management.

To address these challenges, PNG has aligned its government policies with sustainable natural forest management practices, including initiatives like Assisted Natural Regeneration (ANR). ANR plays a key role in maintaining biodiversity, enhancing forest productivity, and ensuring long-term environmental and economic sustainability. This approach supports the fourth goal of the National Constitution, which emphasizes the preservation of the environment for future generations, and complements PNG's Vision 2050, which aims for sustainable land use and ecosystem restoration. Furthermore, the 1991 National Forest Policy advocates for responsible forest management, and the government has set a goal of establishing 800,000 hectares of plantation forests by 2050.

In the 1990s, the Kandrian Gloucester Integrated Development Program (KGIDP) in West New Britain Province pioneered a sustainable approach to natural forest management. The program emphasized the rehabilitation and regeneration of degraded forests through ANR. The successful result of KGIDP provided a basis for ongoing forest management efforts under the PNG Forest Authority, ensuring the long-term sustainability of the country's natural forests.

One of the key initiatives in PNG's Forest management strategy is REDD+ (Reducing Emissions from Deforestation and Forest Degradation). The country has prioritized REDD+ as a core policy initiative, collaborating with development partners like the Food and Agriculture Organization (FAO), the United Nations Development Programme (UNDP), and the Japan International Cooperation Agency (JICA) to promote sustainable forest management practices and advance REDD+ initiatives.

Since 2010, JICA has supported PNG's climate change mitigation efforts through various forestry cooperation programs. These include a grant aid program and technical cooperation projects aimed at developing Forest Base Maps, enhancing the PNG Forest Resource Information Management System (PNG-FRIMS), improving forest monitoring, and strengthening REDD+ data and information. In 2022, JICA launched the "Capacity Development Project for Reducing Carbon Emissions from Forest Degradation through Commercial Logging in PNG," which aims to improve logging monitoring and operations to reduce greenhouse gas emissions from logging activities.

This project focuses on three key outputs:

1. Capacity building for stakeholders to comply with regulations related to logging activities,
2. Promoting ANR following selective logging,
3. Developing a methodology to promote low-emission logging.

As part of the project, the manual has been developed to support stakeholders in implementing ANR as a forest restoration measure following selective logging. Although efforts to restore forests after selective logging have not been widely implemented in PNG, this manual, based on lessons learned from the project implementation and the KGIDP, aims to contribute to the sustainable use of forests and enhance forest restoration efforts in the country.

Chapter 2. Objective and Users of the Manual

1. Purpose of the Manual

This manual is designed to guide stakeholders in implementing Assisted Natural Regeneration initiatives. It outlines the specific actions to be taken at each of the five phases, ensuring that stakeholders can proceed with consensus building, planning, and project implementation.

2. Five Phases of Assisted Natural Regeneration

The five phases are detailed in the table below.

Table 2-1: Five Phases of Assisted Natural Regeneration

Phase I: Preliminary Survey
Phase II: Consensus Building
Phase III: Planning
Phase IV: Implementation
Phase V: Monitoring

3. Scope of Assisted Natural Regeneration

The National Strategies for Reforestation and Afforestation (NSRA) in Papua New Guinea set 15 strategies and the ANR includes an enrichment planting is one of 15 strategies for forest restoration and rehabilitation. Additionally, the Logging Code of Practice (LCoP) also promotes the forest restoration of logged over areas through assisted natural regeneration including enrichment planting.

This manual was developed to enhance the Assisted Natural Regeneration activities.

In this manual, Assisted Natural Regeneration refers to an enrichment planting method in which commercial tree species are planted in gaps created after selective logging. Therefore, this manual applies to logged-over areas where selective logging has been conducted.

The terminologies of Assisted Natural Regeneration and Enrichment Planting are provided in the Table 2-2.

Table 2-2: Terminologies of Assisted Natural Regeneration and Enrichment Planting

Natural Regeneration: Innate (distinctive) process by which forests renew themselves through sexual reproduction (seed dispersal) or asexual mechanisms (e.g., coppicing, suckers) without direct human intervention, relying on ecological factors like seed availability, soil conditions, light, competition, and disturbances to sustain forest resilience and biodiversity.

Assisted Natural Regeneration (ANR):

- ANR is one option to support any forest management objective, either it be for production forest or maintaining the ecological balance of logged over forest.
- ANR is a forest restoration technique that accelerates natural forest recovery by protecting & managing naturally occurring seedlings and seed sources while reducing competition from competitive vegetation.

Enrichment Planting: Enrichment planting is a technique for promoting artificial regeneration of forests in which seedlings of preferred timber trees are planted in the

under-storey of existing logged-over forests and then given preferential treatment to encourage their growth (Lamprecht, 1986)

4. Intended Users of the Manual (Project Implementation Body)

The intended users of this manual are the **PNGFA and logging operators**, who serve as the **project implementation bodies for ANR projects**.

The project implementation body is responsible for **planning, consensus building, implementing project and budget allocation**. The **project implementation body must also appoint a "Supervisor"** within the organization to lead consensus building, planning, and implementation.

5. Role of the Supervisor

For PNGFA, the Supervisor is expected to be a Natural Forest Management Officer, Forestry Officer, while for a logging operator, Company Forester, Planner or Surveyor is expected to take on this role.

Furthermore, the Supervisor may also be required to provide technical guidance to workers and landowners on activities such as seed collection and germination, nursery management, and planting during the implementation phases. Dissemination pamphlets are included to support technical guidance for workers and landowners.

6. Overview of the Manual

Table 2-3: Overview of the Manual

Background: Basic manuals were developed in 1990s. Need more comprehensive manual for project implementation.
Objective: Assist stakeholders in implementing Assisted Natural Regeneration
Expected user and Supervisor: PNGFA forest officers (Natural Forest Management, etc), logging operator (Planer, Surveyor, Company Forester)
Main contents: Five phases for implementing assisted natural regeneration after selective logging
Applicable Concession: Forest Management Agreement (FMA), Timber Right Purchase (TRP), Local Forest Area (LFA)
Main measure: Enrichment Planting

Chapter 3. Preliminary Survey Phase

1. Overview of the Preliminary Survey Phase

In the Preliminary Survey, the Supervisor identifies potential sites for ANR activities and confirms the intentions of stakeholders. They must be informed of short-term benefits (e.g., Direct engagement) and Long-term benefits (e.g., Income from planting trees). The Supervisor must assess the number and scale of potential ANR sites, considering related project plans including Annual Forest Logging Working Plan and budget constraints.

2. Conditions for Selecting a Potential Site

A potential site must meet the following three criteria:

- It is a logged-over area resulting from selective logging operations in specific FMA, TRP or LFA.
- It is away from gardening sites or other land use options.
- The landowner has expressed interest in participating in ANR activities.

Therefore, sites will be selected from logged-over areas based on the following process.

3. Utilizing Maps for screening potential sites

During the site selection process, existing maps of setups or coupes made for logging operations can be referenced to efficiently identify the potential sites.

Additionally, the maps and forest survey data made during logging operations serve as important reference materials for selecting potential sites.

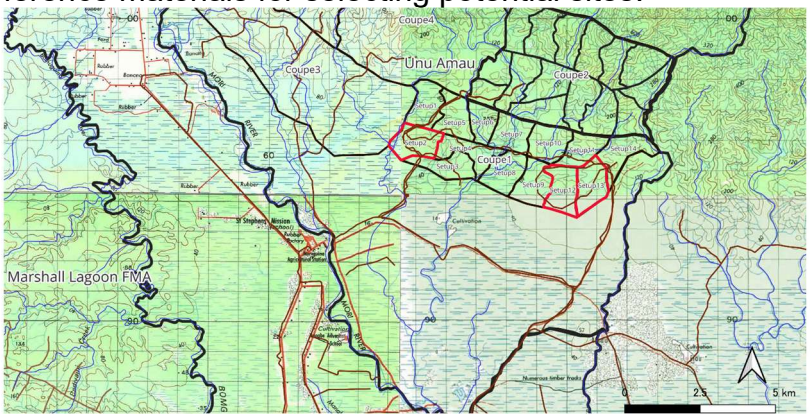


Figure 3-1: Location of the ANR Sites in Map

4. Potential Site Selection Process

The potential sites are selected through the assessments of the following three factors:

(1) Forest Assessment by Field Survey and Hearing:

- Forest Diagnostic sampling (Degree of forest degradation, vegetation, regeneration capability, residual stock, etc.)
- Forest condition after logging (topography, geology, soil, etc.)
- Accessibility (future harvesting prospects)

(2) Stakeholder consultation (Landowner's Intentions)

- Landowner consultation for their interest and willingness, interview them with

necessary information (e.g., social information, interest, land use). (**Appendix 1: Landowner Interview Sheet**).

- Sites where stakeholders consent to the activity will be selected.
- If there is opposition, the site will be excluded from potential site.

Pic 3-1: Consultation at Field

Pic 3-2: Consultation with Stakeholders

(3) Consideration of Other Factors

- Budget availability
- Coordination with other development plans

5. Next Step: Consensus Building with Stakeholders

Once the potential site is identified through forest assessments and stakeholder consultations, the Supervisor will initiate consensus-building with landowners and other relevant stakeholders for implementing ANR activities. (For details, see Chapter 4: Consensus-Building.)

Chapter 4. Consensus Building Phase

1. Purpose and Basic Policy of Consensus-Building

After selecting potential sites, the Supervisor must actively engage in consensus-building with stakeholders. If necessary, this process may proceed in parallel with site selection.

For ANR projects, stakeholders are recommended to coordinate the following key aspects and formalize agreements in written documents.

2. Key Aspects for Consensus-Building

(1) Stakeholders: Three primary stakeholders are involved in ANR projects

- PNGFA (Papua New Guinea Forest Authority)
- Logging company
- Landowner

PNGFA Natural Forest Management Officer is recommended to communicate with Project Supervisor closely to identify the project areas and necessary arrangements.

(2) Roles and Responsibilities

Each stakeholder plays a specific role in project implementation. Among them, the project implementation body (PNGFA or logging company) is responsible for:

- Financial contribution to the project
- Project implementation planning
- Consensus-building among stakeholders

Other aspects, such as project execution and labor provision, will be discussed and determined based on local conditions.

(3) Project Site (Determination of Implementation Area)

- Identification of the project site and boundaries
- Verification of land ownership

(4) Content of the ANR Project

- Nursery Management
- Land Preparation
- Transportation of Seedlings
- Planting
- Silvicultural Treatment

(5) Agreement Items

All three parties must formally document agreements covering the following:

- Roles and responsibilities of each stakeholder
- Project site
- Project contents
- Project implementation period

3. Stakeholder's Consensus Building Process

(1) Conducting Hearings

The Supervisor must conduct comprehensive hearings to confirm the following:

- Stakeholder roles and responsibilities
- Project site
- Details of ANR activities

Particularly for landowners, clear and detailed explanations are essential to obtain their full consent.

(2) Finalizing Written Agreements

To prevent misunderstandings and future disputes, all agreements must be documented in writing agreement, especially each stakeholder's role and responsibility should be clearly specified such as budget, land use, and labor provision.

Key components of the agreement document:

- Roles and responsibilities
- Project site
- ANR activity plan

Since some stakeholders may not be able to read documents, oral explanations should be provided as well.

Pic 4-1: Discussion of MoU among Stakeholders

Pic 4-2: Exchanging MoU with Landowner

(3) Reference Materials for written agreements

To ensure a smooth project implementation process, refer to the following examples of agreement shown in the Table 4-1.

Table 4-1: Example of Agreements for ANR Project

Appendix 2-1: Example of Regeneration Activity Agreement among PNGFA, Logging Entities, and Landowners
Appendix 2-2: Example of Regeneration Activity Agreement between Logging Company and Landowners
Appendix 2-3: Example of Regeneration Activity Agreement between PNGFA and Landowners

4. Responsibilities of the Implementing Body

(1) When Implemented by Logging company

Conduct hearings with stakeholders during the formulation of the Annual Logging Working Plan and ensure its inclusion before project implementation.

(2) When Implemented by PNGFA

The Natural Forest Management Officers must:

- Confirm stakeholder intentions
- Determine the project area and scale
- Apply for necessary budget allocations

5. Next Step: Project Planning

Once consensus-building is completed, the Supervisor will initiate the drafting of the project implementation plan based on the agreements.

(For details, see Chapter 5: Project Implementation Planning.)

Chapter 5. Planning Phase

1. Introduction

The ANR Project is long-term forest management, which aims to ensure sustainable resource management through identifying project areas, selecting planting species, growing and planting seedlings, conducting silvicultural treatment, and performing other activities. It is essential to develop a clear "Project Implementation Plan" to effectively implement the long-term forest management and establish a healthy forest ecosystem.

This manual provides the process for developing the Project Implementation Plan through the following four steps:

- **Implementation of Baseline Surveys** (Environmental Survey, Socio-Economic Survey)
- **Setting the Project Area and Boundaries and preparing project maps**
- **Determination of Planting Methods** (selection of tree species, planting spacing, site preparation, etc.)
- **Development of the Project Implementation Plan** (including seedling production, site preparation, planting, and silvicultural treatment)

2. Implementation of Baseline Surveys

As part of the planning process, the Supervisor must conduct Baseline Surveys and collect the following information. For on-site forest assessments, a Baseline Survey Team may be organized as needed. The team is responsible for developing a survey schedule, conducting field assessments, and gathering data to support project planning and implementation.

The information collected through the Baseline Surveys is categorized into the following three categories:

(1) Environmental Assessment

- **Assessment Components**: Topography, altitude, geology, soils, and weather conditions (including rainfall patterns, total rainfall, dry and rainy seasons, humidity, and wind speed), nearby water sources.
- **Methods of Data Collection**: Reference materials include the Five-Year Forest Working Plan and other relevant documents. Field surveys and interviews with workers and landowners also provide valuable insights.
- **Data Sources**: Environmental data such as topographical, geological, soil, and weather information can be acquired from multiple sources and integrated into GIS software, such as ArcGIS and QGIS, for spatial analysis. The following table outlines key data sources and their access methods.

Table 5-1: Data Sources for Environmental Assessment

1. Topography & Altitude Data

- NASA Shuttle Radar Topography Mission (SRTM)
  - Access: USGS Earth Explorer https://www.earthdata.nasa.gov/data/instruments/srtm
  - Method:
    - Register for a free account.
    - Search for SRTM data by entering the location coordinates.
    - Download DEM (Digital Elevation Model) files.
    - Process the data using GIS software like QGIS or ArcGIS

2. Geology Data

- Geological Survey of Papua New Guinea (PNGS)
  - Access: PNG Mineral Resources Authority https://mra.gov.pg/geological-survey/aboutgeologicalsurvey/
  - Method:
    - Visit the official PNGS website.
    - Contact the PNGS office for specific geological data requests.

3. Soils Data

- PAPUA NEWGUINEA ENVIROMENTAL PORTAL
  - Access: PAPUA NEWGUINEA ENVIROMENTAL PORTAL https://png-data.sprep.org/dataset/soils-png
  - Method:
    - Browse global soil data through the web portal.
    - Download soil maps.
    - Integrate data into GIS platforms.

4. Weather & Climate Data

- World Bank Climate Change Knowledge Portal
  - Access: World Bank Climate Portal https://climateknowledgeportal.worldbank.org/country/papua-new-guinea/climate-data-historical
  - Method:
    - Select the country/region.
    - Download climate projection dataset.

(2) Socio-Economic Survey

To assess the utilization of forest resources and the relationship with local communities, the following aspects will be investigated:

- **Survey on forest ownership and utilization**: Forest area owned by local people, their use of forest resources, access to forests, and livelihood means.
- **Survey on local communities**: Number of clans, population, and decision-making processes within the community.
- **Assessment of local community willingness and capacity**: Willingness of local community to participate in project implementation and their capability to implement the project.
- **Evaluation of community involvement**: Expected level of community participation in project implementation, as well as the customs and traditions related to forest

management.

- **Impact assessment on local resource use**: Potential impact of project implementation on the use of forest resources by local people such as gardening.

(3) Forest Diagnostic Survey

Conduct forest diagnostic survey, and main survey items are: species composition, logging impact assessment, regeneration and residual stock assessment, forest health, soil and water.

The forest diagnostic survey will be conducted parallelly with the determination of ANR contents described in the section below.

3. Determination of the Project Area and ANR Contents

In consultation with stakeholders, the Supervisor must select the project area and determine the ANR contents in order to develop the Project Implementation Plan for ANR activities.

(1) Project Area Determination

The **Supervisor** must reconfirm the **set-up area** designated for project implementation, as agreed upon with stakeholders during the **Pre-survey phase**. After confirmation, the project area will be determined based on the following steps.:

1) Methods for Selecting the Project Area

- Verify whether the set-up area belongs to a single Incorporated Land Group (ILG) / Clan. If multiple ownerships exist, confirm the boundaries in their presence and mark them using paint or other means.
- Estimate the planting area based on the number of trees to be planted and planting spacing. At the same time, identify the skid trails and gaps created after logging and use this information to set the project area.
- The Supervisor must prepare a project area map and utilize GPS on-site to set the boundaries. If modifications are required based on field surveys, adjustments should be made accordingly.
- Based on field surveys and GPS measurement results, the Supervisor will create a 1:10,000 scale project area map.
- If there are stakeholders other than landowners, conduct a boundary confirmation meeting with them and mark the boundaries as needed.
- Since the determination of planting spacing and the number of trees to be planted is crucial for setting the project area, the project area cannot be finalized until these factors are decided. If they remain undecided, they will be determined during the development of the implementation plan.

(2) Determination of ANR Contents

The Supervisor determines the planting methods and tree species to be used within the designated project area.

1) Selection of Planting Methods

This manual aims to increase commercial species at logged over forests. The following three planting methods are applied. The appropriate method should be selected based on the forest conditions and in consultation with stakeholders.

Table 5-2: Planting Methods

Planting Method	Description	Applicable Conditions	Planting Spacing
Line Planting	Trees are planted on strip line within a selectively logged over forest.	Areas where restoration is necessary after logging.	4m–10m intervals of strip line, 4m–5m planting spacing within a strip line.
Gap Planting	Trees are planted in gaps (open spaces) within the existing forest.	Areas where relatively large gaps have formed after logging.	3m × 3m – 5m × 5m
Space Planting	Trees are planted at equal intervals in open spaces.	Log landings and other areas where no trees remain (open spaces).	3m × 3m – 5m × 5m

The following section introduces the Line Planting method implemented at the pilot sites in Mashal Lagoon and Unu Amau FMA.

Design of Enrichment planting in the pilot site (Mashal Lagoon and Unu Amau FMA)

- One Plot Area Size: 100 m x 100 m (1 ha)
- Strip Line: Width is 1.0m and Length is 100.0 m from base line
- Strip Line interval: 10m
- Strip Lines' number: 10 lines per hectare
- Planting Spacing in strip line: 5m (20 seedlings in 1 strip)

Number of seedling per ha: 10 strips x 20 seedlings /strip = 200 seedlings

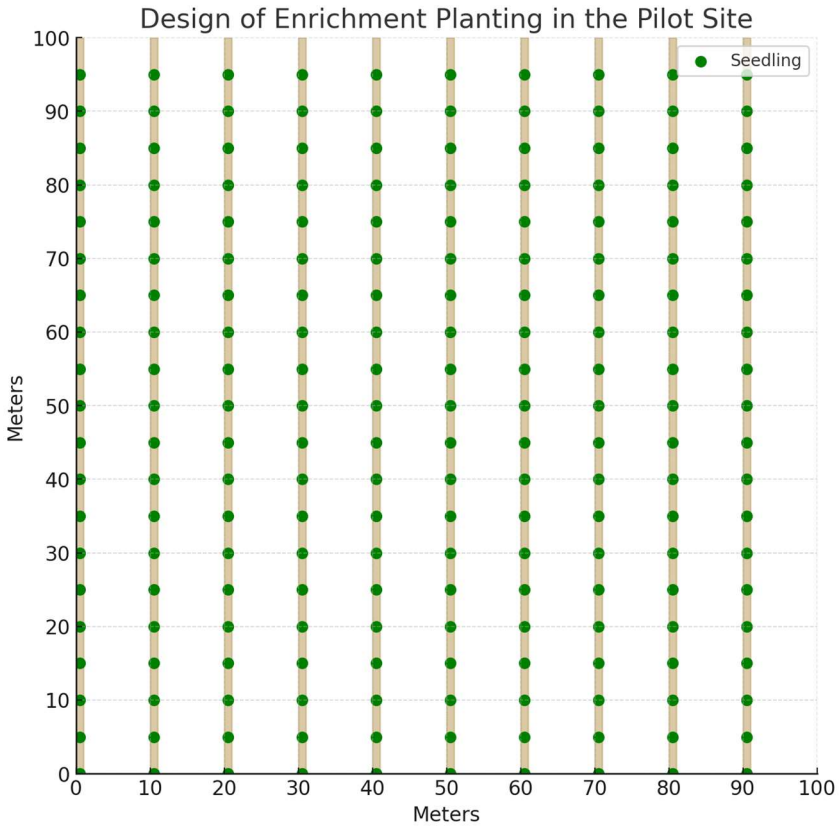


Figure 5-1: Design of Enrichment Planting in Pilot Site (Mashal Lagoon & Unu Amau FMA)

Table 5-3: Design of Enrichment planting in the pilot site (Amanab Block 1-4 FMA)

Design of Enrichment planting in the pilot site (Amanab Block 1-4 FMA)
• Strip Line: Width is 3.0m and Length is 20m – 50m from base line to boundary • Strip Line interval: 15m • Planting Spacing in strip line: 6m

2) Target Species Identification

The target species for assisted natural regeneration should be identified through following investigation and assessment.

- Choose dominant species through residual stock assessment.
- Assess the potential propagation ability of selected species in the area
- Consult landowners for their species preference.
- Identify and select parent trees of target species for seed sources.
- Assess parent tree's viability for seed collection and seedling production.
- Consult National Tree Seed Centre under FRI to obtain seed information including potential distribution.

4. Development of the Project Implementation Plan

The Supervisor should develop the Project Implementation Plan based on the results of the Baseline Surveys, the determination of the project area, and the content of the ANR activities. This plan includes seedling production, planting, silvicultural treatment, working plan, stakeholder roles, and budget.

The Project Implementation Plan should include the following items from (1) to (8).

(1) Overview of the Project Implementation Plan

The Supervisor should summarize the key aspects of the ANR project, including:

- **Agreements and Roles of Stakeholders**: Rights and responsibilities, cost-sharing, and labour provision.
- **Project Area Information**: Planting sites, planting zones, planting area, target tree specie(s), and the number of trees to be planted.

(2) Work Plan

A working plan is essential for systematically carrying out various tasks such as seedling production, nursery management, site preparation, planting and silviculture treatments. It includes a monthly schedule for a period of two to three years, considering factors such as the nursery period, the time required for site preparation and planting, and the appropriate planting season based on rainfall patterns. Additionally, a long-term annual work plan covering approximately ten years should also be developed.

Table 5-4: Example of Annual Work Plan

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Site A			Wilding Collection	Growing Seedlings				Site Preparation	Enrichment planting			Tending
Site B			Wilding Collection	Growing Seedlings			Site Preparation	Enrichment planting			Tending	

Table 5-5: Example of Long-Term Work Plan

Year	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Site A	Tending	Tending			Vine cutting				Vine cutting	
Site B	Tending	Tending			Vine cutting				Vine cutting	

(3) Seedling Production and Nursery Management Plan

Since seedling production and quality control are essential aspects of the ANR project, the following items must be planned:

- **Nursery Establishment**: Planning the nursery scale, duration of use, site selection, securing water sources, and setting up facilities.
- **Selection of Seedling Production Methods**: Methods such as growing seedlings from seeds, wildlings, or cuttings (considering expected quality and production quantity).
- **Seed/Wilding Collection**: Determining collection months and methods for identifying parent trees.
- **Seedling Production and Management**: Defining management criteria (such as watering, tending frequency, and hardening treatments) and setting the seedling growth period.

(4) Seedling Transportation, Site Preparation and Planting Plan

To implement planting appropriately, the following items must be described:

- **Project Area**: The designated project area based on **the Chapter 5, Section 3, (1) Project Area Determination.** If the area has not been finalized, it must be determined based on the criteria in the section.
- **Seedling Transportation and Temporary Storage**: Selecting transportation methods to planting sites and ensuring appropriate storage conditions.
- **Site Preparation**: The necessity of tending and site preparation to planting areas.
- **Planting**: Planting methods (line planting, gap planting, and space planting), planting area, tree species to be planted, planting spacing (refer to Table 5-2: Planting Methods), and the number of trees to be planted.

(5) Silvicultural Treatment Plan

Silvicultural treatments are essential to ensure the healthy growth of seedlings. The plan should include tending, refilling, and vine cutting depending on the site's environmental conditions.

- **Tending**: Tending is one of the silvicultural treatments, which remove the competitive vegetation at initial growth stage. The methods, frequency, and duration should be planed.
    - Guideline: Tending should be conducted until the seedlings outgrow competing vegetation. In areas with good light conditions, tending should be performed every three months.
- **Refilling:** Refilling is supplemental seedling planting in case survival rate is low. It is conducted after the monitoring (survival rate) described in Chapter 7 Monitoring.
- **Vine Cutting**: Removing vines that obstruct seedling growth.

(6) Roles of Stakeholders

The roles of stakeholders in each activity—planning, seedling production, planting, and silvicultural treatment—should be organized based on the agreements reached among the stakeholders. The following table is the "each role of stakeholders at pilot site", this is an example to clarify the stakeholders' roles.

Table 5-6: Example of Stakeholder Roles and Responsibilities of the Project

Activities	Stakeholders
Planning	
1. Select target clans and set-up	PNGFA, Logging Company
2. Stakeholder Discussion	PNGFA, Logging Company, Clans
3. Exchange the MoU	PNGFA, Logging Company, Clans
4. Pilot Set-up Selection	PNGFA, Logging Company
5. Making Plan	PNGFA
6. Survey and design of activities	PNGFA
7. Design of detailed pilot activities	PNGFA
Temporary Nurseries Establishment	
8. Temporary nurseries design & establishment	PNGFA, Logging Company, Clans
Wildings Collection	
9. Training on Wildings collection	PNGFA, Clans
10.Wildings collection	Clans
Seed collection	
11. Training on Seed collection	PNGFA, Clans
12. Seed collection	Clans
13. Seedling Production	Clans
Seedlings Inspection	
14. Seedlings Inspection	PNGFA
15. Payment of seedlings (need payment document)	PNGFA, Logging Company
Nursery and raising seedlings	
16. Main nursery establishment	PNGFA, Logging Company
17. Transportation of seedlings to main nursery	PNGFA, Logging Company
18. Raise Seedlings	PNGFA, Logging Company
Enrichment planting and initial silvicultural treatment	
19. Transport seedling to planting sites	PNGFA, Logging Company
20. Site preparation	Logging Company, Clans
21. Enrichment planting	Logging Company, Clans
22. Periodic casual employ	PNGFA, Clans

(7) Training for Implementing Stakeholders

Necessary training should be provided for stakeholders involved in the project. Expected training topics include:

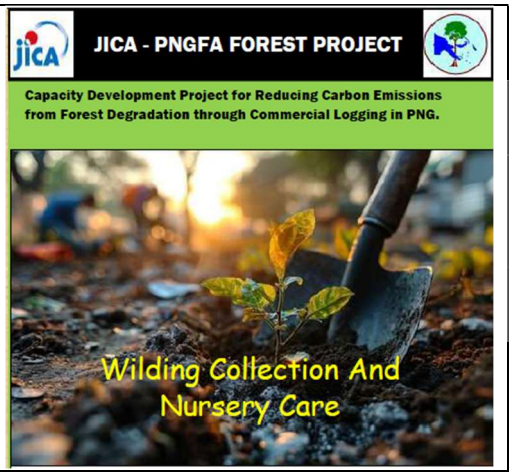
- Technical training for workers involved in seed collection, seedling production, nursery management, site preparation, and planting. Training should be planned based on the work schedule, stakeholder roles, knowledge, skill levels, and experience.
- On-the-job training (OJT) is an effective approach, allowing training to occur alongside project implementation.
- Study tours to visit successful project sites may also be considered.

Trainers should be selected based on local conditions from organizations such as PNGFA, logging entities, and knowledgeable community members.

The PNGFA-JICA project has developed the following dissemination pamphlets to provide technical training for landowners.

Table 5-7: List of Dissemination Pamphlets

Appendix 3-1	Wilding Collection and Nursery Care Guide
Appendix 3-2	Basic Nursery Guide for Tree Seed Collection and Germination
Appendix 3-3	Steps for Seed Collection & Germination" for the Five Target Tree Species in the Project Area
Appendix 3-4	Seedling Inspection Guide – Nursery
Appendix 3-5	Site Preparation & Planting Guide for Natural Forest



(8) Budget Plan

The required budget for implementing ANR activities should be estimated based on the project content and work plan. Costs should include direct expenses related to seedling production, planting, and silvicultural treatment.

In Mashal Lagoon and Unu Amau FMA, the following unit costs were set for each operation, from the establishment of temporary nurseries to planting.

Table 5-8: Example of Unit Costs for Each Operation at Pilot Site

Operation	Unit	Unit Cost (kina)	Notes
Temporary Nursery Establishment	1 unit	500	Labor cost
Seedling Care in Nursery	1 month	200	Management cost during the nursery period
Seedling Production	1 seedling	0.5	Seedling purchase price
Establishing Strip Line	1 ha (100m × 10 line)	200	Cost for 100m × 10 line
Planting	1 seedling	0.5	Labor cost per seedling planted

Also, the following operations were carried out in pilot site of Mashal Lagoon and Unu Amau FMA:

- Nursery operation: 4 months of seedling growth in a temporary nursery
- Strip Line installation: 25 Strip Lines of 100m each (total 2,500m)
- Seedling planting: 500 seedlings

Based on above, the labour costs per hectare were calculated as follows (excluding the cost of temporary nursery establishment).

Table 5-9: Example of Labor Costs per Hectare at Pilot Site

Operation	Duration/Quantity	Unit Cost (kina)	Total Cost (kina)
Nursery Care	4 months * 200 kina / 2.5 hectare	320	320
Seedling Production	200 seedlings	0.5	100
Making Strip Line	1 ha (100m × 10 line)	200	200
Planting	200 seedlings	0.5	100
Total	-	-	720

Chapter 6. Implementation Phase

1. Introduction

This chapter outlines the specific activities and implementation methods during the Assisted Natural Regeneration (ANR) implementation phase. The implementation phase is a critical stage where various ANR activities are carried out appropriately based on the Project Implementation Plan developed during the planning phase.

The primary objective of ANR activities is to promote natural regeneration in logged over forests and ensure sustainable forest resource management. To achieve this goal, this chapter provides detailed explanations of the following key operational processes.

2. Permanent Nursery Establishment

There are two types of nurseries: Permanent Nursery and Temporary Nursery. The appropriate type should be selected based on the project's scale, objectives, and duration. The site requirement and necessary facilities of each type are described below.

Pic 6-1: Permanent Nursery at Amanab Block 1-4 (Maka Camp)

(1) Overview

A permanent nursery is established when a long-term and large-scale supply of seedlings is required for continuous reforestation projects or forest restoration activities.

When establishing a nursery, consider the following site requirements and install the necessary facilities listed below.

(2) Site Requirements

- Water supply: A stable water supply should be secured such as a river, well, or reservoir.
- Topography: The site should be flat or have a gentle slope.
- Accessibility: It should be located along a permanent road for easy transportation of materials and seedlings. Accessibility to the planting sites should also be good considering to minimize transportation costs.
- Drainage: The site should have good drainage, and drainage facilities should be

installable if needed.

- Wind protection: The site should be in an area with minimal wind impact. If wind exposure is significant, windbreaks should be established.

(3) Facilities

A permanent nursery requires the essential facilities listed below: seedling beds, germination houses & germination beds or trays, irrigation systems, shading facilities, and potting houses. Additionally, to efficiently operate the nursery, other facilities may be necessary. The selection of these facilities should be prioritized based on the budget and available land. A layout plan should be prepared to optimize facility placement within the available land.

The following describes the key facilities necessary for a permanent nursery:

- **Seedling / Wildling Beds**: In PNG, the majority of seedling production is potted seedlings. It is instrumental to install seedling bed to grow potted seedlings and wildlings. Common materials for seedling and wildling beds include wooden planks, metal rods, bricks, or concrete blocks. The standard size is approximately 1m wide and 5–10m long, with 70 cm-wide work paths between beds. The number of seedling beds depends on the available area in the nursery and the planting plan including its areas and seedling production. Recently, container-based seedling production has also been introduced, and nursery beds should be designed to accommodate containers.

Pic 6-2: Potted Seedlings

Pic 6-3: Container seedlings

Germination Houses & Germination Beds: These facilities provide an optimal environment for seed germination. A germination house is set up to control temperature, humidity, light, and moisture, ensuring higher germination rates. Inside the house, germination beds are installed for seed sprouting.

- **Irrigation System**: Secure water sources for seedling irrigation from rivers, reservoirs, or wells. Install pressurized pumps and water storage tanks as needed. Additionally, set up necessary facilities for irrigation, including sprinklers and manual watering from faucets.

- **Shading Facilities**: The structure consists of wooden or metal poles with shading nets or palm leaves covering the top. The shading net is attached to both the poles and iron wires stretched between them.

- **Potting House**: This facility is used for storing soil and potting soils into polybags. It must be equipped with a roof to protect the soil from rain.

Table 6-1: Other Facilities for Permanent Nurseries

Facility	Purpose
Nursery Office	Management hub for nursery operations, sometimes integrated with storage or seed storage.
Storage	Store nursery tools, equipment and hazardous chemicals, often established with other facilities.
Compost House	Ferment and decompose organic materials (fallen leaves, bark, branches, grass, etc.) to produce and store compost.
Seed Storage	Store seeds before sowing. Refrigeration may be required depending on seed storage needs.
Soil Storage	Store soil, often integrated with the potting house.
Drainage Facility	Include drainage ditches to manage rainwater.
Water Collection Facility	Use tanks or reservoirs to collect rainwater for irrigation.
Windbreaks	Plant trees around the nursery to reduce wind impact. Fast-growing species like eucalyptus are commonly used.

3. Temporary Nursery

(1) Overview

A temporary nursery is primarily set up to supply seedlings for reforestation / forest restoration project in specific areas. It serves as a temporary seedling production site, particularly in projects aimed at reforestation / forest restoration in designated locations. Temporary nurseries have the advantage of being relatively easy to set up and remove using locally available resources. In addition to the nursery management by project, they can also function as seedling production bases managed by local communities.

The following are the key site requirements and facilities that should be taken into account when establishing a temporary nursery.

Pic 6-4: Temporary Nursery

Pic 6-5: Temporary Nursery

(2) Site Requirements

- Water supply: A stable water supply should be secured.
- Topography: The site should be flat or have a gentle slope.
- Accessibility: The nursery should be close to the planting site to ease seedling

transportation.

- Local materials: Construction materials such as wood, bamboo, and palm leaves should be available.

(3) Facilities

A temporary nursery primarily requires seedling beds, irrigation systems, and shading facilities. The key components are outlined below:

- **Seedling Beds**: Temporary nurseries require seedling beds for the production of potted seedlings. Common materials include wood, bamboo, and wire mesh. Standard sizes range from 1m in width to 2.5–6m in length, with adequate spacing for easy maintenance and care.

Pic 6-6: Establishment of Seedling Beds

Pic 6-7: Establishment of Seedling Beds

Pic 6-8: Seedlings in Temporary Nursery

Pic 6-9: Seedlings in Temporary Nursery

- **Potting Area**: This designated spot is used for potting soils into polybags. It may also be set up outside of a temporary nursery.

The following figure is a design for a temporary nursery made for ANR activities in Marshall Lagoon and Unu Amau FMA.

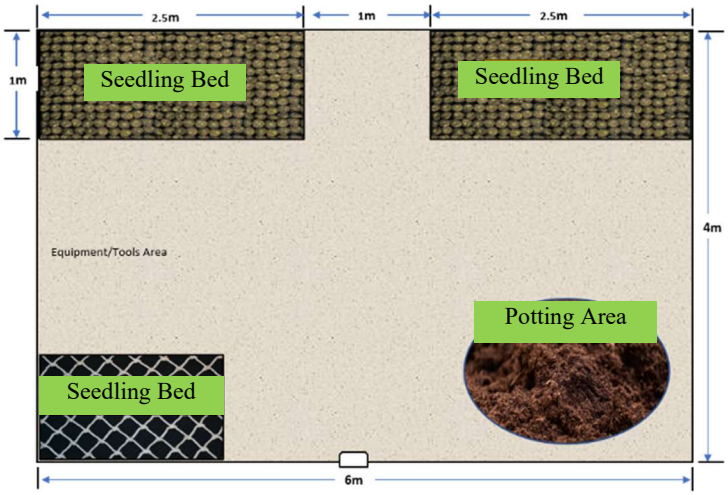


Figure 6-1: Layout example of temporary nursery (Seedling bed and potting area)

- **Irrigation System**: If a water source is available, a simple irrigation system should be installed, such as a rainwater storage tank, and a pump to draw water from a river or well.

- **Shading Facilities**: To protect seedlings from strong sunlight and dryness, simple shading facilities should be built. The structure consists of wooden or bamboo poles (Figure 6-2: Structure of Shading Facility), with a roof covered by palm leaves (Figure 6-3: Roof Structure of Shading Facility) and shading nets attached to the poles.

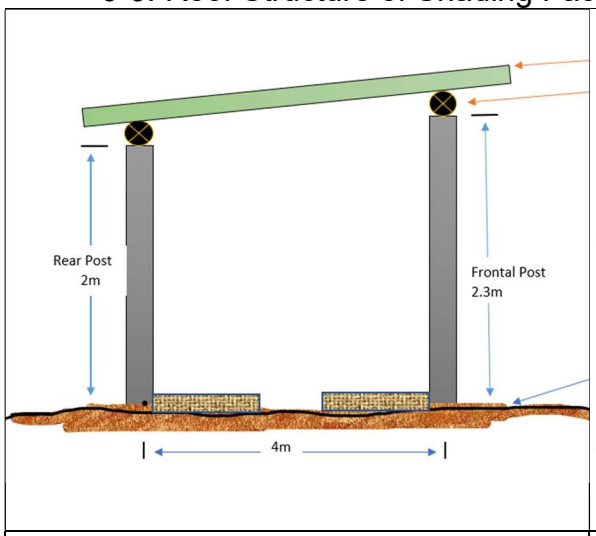


Figure 6-2: Structure of Shading Facility

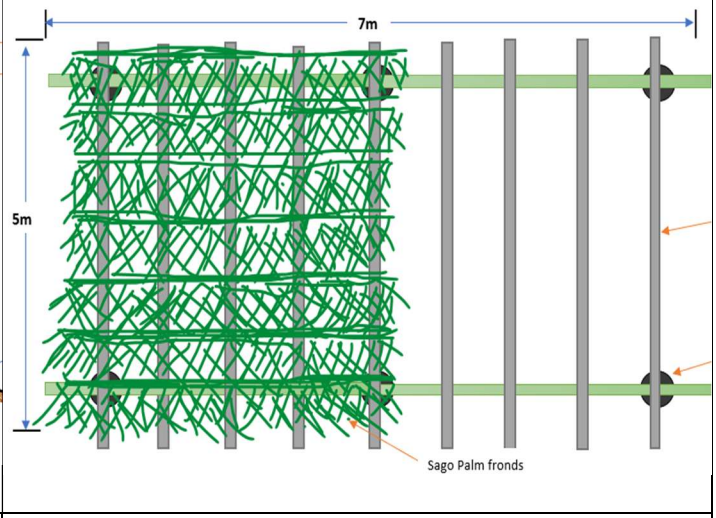


Figure 6-3: Roof Structure of Shading Facility

Table 6-2: Other Facilities for Temporary Nursery

Facility	Purpose
Soil Storage	Store potting soil.
Simple Storage	Store nursery materials such as pots, soil, and tools.
Compost Area	Used for storing leaves and organic matter for soil improvement.

4. Seedling Production

(1) Overview

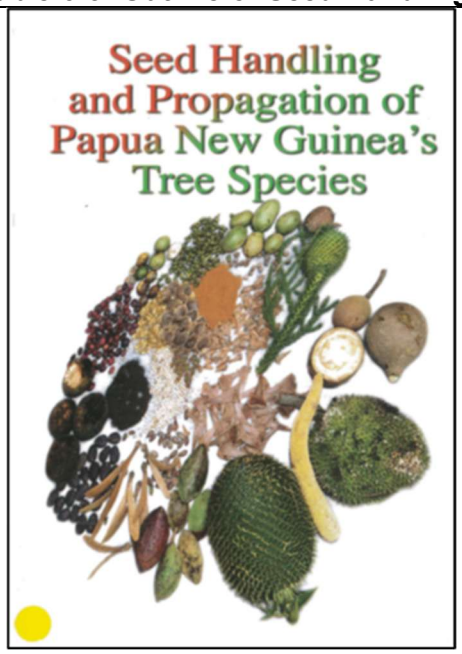
Once the nursery is established, it is necessary to produce seedlings for planting in the ANR project. The cultivation of healthy seedlings is essential for the successful implementation of the ANR project. This manual outlines key points for producing seedlings from seeds or from wilding collection.

This manual provides guidelines for managing the key processes involved in seedling production from seeds, including seed / wildling collection, cleaning, sowing, tubing / potting, transplanting, and nursery management. For more specialized information, please refer to the section "Information on Seedling Production" below.

(2) Information on Seedling Production

Proper seed handling is crucial for growing healthy seedlings, as it must be done in accordance with the characteristics of each tree species. Detailed guidelines for handling seeds of different species can be found in "Seed Handling and Propagation of Papua New Guinea's Tree Species." This document contains comprehensive information on seed production in PNG (see the Table 6-3).

Table 6-3: Outline of Seed Handling and Propagation of Papua New Guinea's Tree Species



Published by:

- Australian Centre for International Agricultural Research (ACIAR)
- Papua New Guinea Forest Authority (PNGFA)
- Commonwealth Scientific and Industrial Research Organization (CSIRO)

Published: 2004

Contents

- Section 1: Background
- Section 2: Seed Collection
- Section 3: Seed Processing
- Section 4 : Seed Storage
- Section 5; Nursery Techniques
- Section 6: Species Descriptions (27 species)

URL https://publications.csiro.au/rpr/download?pid=procite:24a220b0-eb34-4d87-a6b2-66b67a93a915&dsid=DS1

However, the above information may not be practical for field workers and landowners for ANR project implementation. Therefore, the project developed the following dissemination pamphlet on seedling production based on this information and used them in dissemination activities for landowners and logging Company staff.

(**Appendix 3-3: Steps for Seed Collection & Germination for the Five Target Tree Species in the Project Area**)

(3) Key Operations in Seedling Production

The key operations in seedling production include seed collection, sowing, seedling transplanting, and nursery management. Below, the details and important considerations for each operation are outlined.

1) Seed / Wildling Collection

a. Planning for Seed / Wildling Collection:

Develop a collection plan that considers the number of seedlings to be planted, the fruiting season of the target tree species, and the appropriate timing for seed collection, while also accounting for wildling collection by specifying the required size, season, and collection methods.

For identifying the fruiting season, firstly refer to the "Outline of Seed Handling and Propagation of Papua New Guinea's Tree Species, especially Appendix1. Phenological Data for PNG Forest Species.

Monitor the flowering, fruiting and seed fall season at project areas for efficient seed collection and seedling production.

(Reference) Appendix1. Phenological Data for PNG Forest Species in "Outline of Seed Handling and Propagation of Papua New Guinea's Tree Species"

Appendix I. Phenological Data for PNG Forest Species

Species	Location[1]	Altitude (m)	Flowering[2]	Fruiting[2]	Seed fall[2]
Adenanthera pavonina	Gogol		Jan, Sep, Oct (Jan)	Nov–Mar* (Nov, Mar)	
Agathis alba			Aug	Sep–Oct	Nov–Dec
Alangium javanicum	Gogol	200	Mar–Jul	Jun–Sep (Mar–May)	May
Alangium javanicum	Oomsis	100	Jun	Jul	Aug
Alangium javanicum	Talasia, WNB	100	Jul	Aug	Sep
Aleurites moluccana	Bulolo (N)	700–1000	(Jan–Apr), (Aug–Nov)	(May–Jul), Nov–Dec	(Jul–Aug), Feb–Apr
Aleurites moluccana	Highlands		Sep–Jan	Jun (Oct–Dec)	
Aleurites moluccana	Keto/Aseki (N)	1850	Jan–Mar, Aug–Nov	Mar–May	Jun–Aug

b. Collection Site

It is recommended to collect seeds / wildlings from forests surrounding the planting site.

c. Seed Collection from Parent Trees (Seed Trees)

For long-term seed collection, it is desirable to select parent trees for seed collection with the following characteristics:

- Straight trunk with a high first branch (indicating superior traits)
- High seed production capacity (ensuring a stable seed supply)
- Easily accessible location (for convenient seed collection)

d. Seed Collection without Parent Trees Selection

If parent trees have not yet been selected, seeds can be collected using the following methods:

- Direct collection from well-shaped trees

- Gathering seeds that have fallen around potential parent trees
- Storage of Collected Seeds

2) Seed Cleaning

- Clean the seeds to remove pulp and foreign matter, preventing mold and pest infestation.
- During cleaning, conducting a floatation test is effective in assessing seed viability. Seeds that float in water are likely immature or deteriorated and should be discarded.

3) Seed Storage

- Collected seeds should be stored in a cool, well-ventilated place away from direct sunlight.
- Some seeds may not be suitable for long-term storage, so appropriate handling should be based on the characteristics of each tree species.

4) Preparation of germination bed medium

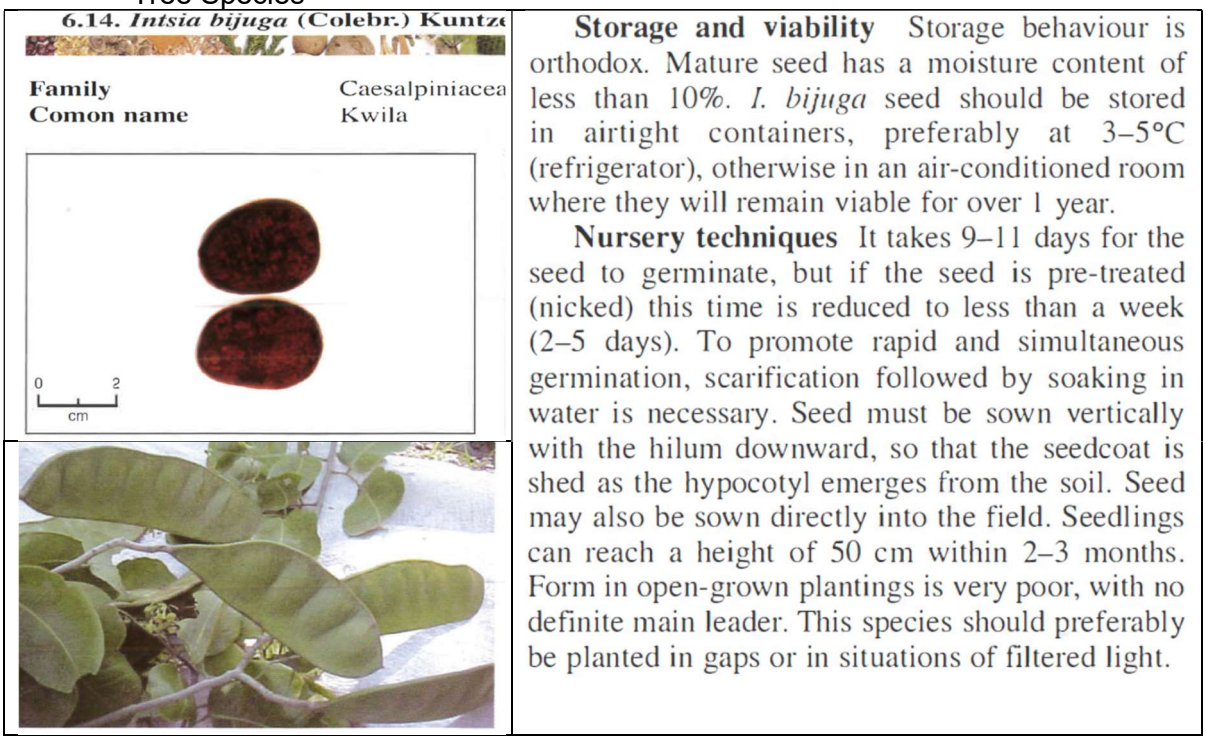
- **Use of local soil**: Ideally, the germination bed medium should consist of local soil where the target tree species naturally grow.
- **Use of additional materials for better drainage**: If the soil has poor drainage, sandy loam or cocopeat can be added to improve water drainage.
- **Sterilization treatment**: To prevent pests and diseases, heat treatment and sterilization of the medium should be performed.
- **Fertilizer application**: To promote seed germination, an appropriate amount of chemical or organic fertilizer can be mixed into the medium if necessary

5) Sowing

- **Media (Soil) Preparation:** Select suitable soil for each target species, Refer to the Outline of Seed Handling and Propagation of Papua New Guinea's Tree Species, especially Chapter 6. Species Descriptions (27 species) for selecting suitable soil for each specie in Table 6-3
- **Pre-treatment**: For low germination species, pre-treatment should be applied before sowing according to seed characteristics

  Example: For walnut, carefully crack the seed coat or sand it lightly, then soak it in water overnight to improve germination rate.
- **Depth**: Sow the seeds at a depth of 1–5 cm into the media.

(Reference) Chapter 6. Species Descriptions (27 species) for selecting suitable soil for each specie in "Outline of Seed Handling and Propagation of Papua New Guinea's Tree Species"



6.14. *Intsia bijuga* (Colebr.) Kuntze

Family Caesalpiniacea
Comon name Kwila

0 2 cm

Storage and viability Storage behaviour is orthodox. Mature seed has a moisture content of less than 10%. *I. bijuga* seed should be stored in airtight containers, preferably at 3–5°C (refrigerator), otherwise in an air-conditioned room where they will remain viable for over 1 year.

Nursery techniques It takes 9–11 days for the seed to germinate, but if the seed is pre-treated (nicked) this time is reduced to less than a week (2–5 days). To promote rapid and simultaneous germination, scarification followed by soaking in water is necessary. Seed must be sown vertically with the hilum downward, so that the seedcoat is shed as the hypocotyl emerges from the soil. Seed may also be sown directly into the field. Seedlings can reach a height of 50 cm within 2–3 months. Form in open-grown plantings is very poor, with no definite main leader. This species should preferably be planted in gaps or in situations of filtered light.

6) Pot Filling

- **Polybag** size: Select the appropriate polybag size according to the tree species.
- **Media**: Use sterilized local soil from the area where the target tree species naturally grow. If necessary, mix in organic fertilizer, cocopeat, or other materials.
- **Compaction**: When filling the polybag with soil, avoid excessive compaction to ensure adequate aeration, allowing roots to grow ropery.

7) Seedling Transplanting

- **Hole**: Create a planting hole in the centre of the polybag filled with soil, suitable size to transplant seedling.
- **Handle carefully small seedling**: Handle the seedling carefully to minimize root damage and transplant it gently into the polybag.
- **Watering**: To promote survival rate, water the seedling immediately after transplanting.

8) Grow Seedlings in Nursery

- **Placing seedlings at seedling beds**: Place the potted seedlings in the seedling beds to prevent seedlings from being exposed to direct sunlight.
- **Spacing of potted seedling**: Ensure adequate space to allow proper seedling growth.
- **Watering**: Water the seedlings in the early morning and evening.
- **Weeding**: Remove weeds inside the polybags.
- **Check seedlings**: Regularly check seedling health, mortality, and the presence of pests or diseases. If pests or diseases are detected, consider appropriate control measures, such as the use of pesticides.

5. Site Preparation for enrichment planting

(1) Overview

Site preparation is a part of process in forest management operation, primarily carried out for post-harvest regeneration efforts. Its objective is to prepare a suitable condition for tree planting. Specifically, it involves selecting planting sites, removing residual branches left after logging, and weed strip lines in order to prepare the soil surface to enhance seedling healthy growth. Below are the steps for site preparation in the case of line planting for enrichment planting.

(2) Site Preparation Steps

Site preparation for line planting in ANR is carried out in the following three steps: (1) Planting Site Selection, (2) Making Baseline, and (3) Making Strip Line including marking planting points

(3) Step1 Planting Site Selection:

1) Firstly the designated project area during planning phase with relevant stakeholders (as per Chapter 5, Section 3.(1): Project Area Determination) should be confirmed by field survey or maps.
2) Next, within that area, locations where forest degradation is severe due to logging or other factors, and where forest restoration / assisted natural regeneration are needed, will be selected as planting sites.
3) Additionally, factors such as topography, soil conditions, suitability for planting tree growth, and operational condition (accessibility) are taken into consideration.

(4) Step2 Making Baseline:

The baseline is a straight line used to set the entry points of the strip lines. To set up the baseline,

1) First, set a long straight line along a road or skid track using a measuring tape or in alignment with the site topography / terrain.
2) Next, measure the intervals for the strip lines (e.g., 10m) along the baseline, and mark the intervals using stakes. To ensure visibility, tape or paint is applied to the stakes, preventing workers from overlooking them.
3) Finally, from each stake, set entry points of the strip lines perpendicular to the baseline within the forest using a compass. Setting them at right angles prevents strip lines from intersecting inside the forest.
4) In the case of Mashal Lagoon and Unu Amau FMA, a baseline of approximately 400m was set along the road, and strip lines were set at 10m intervals. (See Chapter 5 Figure 5 1: Design of Enrichment Planting in Pilot Site (Mashal Lagoon & Unu Amau FMA.))

	
Pic 6-10: Stakes along Baseline	Pic 6-11: Setting Entry Point of Strip Line

(5) Step3 Making Strip Line:

A strip line is a designated strip-shaped area within a forest where trees are planted. It is particularly set for enrichment planting, which aims to restore degraded forests. The strip line is set up using the following steps:

1) **Check Entry Point**: Identify and confirm the designated entry point from the baseline.
2) **Setting Direction and Measurement**: Using a compass, establish a perpendicular direction from the baseline and extend a measuring tape into the forest.
3) **Weeding**: Along the measuring tape, clear the vegetation within a designated width in its design (e.g., 1m).
4) **Marking Planting Points**: While checking the planting interval (e.g., 5m) with the measuring tape, use stakes and colour tape to mark the planting points.
5) **Completion of Setting Strip Line**: Once the designated strip line length is reached, the setup of that strip line is complete.

		
Pic 6-12: Entry of Strip Line	Pic 6-13: Setting Strip Line	Pic 6-14: Planting Points

6. Enrichment Planting

(1) Overview

Enrichment planting is a method of seedling planting in degraded forests by such as logging in order to restore forest resources.

At this stage, the following activities are conducted: transporting seedlings from the nursery to the planting site, planting, and mulching.

(2) Seedling Transport

Seedlings are transported from the nursery to the designated planting site according to the planting schedule.

- **Watering**: Before transport, seedlings should be well-watered.
- **Protection from sunlight**: After transport, seedlings should be temporarily placed under tree shade or another area protected from direct sunlight.

(3) Planting seedlings

- Demonstration is recommended by forest officers before planting.
- **Digging Planting Hole:** Use shovel or digging tools to dig a planting hole at designated planting point. The hole depth should be slightly deeper than the root ball height, and the width should be approximately twice the root ball.

Pic 6-15: Digging Tool at Marshall Lagoon and Unu Amau FMA

Pic 6-16: Original Digging Tool at Amanab

- **Removal of Seedlings from Polybags**: Carefully removing the seedling from the polybag without damaging the roots. Tear the polybag along the vertical line to free the seedling, avoiding the use of sharp tools that could cut the roots.

- **Planting seedlings**:
  - Planting should be done during the rainy season. If planting during the dry season, it should be done in the morning or late afternoon (after 3 pm) to minimize excessive transpiration. In waterlogged areas, planting should be conducted during the dry season.
  - Place the seedling upright at the centre of the planting hole.
  - While refilling soils into the hole, ensure the seedling remains stable and does not tilt.
  - Finally, firmly press the soil around the stem with both feet to stabilize the seedling.

Pic 6-17: Planting of Walnut Seedling

Pic 6-18: Planting of Kwila Seedling

- **Mulching**: Mulching involves placing fallen leaves, dried grass, or other organic materials around the seedling to retain soil moisture and suppress weed growth. This practice is particularly useful in areas prone to dry conditions or high weed competition.

7. Tending

(1) Overview

Tending is an essential silvicultural treatment to ensure the healthy growth of seedlings after tree planting, aimed at removing competing vegetation around seedlings. In tropical regions, weeds grow rapidly, and if young seedlings are covered by weeds or vines, they will compete for light, water, and nutrients, which can hinder their growth and even lead to mortality. Therefore, tending must be carried out until the seedlings grow taller than the competing vegetation to ensure their survival and healthy growth.

The following sections describe the different tending methods, recommended tending frequency, and key considerations for effective tending operations.

(2) Tending methods

There are three types of tending (weeding) methods described below.

- **Complete Tending**
  - **Method**: Cutting and removing all competing vegetation across the entire plantation area.
  - **Application Areas**: Plantation sites, log landing, and relatively large open gaps.
- **Strip Tending**
  - **Method**: Cutting and removing weeds in a strip (belt) along planting rows or skid tracks.
  - **Application Areas**: Plantation sites, row-planted areas, and skid tracks.
- **Ring Tending**
  - **Method**: Cutting and removing weeds only around the seedlings (within a radius of approximately 50 cm to 1 m).
  - **Application Areas**: , Log landings, skid tracks, and any other disturbed areas.

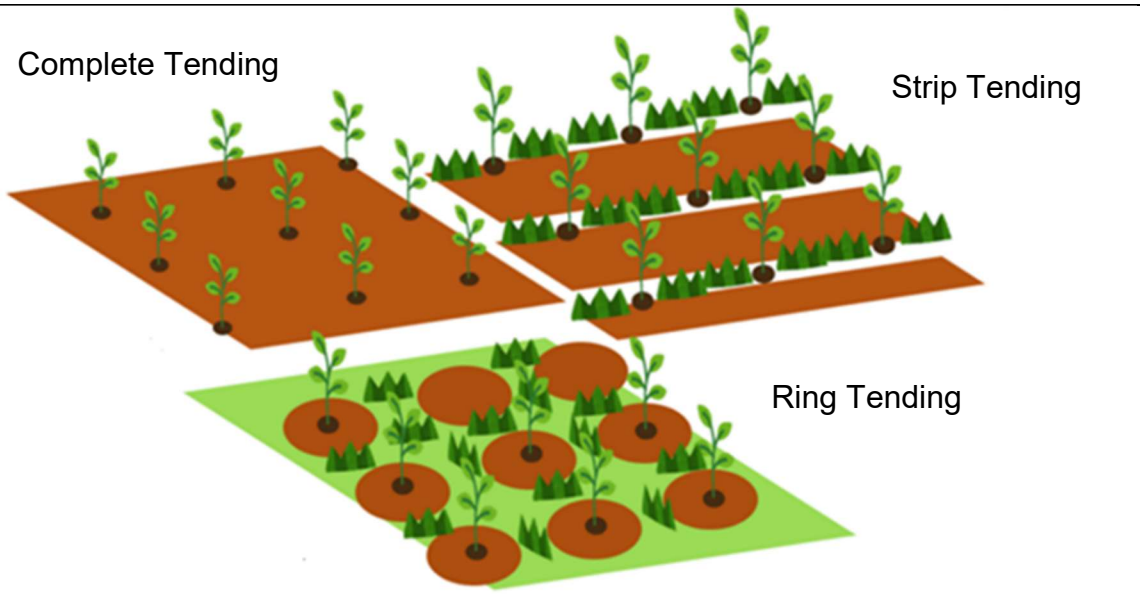


Figure 6-4: Tending Methods

(3) Tending Frequency

The frequency of tending is determined based on factors such as the growth of competing vegetation and seedlings, the planted areas (under-canopy or open space), the applied tending method, and climatic conditions.

The following points are key considerations for setting the tending frequency.

1) Suggested Tending Frequency

- **General**: For the first 18 to 36 months after planting, tending should be conducted regularly to prevent seedlings from being covered by competing vegetation. The first tending should be scheduled and conducted around after 3 months of planting.
- **For under-canopy planting**: Tending should be performed every 3 to 4 months (approximately 3–4 times per year), depending on vegetation conditions. During the peak growing season in the rainy season, tending should be intensified to prevent seedlings from being covered by weeds.
- **For open areas painting such as log landing**: Monthly tending is recommended until the end of the first rainy season. In such areas, more frequent management is required in the first year after planting.

2) Adjustments Based on Climatic Conditions

- **In regions with distinct rainy and dry seasons**, tending frequency should be increased during the rainy season and reduced during the dry season.
- **In regions with year-round rainfall**, tending should be conducted regularly throughout the year.

3) Criteria for Stopping Tending

- **For under-canopy planting**, tending can be stopped once the seedlings grow taller than the competing vegetation and their canopy begins to shade out weeds.
- **In open areas**, tending is no longer necessary once canopy is closed.

(4) Considerations points for tending work

1) **Pre-check of seedling location**: Check the position of seedlings before starting work to avoid accidentally cutting them.
2) **Safety Work**: Check the terrain and any obstacles in the work area to secure a safe working route. When using blades, pay due caution to prevent injuries to yourself and surrounding people.
3) **Working Tools**: Use a bush knife or brush cutter to remove competing vegetation. For small seedlings, manually remove weeds around the roots to prevent damage.
4) **Mulching**: Place removed vegetation around the seedlings to maintain moisture and control weed growth.

Chapter 7. Monitoring Phase

1. Overview

Monitoring is the continuous evaluation and assessment process of the natural forest regeneration and plantation projects, involving the regular observation and recording of seedling / wildling growth conditions and environmental factors. Through this process, appropriate management actions and necessary interventions can be implemented to ensure the healthy growth of forests and sustainable management.

In ANR projects, monitoring is essential for adaptive management and sustainable forest operations. Supervisors must conduct monitoring alongside planting and tending activities to assess progress and effectiveness.

The following section outlines the procedures for implementing monitoring.

2. Preparing a Monitoring Plan

The monitoring plan should be prepared based on the following components:

(1) **Standard number for monitoring sample plots**

- **Line Planting**: Three sample plots of 50m length. (Minimum sample number and size)
- **Open Area and Gap Planting**: Three sample plots of 20m × 20m each. (Minimum sample number and size)

(2) **Criteria for setting of monitoring sample plots**

- To capture overall growth trends across the project site, sample plots should be selected considering factors such as growth conditions, vegetation, topography, soil, and water availability.

(3) **Monitoring items**

- **Seedling / Wildling Growth**: Measure height (cm) and diameter (mm). Both height and diameter are important in order to measure growth performance.
- **Survival Rate**: Count both surviving and dead trees to calculate survival rate.
- **Environmental Factors**: Soil, light conditions, and vegetation.

(4) **Monitoring Frequency:**

- **Regular Monitoring**: Conduct monitoring at 3 months, 6 months, 1 year, 2 years and 3 years or more after planting, however the monitoring frequency depends on forest types, locations and project objective.
- **Completion of initial monitoring**: If, at any point, the planted trees have grown taller than the competing vegetation, initial monitoring for tending working can be concluded. Although the initial monitoring has been completed, additional silvicultural treatments may be required depending on species and site conditions.

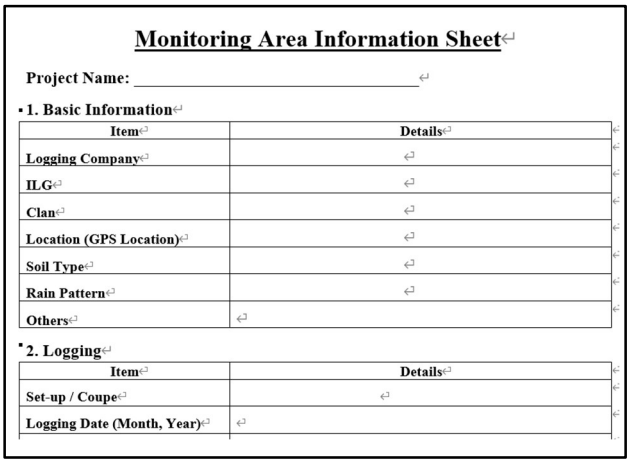
3. Monitoring Implementation

(1) **Preparation of Tool:**

The following equipment should be prepared for monitoring:

- Tape measure (for height measurement)

- **Caliper / Diameter Tape (for diameter measurement)**
- Camera (for recording and verification) – Capture and document different growth stage during the specified monitoring intervals.
- GPS (for recording location)
- Recording sheet (Monitoring Area Information Sheet, Monitoring Record Sheet)
  Appendix 4-1: Monitoring Area Information Sheet
  Appendix 4-2: Monitoring Record Sheet



Monitoring Area Information Sheet

Project Name: _____

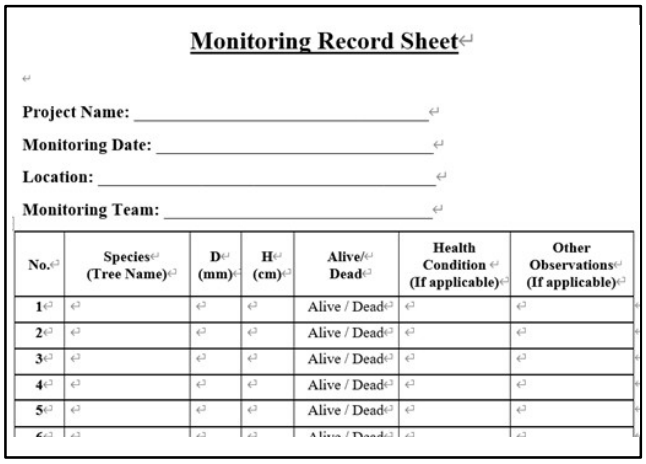
1. Basic Information

Item	Details
Logging Company	
ILG	
Clan	
Location (GPS Location)	
Soil Type	
Rain Pattern	
Others	

2. Logging

Item	Details
Set-up / Coupe	
Logging Date (Month, Year)	

Figure 7-1: Monitoring Area Information Sheet



Monitoring Record Sheet

Project Name: _____

Monitoring Date: _____

Location: _____

Monitoring Team: _____

No.	Species (Tree Name)	D (mm)	H (cm)	Alive/ Dead	Health Condition (If applicable)	Other Observations (If applicable)
1				Alive / Dead		
2				Alive / Dead		
3				Alive / Dead		
4				Alive / Dead		
5				Alive / Dead		

Figure 7-2: Monitoring Record Sheet

(2) **Setting of Sample Plots:**

- **Plot shape and setting method**: The appropriate plot shape should be determined based on the planting method (e.g., line planting, gap planting).
- **Marking / Recording of Plot Locations**: To ensure continuity in monitoring, stakes with ribbons should be used to mark plot locations. GPS should be used to record the plot locations.

(3) **Monitoring Survey**

- **Growth Measurement**: Measure and record height (cm) and diameter (mm).
- **Survival Status Recording**: Record survival status (alive or dead) during the growth measurement.
- **Health Condition Evaluation**: Record seedlings with poor vitality based on leaf colour and identify those suspected of being affected by pests or diseases. This assessment should be conducted on all seedlings in the sample plot.
- **Environmental Condition Assessment**: Record factors affecting growth, such as soil, moisture, light conditions, and competing vegetation. This assessment is conducted for overall plot and specific locations.

(4) **Record keeping**

All original monitoring record sheets used during field surveys should be securely stored for future reference, along with the digital data described in the next section

	
Pic 7-1: Growth Measurement	Pic 7-2: Growth Measurement
	
Pic 7-3: Status of planting (Amanab,Taun)	Pic 7-4: Growth Status after 6 months (Amanab, Kwila)

4. Analysis of monitoring results and consideration of measures

(1) **Data entry and analysis**

The data obtained from monitoring will be entered into the Excel software to analyse, in particular by checking the growth and survival rates.

Monitoring result is summarized using the filled monitoring survey sheet, the analysis is conducted based on each plot. Points to consider are as follows.

- **Survival rate calculation**: Survival rate is calculated as 'number of surviving seedlings ÷ total number of seedlings surveyed × 100'.
- **Growth**: Summarize measured height and diameter data over time.
- **Comparison of growth data**: Compare growth data with other plots to assess the relative growth of the project area.

Table 7-1: Sample form for Capturing Data Survival Rate Survey (Result at Amanab)

Survival Rate of the Strip Planting

Compartment	Setup 1		
Plot	Total Count	Dead Seedling	Survival Rate
1 (1st Strip)	10	0	100%
2 (2nd Strip)	10	0	100%
3 (3rd Strip)	9	3	67%
4 (4th Strip)	10	4	60%
Total	39	7	82%

Survival Rate of the Skid Track

Compartment	Setup 2		
Plot	Total Count	Dead Seedling	Survival Rate
1 (Landing)	14	3	79%
2 (Skid track)	14	3	79%
3 (Skid Track)	14	3	79%
4 (Skid Track)	12	0	100%
Total	66	11	83%

Table 7-2: Result of Field Survey of Walnut Seedling Growth and Survival Rates

Stripe Line	Total Seedling	Dead Seedling	Survival Rate	Average Height (cm)		Height Increment (cm)
				Oct-24	Jan-25	
1st Line	20	0	100%	15.3	21.0	5.7
2nd Line	20	0	100%	16.2	21.8	5.6
3rd Line	20	0	100%	13.1	18.2	5.1
4th Line	20	0	100%	14.6	19.1	4.5
5th Line	17	1	94%	14.8	18.8	4.0
Total	97	1	99%	14.8	20.0	5.2

(2) **Measures based on monitoring results**

Analyse the monitoring results and consider the necessary measures as needed. By responding adaptively to issues, the survival rate and growth of planted trees can be improved, leading to better forest regeneration. The following outlines potential challenges identified through monitoring and corresponding countermeasures.

1) Poor Survival Rate

- If the survival rate falls below 80%, assess the necessity of replanting.
- If the survival rate is below 50%, consider not only replanting but also reviewing species selection to ensure suitability for the site.

2) Poor Growth

Evaluate factors of poor growth such as insufficient light, water stress, and competing vegetation, and implement the following measures as needed:

- **Additional tending**: Remove competing vegetation
- **Mulching**: Prevent soil moisture loss
- **Fertilization**: Enhance nutrient supply

3) Other Issues

If there are other poor performance result, supervisors need to evaluate the cause of poor performance including review work processes and provide training for workers if necessary. Potential causes and corresponding measures include:

- **Poor seedling quality**: Ensure proper nursery management for producing healthy

seedlings.

- **Inappropriate seedling storage**: Conduct proper storage management to prevent drying, overheating, and disease infections.
- **Improper species selection**: Reassess whether the soil and rainfall conditions are suitable for the tree characteristic of selected species.
- **Planting according to weather and natural condition**: Adjust working schedules to conduct planting according to the local weather patterns and natural conditions.
- **Improper planting techniques** (e.g., root damage, insufficient compaction of seedlings): Provide training and supervision for planting operations.
- **Improper tending practices** (seedling damage): Conduct training and supervision to ensure proper tending operation.
- **Damage from pests or animals**: Implement control measures for pests and animals to protect seedlings.

5. Applicability of this monitoring process

This monitoring applies to the implementation of ANR projects in new project areas.

As stated in "2. Preparing a Monitoring Plan - 4) Monitoring Frequency," the initial monitoring can be concluded when the planted trees have grown taller than the competing vegetation.

If the monitoring results are positive and the planted trees are confirmed to be growing well in new project areas, this monitoring method should be concluded, and the possibility of transitioning to a more simplified monitoring approach should be considered for the following monitoring in the same area.

Additionally, monitoring should not only evaluate tree growth but also assess the budget execution, the implementation quality of each operation, and changes in stakeholders' engagement and attitude in the project. These evaluation criteria should be appropriately set and assessed according to the project objectives and the policies of the implementing body.

APPENDICES

Appendix 1 Landowner Interview Sheet

Landowner Interview Sheet

1. Name _____
2. Clan name _____
3. Role in the clan _____
4. Detail of clan (population, number of households, distance to town, main work, major challenges, etc.)

   _____

   _____

   _____
5. How large is your land areas?

   _____
6. How to utilize your land/forest?

   _____

   _____

   _____
7. Could you explain the decision-making process to determine land use in the clan?

   _____

   _____

   _____
8. What kind of forest roles are important for you or your communities? (e.g., income from timber, water conservation, hunting, food (seeds or mushroom), culture and spirit, or others).

   _____

   _____

   _____

   _____
9. Has logging been operated in your forests? If yes, how would you evaluate the forest condition after logging? (e.g., well naturally regenerated, damaged, less animal, water issues, etc)

   _____

   _____

   _____

   _____
10. Are you interested in participating in the tree planting project?

    Yes, No

    Reason _____

    _____

11. If yes, which species are good for you and your community?

Specie name(s): _____

Reason _____

12. How can you contribute to the tree planting project?

(Providing land, Providing labor (planting, maintenance, etc.), Collecting seeds, Managing nursery, Others (___ __)

Comments: _____

_____

13. If tree planting project is implemented, do you agree to exchange document with implement body (PNGFA or logging company) ?

Agree, Disagree

Request: _____

_____

_____

14. Any questions, comments, suggestions for new project?

_____

_____

_____

_____

_____

Appendix 2-1:
Example of Regeneration Activity Agreement among PNGFA, Logging Entities, and Landowners

Agreement on Clan Land Usage and Forest Regeneration Activity

DATE OF AGREEMENT

This agreement is made on the ……day of……..……...20XX

PARTIES TO THE AGREEMENT

The parties to the agreement are:

The PNG FOREST AUTHORITY (known in this agreement as "the Authority")

and

The……CLAN (known in this agreement as "the Clan") being the customary owners of the land as described in the plan hereof

and

The Company Name, (known in this agreement as "the Company").

WHEREAS:

The parties are desirous to promote forest regeneration activities after logging for sustainable forest management through seedling preparation, seedling planting and silvicultural treatment.

****** ******* FOREST MANAGEMENT AREA (FMA) and;

The Authority, the Clan and the Company shall make available for the purpose of this agreement.

THE PARTIES AGREES AS FOLLOWS:

1. This agreement shall commence on the date of the Agreement (above) and shall be for a term of one rotation of the regenerating forest (a period until the forest is next ready for optimum commercial harvesting).

2. Ownership of the land and trees, subject to the conditions of a current FMA, remain vested in the customary owners.

3. The Clan and the Authority shall mutually select one Set-Up site for forest regeneration activities (known in this Agreement as "Pilot Set-up").

4. The Authority shall plan and supervise the forest regeneration activities (known in this Agreement as "Pilot Activity") including enrichment planting and initial silvicultural treatment on the selected Pilot Set-up.

5. The Company shall collaborate the Pilot Activity especially site preparation of

enrichment planting, seedling planting, and initial silvicultural treatment through providing manpower and necessary machineries.

6. The Authority and the Company shall coordinate the timing of logging on the Pilot Set-up for its smooth implementation of Pilot Activity.

7. The Clan shall, in Pilot Set-up, continue to have the traditional rights access and traditional use for purposes other than clearing for gardens.

8. The Clan grants to the Authority and the Company the rights for Pilot Activity including but not limited to, access, survey, marking of trees, measurement of trees, initial silvicultural treatment and further treatment as determined by the Authority.

9. The Authority reserves the right to engage machinery to maintain roads and tracks for the essential access and firefighting operations required.

10. This Agreement is subjected to the Forest Management Agreement in force during the currency of this agreement, provided in the event of an inconsistency between the conditions of this agreement and the FMA, the protection of the regenerating forest shall be paramount.

11. Pilot Set-Up shall be surveyed to specify the area for Pilot Activity and clearly demarcated for the activities.

12. The Authority shall design the detail plan of Pilot Activity on the specified area above whereby the clan confirms the conditions of this agreement and the detail plan for the specified area if necessary. The detail plan shall include seedling production for enrichment planting, enrichment planting, initial silvicultural treatments and other treatments.

13. The Clan will assist seedling production through collecting wildings from their own forests and carry the collected seedlings to the place where the Authority designate.

14. The Authority shall inspect the collected seedlings within four weeks after the seedling collection. The inspection criteria are survival of seedings, its height from 20 to 30 cm and right species. The Authority designate the Project Supervisor as the inspector, and collectors and number of seedlings passing the inspection are recorded.

15. The ***** shall pay the cost of the seedling according to the number of seedlings passing the inspection to respective collectors. The respective collectors are requested to sign on a document prepared by the JICA at the time of payment.

16. The ***** shall pay the cost for the seedling collection, the price of each seedling is ***** Toea.

17. The Authority shall establish main nursery and the Company shall assist the establishment through providing partial materials including sawn timbers, water supply and manpower for construction and manage the nursery.

18. The Company shall commence seedling production not only for achieving the Project Agreement / Timber Permit Condition but also for contributing to the Pilot Activity. The Company may provide seedlings for Pilot Activity if the production is successful and the Authority request.

19. The Authority will employ periodic casuals for Pilot Activity, and the casuals will come from the Clan members to be selected by the Clan Leader.

20. All parties must consult each other prior to undertaking any activities directly associated with the Pilot Set-up or any activities that may have an effect on the Pilot Activity.

21. All parties agree to honor and adhere to this agreement. This agreement shall remain binding on all assigns and/or successors in title.

On behalf of the Clan:

Full Name of Clan Leader	Signature	Village (Clan)

(Additional name as required)

Full Name of Clan Leader	Signature	Village (Clan)

On behalf of the PNG Forest Authority:

Full Name	Signature	Title

On behalf of the Company Name:

Full Name	Signature	Title

Appendix 2-2: Example of Regeneration Activity Agreement between Logging Entity and Landowners

CLAN LAND USAGE AGREEMENT

DATE OF AGREEMENT

This agreement is made on the ….……day of……..…….20……

PARTIES TO THE AGREEMENT

The parties to the agreement are:

The ******** Ltd. (known in this agreement as "the Company")

and

The ……CLAN (known in this agreement as "the clan"),

being the customary owners of the land as described in the plan hereof.

WHEREAS:

The parties are desirous to promote sustained yield management of forest through silvicultural treatment of forest before, during and after logging under

…….Timber Rights-Purchase/Forest Management Agreement and;

The Clan shall make available for the purpose of this agreement.

THE PARTIES AGREES AS FOLLOWS:

1. This agreement shall commence on the date of the Agreement (above) and shall be for a term of one rotation of the regenerating forest (a period until the forest is next ready for optimum commercial harvesting).
2. Ownership of the land and trees, subject to the conditions of any current Timber Rights Purchase (hereinafter TRP) or Forest Management Agreement (hereinafter FMA), remain vested in the customary owners.
3. The Clan and the Company shall mutually select sites for silvicultural treatment (being areas of forest with clearly definable boundaries, known in this Agreement as "Blocks").
4. The Company shall plan and supervise the silvicultural treatment of the selected Blocks.
5. Blocks shall be surveyed and clearly demarcated and shall be subjected to a further Dedicated Forest Land Agreement for each block whereby the clan confirms the conditions of this agreement for each block.

6. The Clan shall, in all Blocks, continue to have the traditional rights access and traditional use for purposes other than clearing for gardens.
7. The Clan grants to the Company the rights of forest management, including but not limited to, access, survey, marking of trees, measurement of trees and initial silvicultural treatment and further treatment as determined by the Company.
8. The Company reserves the right to engage machinery to maintain roads and tracks for the essential access and firefighting operations required.
9. Case of accidents

   The activity groups shall take full responsibilities for safety when implementing the Activities, and the project shall not bear any responsibilities for any kinds of accidents, injuries, fatalities and damages occurred, regardless of whether the equipment and tools provided by the project are involved or not.
10. Dispute resolution

    In case any dispute arises in the activity group regarding the implementation of the Activities, the activity group should resolve the dispute by their initiatives. The project shall not bear any responsibilities for the dispute but shall endeavor to provide support for the resolution.
11. Others

    Any other disagreements and/or problems that arise regarding the Activities shall be resolved through mutual consultation by the stakeholders, or if this fails, through mediation by a third party mutually acceptable to all the stakeholders.
12. This Agreement is subjected to the Timber Rights Purchase/Forest Management Agreement in force during the currency of this agreement, provided in the event of an inconsistency between the conditions of this agreement and the TRP/FMA, the protection of the regenerating forest shall be paramount.

On behalf of the Clan:

Full Name of Clan Leader	Signature/mark	Village
(additional names as required)		
Full Name of Clan Leader	Signature/mark	Village

On behalf of (Company Name):

Full Name	Signature/mark	Title
Full Name	Signature	Title

Appendix 2-3: Example of Regeneration Activity Agreement between PNGFA and Landowners

CLAN LAND USAGE AGREEMENT

DATE OF AGREEMENT

This agreement is made on the ….……day of……..……20……

PARTIES TO THE AGREEMENT

The parties to the agreement are:

The PNG FOREST AUTHORITY (known in this agreement as "the Authority")

and

The ……CLAN (known in this agreement as "the clan"),

being the customary owners of the land as described in the plan hereof.

WHEREAS:

The parties are desirous to promote sustained yield management of forest through silvicultural treatment of forest before, during and after logging under ……Timber Rights-Purchase/Forest Management Agreement and;

The Clan shall make available for the purpose of this agreement.

THE PARTIES AGREES AS FOLLOWS:

1. This agreement shall commence on the date of the Agreement (above) and shall be for a term of one rotation of the regenerating forest (a period until the forest is next ready for optimum commercial harvesting).
2. Ownership of the land and trees, subject to the conditions of any current Timber Rights Purchase (hereinafter TRP) or Forest Management Agreement (hereinafter FMA), remain vested in the customary owners.
3. The Clan and the Authority shall mutually select sites for silvicultural treatment (being areas of forest with clearly definable boundaries, known in this Agreement as "Blocks").
4. The Authority shall plan and supervise the silvicultural treatment of the selected Blocks.
5. Blocks shall be surveyed and clearly demarcated and shall be subjected to a further Dedicated Forest Land Agreement for each block whereby the clan confirms the conditions of this agreement for each block.

6. The Clan shall, in all Blocks, continue to have the traditional rights access and traditional use for purposes other than clearing for gardens.
7. The Clan grants to the Authority the rights of forest management, including but not limited to, access, survey, marking of trees, measurement of trees and initial silvicultural treatment and further treatment as determined by the Authority.
8. The Authority reserves the right to engage machinery to maintain roads and tracks for the essential access and firefighting operations required.
9. Case of accidents

   The activity groups shall take full responsibilities for safety when implementing the Activities, and the project and shall not bear any responsibilities for any kinds of accidents, injuries, fatalities and damages occurred, regardless of whether the equipment and tools provided by the project are involved or not.
10. Dispute resolution

    In case any dispute arises in the activity group regarding the implementation of the Activities, the activity group should resolve the dispute by their initiatives. The project shall not bear any responsibilities for the dispute but shall endeavor to provide support for the resolution.
11. Others

    Any other disagreements and/or problems that arise regarding the Activities shall be resolved through mutual consultation by the stakeholders, or if this fails, through mediation by a third party mutually acceptable to all the stakeholders.
12. This Agreement is subjected to the Timber Rights Purchase/Forest Management Agreement in force during the currency of this agreement, provided in the event of an inconsistency between the conditions of this agreement and the TRP/FMA, the protection of the regenerating forest shall be paramount.

On behalf of the Clan:

Full Name of Clan Leader	Signature/mark	Village
(additional names as required)		
Full Name of Clan Leader	Signature/mark	Village

On behalf of the PNG Forest Authority:

Full Name	Signature/mark	Title
Full Name	Signature	Title

Tok Pisin - Painim na Lukautim Pikinini Diwai

Painim na Kisim Pikinini Diwai

- ☑ Makim diwai we yu laikim na bai yu planim.
- ☑ Painim pikinini diwai bilong en lo bush we e grow aninit lo mama diwai.
- ☑ Pikinini diwai imas grow stap namel lo 1-3 mun.
- ☑ Pikinini diwai imas igat longpela blo 10-15cm.
- ☑ Pikinini diwai imas igat 2-4pela lip.
- ☑ Yusim savol, kamautim isi lo graun. Noken bagarapim ruts bilong pikinini diwai.
- ☑ Karamapim gud ruts wantaim skin blo banana or pangal blo ol palm diwai or ol bikpla lip blo ol diwai.
- ☑ Gutpela taim blo kisim pikinini diwai em lo morning na lo avinun.

Stretim Pikinini Diwai igo lo Polybag

- Stretim polybag na graun blo planim pikinini diwai.
- Pulmapim polybag wantaim graun inap e pulap.
- Yusim hap stik, wokim hol lo graun insait lo polybag.
- Putim isi pikinini diwai igo insait lo dispela hol ikam lo mak blo rut kola blo pikinini diwai.
- Putim lus graun lo karamapim hol na presim graun sait -sait lo pikinini diwai lo strongim em sanap gud.
- Tingim lo givim wara taim yu pinis wantaim potting.

Lukautim Pikinini Diwai lo Haus Neseri

- Putim pikinini diwai lo neseri bed. Neseri bed imas silip makim north igo south.
- Pikinini diwai imas noken stap ples klia lo sun na strongpela rain.
- Givim wara olgeta taim lo pikinini diwai lo morning na avinun.
- Rausim ol grass or weed we ikamap insait lo polybag.
- Spacim gud ol pikinini diwai na noken larim ol paspas.
- Sekim neseri olgeta taim lo binatang nogut na sik we iken bagarapim pikinini diwai na rausim.

Do Not Trespass!

A final precaution when gathering wildings: Be sure that you are either on your clan's land or if you are on another clans' land, then you seek permission from the appropriate land-owners before you begin collecting wildings. Trespass is a serious matter. You can avoid it with minimal inconvenience by communicating with each other before you act.

For Further Reading

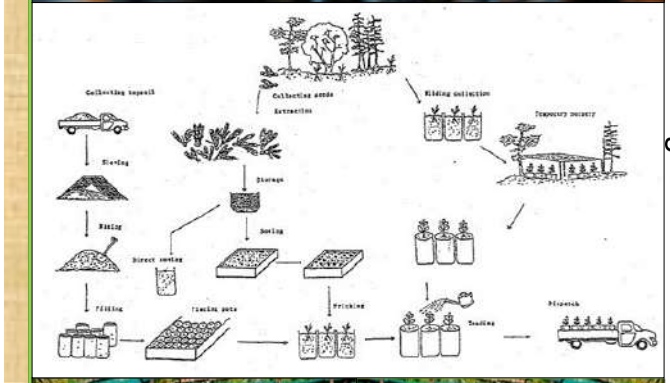
1. Gregorio, N., Herbohn, J., and Steve, R. 2010. Guide to quality seedling production. http://www.rainforestation.ph/resources/
2. Thomas, A. Identification and selection guideline for seed source. ITTO Project, MEF, Manila, Philippines.
3. Tuiwawa, M. and Dayal, B. 2021.A Guide to Planting Local Tree Species for Forest Restoration, USP, Suva, Fiji.
4. Tuiwawa, M. and Dayal, B. 2021.How to Build a Low-Cost Community Nursery , USP, Suva, Fiji.
5. DeYoe, D.R. 1985. Reforestation—Transplanting Wildings. Circular 1121.Extension Service, Oregon State Uni, Corvallis.

JICA-PNGFA FOREST PROJECT

PNG Forest Authority HQ
PO Box 5055
BOROKO, NCD
Papua New Guinea

JICA - PNGFA FOREST PROJECT

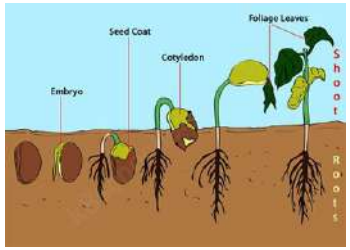
Capacity Development Project for Reducing Carbon Emissions from Forest Degradation through Commercial Logging in PNG.



1.Tree Wildlings

What is a Wilding?

A wilding is basically a naturally germinated seedling. Tree wildings refers to the spontaneous and natural regeneration of trees within an ecosystem without direct human intervention. It involves the self-seeding, sprouting, or natural propagation of trees in a given area, contributing to the restoration and enhancement of the ecosystem. Tree wilding is a process driven by the natural dispersal of seeds, the growth of new saplings from existing roots, or the sprouting of seeds from the soil seed bank.



Why is Tree Wilding important?

Tree wilding plays a vital role in addressing environmental challenges, promoting biodiversity, and enhancing ecosystem health and resilience. By restoring degraded landscapes and fostering community participation, wilding contributes to a more sustainable and equitable future for both people and the planet.

2.Tree Species Selection

How do you choose tree species?

Choosing the appropriate tree species for regeneration and restoration efforts in natural forest environment is very crucial for its sustainability and success. Based on a comprehensive assessment in relation to your objectives, tree species can be identified and selected on the following basis.

* Economic value
* Silvicultural traits
* Biotic Interactions
* *Ecological Suitability
* *Resilience & Adaptability
* *Stakeholder Preferences

What are the selected tree species?

- Anisoptera thurifera (Mersawa)
- Hopea iriana (Heavy Hopea)
- Pometia pinnata (Taun)
- Dracontomelon dao (PNG Walnut)
- Pterocarpus indicus (PNG Rosewood)

What is the source for tree wildings collection?

Identified and selected "superior" mother trees for each of the chosen tree species must be located and mapped out as candidate wilding source for collection within the project sites. For this project, the primary focus is on the economical value of high grade timber regenerated within the degraded natural forest post logging operations.

Candidate superior mother trees must possess the following desirable characteristics;

*Stem form: straight (tall), bole and no fork
*Branching: light (few) with less persistence
*Health: No signs of pests and diseases

3. Wilding Collection

What is the required wilding size ?

- Germinated within the last 1-3months
- Height between 10-15cm (avoid +20cm)
- Diameter should be less than 7mm
- Normally should have 2-4 pairs of leaves

When to collect wilding?

- Should be collected while they are still very young
- Should be collected early in the morning and late afternoon
- If collection is done during a sunny day, wilding should be covered to protect them from wilting.

How to collect wilding?

- Carefully dig around and into the soil surrounding the wilding with a hand shovel.
- Carefully lift the shovel with a ball of earth around the roots of the wilding making sure not to damage the roots.
- Place the dug out wilding in a palm/ banana sheath and wrap it carefully. Avoid damaging the shoot and its leaves.

- Use a rope to tie around the sheath to hold it together. Avoid tightly packing the wildings in a sheath.

4. Storage & Transportation

After collecting and wrapping wildings from the forest, care must be taken to ensure safe storage and transportation to the nursery.

- Use a box to store, secure and transport the wildings. Palm basket can be another option to be used to carry wildings.
- Avoid transporting wildings during sunny days when temperature is high and expose to direct heat from sunlight.
- Do not use plastic bags to wrap wildings. Rapid heat build can directly affect the survival of the wildings.
- Keep the wildings cool and moist until transplanting on the same day or the following day.
- Do not store wildings longer that 24 hours.

5. Transplanting & Potting

- Prepare polybags for potting with good drainage holes.
- Prepare the soil by sieving and sterilizing it.
- Fill the polybags with the prepared soil to the brim, making sure the polybags are completely filled and uptight.
- Use a stick or your index finger, poke a hole through the soil in the centre of the filled polybag.
- Gently, place the root of the wilding downright through the poke hole until the root collar is level with the top soil of the polybag.

- Place some loose soil to cover the hole and gently press the soil around the wilding to secure it.
- Always remember to water the wildings just after potting.

6. Care in Nursery

- Place the polybags with wildings in the nursery beds, making sure the nursery beds are oriented north-south.
- Make sure the wildings are protected from direct sunlight and heavy rain downfall.
- Water the wildings regularly to keep the soil moist but not waterlogged. Early morning and late evening is recommended.
- Always check and remove any weeds or unwanted matter in the polybags that might compete for nutrients.
- Avoid crowding of wildings. Ensure enough space for each wilding to grow.
- Regularly inspect the wildings for any signs of mortality, pests and diseases and take appropriate measures.

Tok Pisin - Painim na planim sid blo Diwai

Painim na Kisim Sid bilong Diwai

- ☑ Painim na markim gudpla mama diwai we yu laikim lo kisim sid lo en blo planim.
- ☑ Painim na kisim sid weh e pundaun aninit lo mama diwai, or kalapim tu na kisim sid.
- ☑ Bungim ol sid blo mama diwai na putim gud igo insait lo bek.
- ☑ Karim ol dispela sid ikam bek lo haus neseri.
- ☑ Stretim gud na klinim ol sid wantem wara lo rausim pipia na binatang.
- ☑ Sekim gud ol displa sid na rausim tu ol bagarap sid weh igat binatang na sik nogut lo em.
- ☑ Bungim olgeta gutpela sid wantem na redi lo planim.

Planim Sid lo Kamapim Pikinini Diwai

- Stretim polybag na graun blo planim sid.
- Pulmapim polybag wantaim graun inap e pulap.
- Yusim stik, wokim hol lo graun insait lo polybag.
- Putim isi sid blo diwai igo insait lo dispela hol.
- Kisim graun na karamapim bek gen dispela hol.
- Givim wara taim yu pinis wantaim planim sid.

Lukautim Sid blo Diwai lo Haus Neseri

- Putim gud ol polybags yu planim lo neseri bed.
- Polybags noken stap ples klia lo sun na rain.
- Givim wara gud lo sid blo diwai lo rait taim.
- Rausim ol weed weh ikamap insait lo polybag.
- Spacim gud ol pikinini diwai na noken paspas.
- Sekim neseri olgeta taim lo binatang nogut na sik we iken bagarapim pikinini diwai na rausim.

Advantages of Growing Seedlings from Seeds

- ☑ Genetic Diversity - Growing seedlings from seeds reflects the genetic diversity with high environmental adaptability.
- ☑ Cost Reduction - Compared to wildlings, seeds are easier to transport and store, making them suitable for large-scale afforestation and restoration.
- ☑ Reduced Risk of Pests and Diseases - Wildlings may carry existing pests or diseases, while seeds minimizes this risk.
- ☑ Uniformity - Makes it easier to grow seedlings in nurseries.

Do Not Trespass!

A final precaution when gathering and collecting seeds: Be sure that you are either on your clan's land or if you are on another clans' land, then you seek permission from the appropriate landowners before you begin collecting seeds. Trespass is a serious matter. You can avoid it with minimal inconvenience by communicating with each other before you act.

For Further Reading

1. Brian Gunn, Alex Agiwa, Derek Bosimbi, Brioni Brammall, Lawrence Jarua and Annonciata Uwamariya. 2004. *Seed Handling and Propagation of Papua New Guinea's Tree Species.* CSIRO Forestry and Forest Products, Canberra.
2. Quayle, S., Arnold, R., Gunn, B. and Mohns, B. 2001. Tree Nursery Manual for Sri Lankan Plantation Industry. Estate Forest and Water Resources Development Project, 114 pp.
3. Robbins, A.M.J. and Shrestha, N.B., (1986). Guidelines for tree seed collection - Tree Seed Handling: A manual for field staff in Nepal. HMG/UNDP/FAO Community Forestry Development Project.

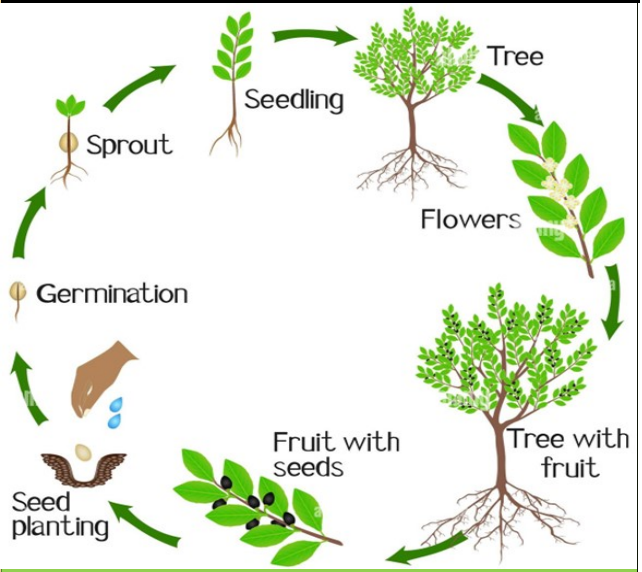
JICA-PNGFA FOREST PROJECT

PNG Forest Authority HQ
PO Box 5055
BOROKO, NCD
Papua New Guinea

JICA - PNGFA FOREST PROJECT

Capacity Development Project for Reducing Carbon Emissions from Forest Degradation through Commercial Logging in PNG.

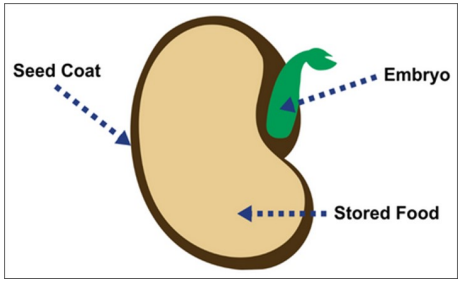
Basic Nursery Guide for Tree Seed Collection & Germination.



Let's grow together for a greener tomorrow!

1.Seed & its importance

What is a seed? A seed is the embryonic stage of the plant life cycle. Most seeds consist of three parts: embryo, endosperm, and seed coat. The embryo is a tiny plant that has a root, a stem, and one or more leaves. The endosperm is the nutritive tissue of the seed, often a combination of starch, oil, and protein. The seed coat is a protective covering that can help seeds remain viable for long periods of time.



Why Collect Seeds in Natural Forests?

- ☑ Enables the propagation of tree/plant species .
- ☑ Preserves the genetic diversity of tree/plant species.
- ☑ Supports reforestation degraded and deforested areas.
- ☑ Supports rural livelihoods and ensure food availability.
- ☑ Supplying resources for locals to build houses, etc.
- ☑ Supply herbs and traditional medication for locals people.
- ☑ Ensuring the survival and sustainability of native tree species for future generations.

Role of seeds

Seeds play a crucial role in environmental restoration, stabilizing soils, and mitigating climate change through reforestation and carbon sequestration. Economically, seeds drive agriculture, forestry, and trade, while culturally and medicinally, they hold significance in traditions and healthcare. Seeds also ensure the preservation of plant species through conservation efforts like seed banks, fostering adaptation and sustainability in the face of climate and environmental changes. In essence, seeds are the cornerstone of ecosystems, economies, and human well-being.

2. Seed Collection & Preparation

A. Plan and Prepare Ahead

- ⊗ Research and identify which tree species to collect based on project goals (for example; reforestation).
- ⊗ Research and identify the seed-fall period for each of the different tree species. Collect during peak maturity.
- ⊗ Make sure to use the right tools and equipment such as carry bags, poles, climbing gear (if needed), and labels for proper handling and identification.

B. Choose The Right Trees/Superior Mother Trees

- ⊗ Identify and select superior mother trees that are disease-free, mature, vigorous growth and other traits that suit your project end goals.
- ⊗ Collect seeds from multiple superior mother trees across the area (minimum 20-30 trees per species) to maintain genetic variability.
- ⊗ Make sure to mark these mother trees for future collection and also to avoid cutting them down.

C. Collect The Seed

- ⊗ Ensure seeds are fully mature; look for indicators like color changes, seed detachment, or falling fruits.
- ⊗ Collect only a portion of the seeds to allow for natural regeneration and avoid overharvesting.
- ⊗ Use poles, climbers, or nets to safely collect seeds without harming the tree or surrounding vegetation.

D. Handle With Care

- ⊗ Note down species name, collection date, and location.
- ⊗ Remove any pulp, flesh, outer layers to reduce the risk of mold, fungi or pest attack.
- ⊗ Store seeds in breathable containers (e.g., cloth bags) to prevent overheating or mold growth.
- ⊗ Some seeds, such as Rosewood, may be stored in air-tight containers.
- ⊗ Keep seeds in a cool, dry place during transport to the nursery or storage facility.

3. Seed Sowing & Germination

Basic steps to germinates seeds

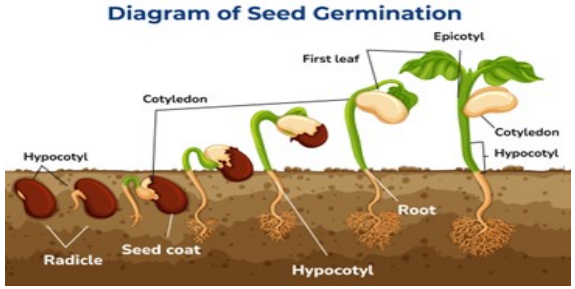
- ☑ Prepare a well-draining, nutrient-rich growing medium by mixing sand, compost, and sterilized, sieved soil to eliminate pests and debris.

- ☑ Fill up the germination beds and polybags with the prepared gowing medium.

- ☑ Prepare the seeds by treating /soaking in water or scarifying if needed be.
- ☑ Sow the seeds by making a hole 1-2cm deep into the soil of the prepared medium in the polybags. Place one or seeds per polybag and lightly cover with soil.

- ☑ Water gently to keep the soil moist but not waterlogged.
- ☑ Make sure to arranged the placement of the polybags with the planted seeds in a shaded, well-drained area.

- ☑ Monitor and provide nursery care by daily check up for moisture, pests and germination. Remove weeds and ensure consistent care is applied.



PNG Rosewood - Pterocarpus indicus

Seed Collection and Preparation

1. Superior **Mother Trees** – Identify and select superior Rosewood trees for seed collection.
2. **Time Your Collection** - Collect seeds when the pods are mature, which can be identified by their dry, brownish color. In Abau District, Rosewood flowering may occur from September to October and fruiting from November to January. Seed ripening from February to April and seed fall around May.
3. **Collect Seed Pods** - Use long-handled pruners or poles to reach pods high in the canopy. You may also climb and cut off a couple of branches with ripe pods. Alternatively, you can gather fallen seed pods from the ground, ensuring they are clean and free of mold or damage.
4. **Separate Seeds from Pods** - Open the pods carefully using a knife or by gently crushing them with your hands to extract the seeds. Be cautious not to damage the seeds during this process.
5. **Clean the Seeds** - Remove any remaining pod debris or foreign matter from the seeds. Wash the seeds in clean water to eliminate dust, dirt, or contaminants.
6. **Dry the Seeds** - Spread the seeds in a single layer on a clean, dry surface in a shaded area with good air circulation. Allow the seeds to dry for 2–3 days or until they reach a consistent dryness.
7. **Test for Viability** - Perform a simple float test: place the seeds in water and discard those that float, as they are likely unviable. Viable seeds usually sink to the bottom.
8. **Treat the Seeds** (Optional) - To improve germination rates, pre-treat seeds by soaking them in lukewarm water for 12–24 hours before planting.
9. **Store the Seeds** - If not planting immediately, store the seeds in a cool, dry place in an airtight container.

Seed Sowing and Germination

1.Soil Preparation:

- Use well-draining sandy loam soil mixed with organic compost.
- Sterilize the soil to remove pests, pathogens, or weed seeds.
- Fill germination beds or polybags with the prepared soil, ensuring polybags have drainage holes to prevent waterlogging.

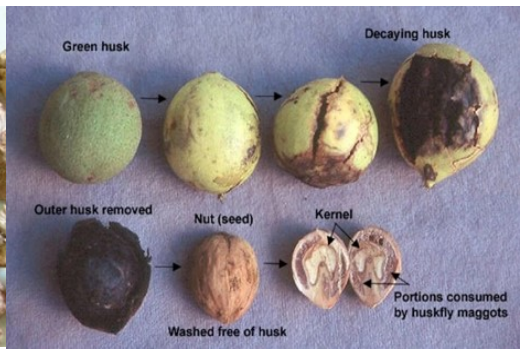
2. Sowing the Seeds:

- Seed depth: Sow seeds 1–2 cm deep and cover with a thin layer of fine soil or sand. Avoid compacting the soil to allow easy sprouting.
- Seed spacing: in seedbeds, space seeds 5–10 cm apart in rows, with rows 15–20 cm apart, and in polybags, plant one seed per polybag to prevent crowding.
- Orientation: Lay seeds flat, with the broader side facing downward, to promote even moisture absorption and uniform germination.

3. Watering: Water the seedbed or polybags immediately after sowing to moisten the soil. Maintain consistent moisture, avoiding waterlogging to prevent seed rot.

4. Germination Period: Seeds can germinate 3-4 days after sowing but usually begins within 7–14 days under optimal conditions. Check daily, ensure the soil remains moist, and remove weeds that may compete with germinating seeds for sunlight and nutrients.

PNG Walnut - *Dracontomelon dao*



Seed Collection and Preparation

1**. Superior Mother Trees:** Identify and select the superior mature tree to collect the seeds.

2. Time Your Collection: In Abau, Central Province, flowering may occur from December to February, fruiting around March to April and the fruit ripening around June to September. Ripe fruits change colour from green to yellow.

3. Collect Mature Fruits: Use long-handled pruners or poles to harvest fruits from the tree canopy. Alternatively, collect fallen fruits from the ground, ensuring they are free of mold, damage, or insect infestation.

4. Extract Seeds from Fruits: Remove the fruit pulp by manually peeling or gently scraping the fruit, or soak the fruits in water for 2-6 days (exchanging the water daily) to soften the pulp, making it easier to separate. Wash the extracted seeds thoroughly to remove any remaining residue.

5.Dry the Seeds: Spread the cleaned seeds in a single layer on a clean surface in a shaded area with good ventilation. Allow seeds to dry for 2–3 days or until they feel dry to the touch but not brittle.

6. Test for Viability: Perform a float test by placing seeds in water: Viable seeds will sink to the bottom. Unviable seeds will float and should be discarded.

7. Treat the Seeds (Optional): To enhance germination, seed can be pre-treated. Either by carefully cracking the hard seed coat or by abrasion using a file, grinding machine or a sandpaper and then soaking it in water overnight.

8. Store the Seeds: The storage life of Walnut seed is unknown but is likely to be relatively short (<6 months). If not planted immediately, store the seeds in a cool, dry place in an unsealed container.

Seed Sowing and Germination

1.Soil Preparation:

- Use well-draining sandy loam soil mixed with organic compost.
- Sterilize the soil to remove pests, pathogens, or weed seeds.
- Fill the polybags with the prepared soil, ensuring polybags have drainage holes to prevent waterlogging.

2. Sowing the Seeds

- Seed Depth: Sow seeds about 3–5 cm deep, slightly deeper than smaller seeds to provide stability and promote proper root anchoring. Cover with a thin layer of soil or sand.
- Seed Spacing: In seedbeds, space seeds 10–15 cm apart in rows, with rows spaced 20–25 cm apart for adequate growth and maintenance. In polybags, sow one seed per bag to minimize root disturbance during transplanting.
- Orientation: Lay seeds flat, with the broader or flatter side facing downward. This promotes even moisture absorption and supports uniform germination.

3. Watering: Water the seedbed or polybags immediately after sowing to moisten the soil. Maintain consistent moisture levels, but avoid overwatering to prevent seed rot or waterlogging.

4. Germination Period: Germination is slow and sporadic, taking 28-56 days or longer but under optimal conditions, can typically begin within 15–30 days. Monitor by checking daily for emerging sprouts, and ensuring the soil remains moist. Remove any weeds to prevent competition for nutrients, water, and sunlight.

Taun - *Pometia pinnata*



Seed Collection and Preparation

1. **Identify Superior Mother Trees:** Select healthy and mature Taun trees with desirable traits, such as a straight bole, dense canopy, and abundant fruit production, as sources for seed collection.

2. **Timing Your Collection:** In regions like Abau, Central Province, flowering occurs from December to February. Fruits develop around March to April and ripen from June to September. Ripe fruits transition from green to yellow or reddish hues. Collect seeds during this phase to ensure maturity.

3. **Collect Mature Fruits:** Use long-handled pruners or poles to harvest fruits from the canopy. Alternatively, gather fallen fruits from the ground, ensuring they are free of mold, damage, or insect infestations. Handle fruits gently to avoid bruising or damaging the seeds inside.

4. **Extract Seeds from Fruits:** Remove the fleshy fruit pulp by peeling or scraping it manually. Rinse the seeds with clean water thoroughly to remove any pulp residue and dirt and to ensure they are free of pathogens and ready for drying.

5. **Dry the Seeds:** Spread the cleaned seeds in a single layer on a clean, dry surface in a shaded, well-ventilated area. Avoid direct sunlight, which can harm seed viability.

6. **Test for Viability:** Perform a float test by placing seeds in water: Viable seeds will sink. Unviable seeds will float and should be discarded.

7. **Store the Seeds:** Taun seeds have a short viability period, typically less than six (6) weeks with skin intact. It is recommended that seeds be sown as soon as possible after collection.

Seed Sowing and Germination

1. Soil Preparation:

- Use well-draining, sandy loam soil mixed with organic compost to provide nutrients.
- Sterilize the soil to eliminate pests, pathogens, and weed seeds.
- Fill germination beds or polybags with the prepared soil, ensuring polybags have drainage holes to prevent waterlogging.

2. Sowing the Seeds: It is recommended that seeds be sown as soon as possible after collection.

- Seed Depth: Sow Taun seeds 3–5 cm deep to promote proper root anchoring. Cover the seeds with a thin layer of soil or sand.
- Seed Spacing: In seedbeds, space seeds 15–20 cm apart in rows, with rows spaced 25–30 cm apart to allow ample room for growth and maintenance. In polybags, sow one seed per bag to minimize root disturbance during transplanting.
- Orientation: Lay seeds flat, with the flatter side or broader base facing downward. This orientation promotes even moisture absorption and uniform germination.

3. Watering: Water the seedbed or polybags immediately after sowing to moisten the soil. Maintain consistent moisture levels but avoid overwatering to prevent seed rot or waterlogging.

4. Germination Period:

It takes 7-10 days for Taun seeds to germinate. If planted in seedbeds, pricking-out to polybags must be done as soon as the seed germinate because the young seedlings grow very fast during the first month of germination.

Mersawa - *Anisoptera thurifera*

Seed Collection and Preparation

1. **Identify Superior Mother Trees:** Select mature and healthy Mersawa trees with desirable traits, as sources for seed collection.

2. **Timing Your Collection:** Mersawa produces winged seeds in sync with its flowering and fruiting cycle. In Abau District, flowering typically occurs from June to August, and seed fall from September to November. Collect seeds during this seed fall period, when the fruits naturally detach and fall to the ground.

3. **Collect Mature Fruits:** Ripe fruits change colour from green to brownish. Gather these fallen fruits from the ground, ensuring they are free of mold, insect damage, or physical defects. Alternatively, use long-handled pruners or poles to collect mature seeds directly from the tree canopy.

4. **Separate Seeds from Wings:** Carefully detach the papery wings from the seeds by hand, or it can be collected and stored with the wings attached. Ensure all seeds are intact and free from visible cracks or bruising.

5. **Clean the Seeds:** Remove any debris, dirt, or foreign material clinging to the seeds. Rinse seeds with clean water to eliminate dust or potential pathogens.

6. **Dry the Seeds:** Lay the cleaned seeds in a single layer on a clean surface in a shaded, well-ventilated area.

7. **Store the Seeds:** Mersawa seeds have a relatively short storage life hence it is desirable to sow the fruit immediately after collection as stored seed does not retain viability for long.

Seed Sowing and Germination

1. Soil Preparation:

- Use well-draining sandy loam soil enriched with organic compost for optimal nutrient supply.
- Sterilize the soil to eliminate pests, pathogens, and weed seeds.
- Fill germination beds or polybags with the prepared soil, ensuring polybags have adequate drainage holes to prevent waterlogging.

2. Sowing the Seeds:

- Seed Depth: Sow Mersawa seeds about 2–4 cm deep to provide stability and ensure proper root development. Cover the seeds lightly with a thin layer of fine soil or sand.
- Seed Spacing: In seedbeds, space seeds 10–15 cm apart in rows, with rows spaced 20–25 cm apart to facilitate growth and maintenance. In polybags, plant one seed per bag to minimize root disturbance during transplanting.
- Orientation: Place seeds with the pointed or narrower side facing downward to ensure proper rooting and even germination.

3. Watering: Water the seedbed or polybags immediately after sowing to moisten the soil. Maintain consistent moisture levels but avoid overwatering to prevent seed rot or fungal issues.

4. Germination Period: Mersawa seeds typically germinate within 18–35 days under optimal conditions but can take longer if conditions are less favorable. Monitor the seeds daily for signs of sprouting, keeping the soil moist but not waterlogged. Remove weeds regularly to prevent competition for sunlight, water, and nutrients.

Heavy Hopea - *Hopea iriana*

Seed Collection and Preparation

1. **Identify Superior Mother Trees:** Select mature *Hopea iriana* trees with desirable traits, as sources for seed collection.

2. **Timing Your Collection:** *Hopea iriana* produces winged seeds seasonally, following its flowering and fruiting cycle just like its cousin – Mersawa. In Abau District, flowering occurs from July to August, with fruiting from September to October. Seed fall period typically occurs from late October to November.

3. **Collect Mature Fruits:** Ripe fruits change colour from green to brownish. These ripe fruits can be collected from the ground, ensuring they are free of mold, insect damage, or physical defects. Alternatively, long-handled pruners or poles can be used to collect mature seeds directly from the tree canopy.

4. **Separate Seeds from Wings:** Carefully detach the papery wings from the seeds by hand, or it can be collected and stored with the wings attached. Ensure all seeds are intact and free from visible cracks or bruising.

5. **Clean the Seeds:** Remove any debris, dirt, or foreign material clinging to the seeds. Rinse seeds with clean water to eliminate dust or potential pathogens.

6. **Dry the Seeds:** Lay the cleaned seeds in a single layer on a clean surface in a shaded, well-ventilated area.

7. **Store the Seeds:** Hopea seeds have a relatively short storage life hence it is desirable to sow the fruit immediately after collection as stored seed does not retain viability for long.

Seed Sowing and Germination

1. **Soil Preparation:** Use well-draining sandy loam soil mixed with organic compost to create a nutrient-rich medium. Sterilize the soil to remove pests, pathogens, and weed seeds. Fill germination beds or polybags with the prepared soil, ensuring polybags have proper drainage holes to prevent waterlogging.

2. Sowing the Seeds:

- Seed Depth: Sow *Hopea iriana* seeds 2–4 cm deep to provide stability and allow proper root establishment. Cover lightly with a thin layer of soil or sand.
- Seed Spacing: In seedbeds, space seeds 10–12 cm apart in rows, with rows spaced 15–20 cm apart for adequate air circulation and easy maintenance. In polybags, plant one seed per bag to reduce root disturbance during transplanting.
- Orientation: Place seeds with their flatter or broader side facing downward to promote uniform moisture absorption and healthy germination.

3. Watering: Water the seedbed or polybags immediately after sowing to ensure soil is evenly moist. Maintain consistent moisture levels throughout the germination period but avoid overwatering to prevent fungal growth or seed rot.

4. Germination Period: Germination for *Hopea iriana* typically occurs within 20–40 days under optimal conditions but may take longer if environmental factors are suboptimal. Regularly monitor for emerging shoots, ensuring the soil remains moist but not waterlogged. Remove any weeds to minimize competition for nutrients, water, and sunlight, supporting the healthy growth of seedlings.

Tok Pisin - Inspectim Pikinini Diwai

Au lo sekim pikinini diwai lo neseri

⊗ Wokim wanpela seklist wantaim olgeta kraiteria bilong sekim pikinini diwai.

⊗ Yusim rate bilong 0 igo lo 5 bilong skelim lukluk bilong pikinini diwai na raitim go daun.

⊗ Sekim ol kala, seip na lukluk bilong lif bilong pikinini diwai. Raitim go daun long seklist.

⊗ Sekim stik bilong pikinini diwai sapos em isanap strong na streit. Raitim go daun long seklist.

⊗ Rausim sampla pikinini diwai na sekim ruts blo ol sapos e orait or nogat. Raitim go daun long seklist.

⊗ Sekim sais na longpela bilong pikinini diwai na raitim go daun lo seklist.

⊗ Sekim ol binatang nogut na sik lo lif, stik na ruts bilong pikinini diwai na raitim go daun lo seklist.

⊗ Sekim bek/pot yu planim pikinini diwai insait lo en, imas stap gud. Ruts noken tanim aninit.

⊗ Taim yu sekim olgeta samting lo pikinini diwai pinis, yu imas kamap lo sampla kain wei bilong halivim pikinini diwai, kain olsem rausim binatang nogut or sik lo pikinini diwai yusim marasin (insecticides).

Do Not Trespass!

A final precaution when carrying out seedling inspection: Be sure that you are doing seedling inspection either on your clan's property such as nursery or planting site., or if you are on another clans' property, seek permission from the appropriate landowners before you begin. Trespass is a serious matter. You can avoid it with minimal inconvenience by communicating with each other before you act.

For Further Reading

1. Duryea, Mary L., and Thomas D. Landis (eds.). 1984. *Forest Nursery Manual*: *Production of Bareroot Seedlings.* Martinus Nilhoff/Dr W. junk Publishers, The Hague/Boston/Lancaster, for Forest Research Laboratory, Oregon State University, Corvallis. 386 p.
2. Wightman, K.E.(1999), Good Tree Nursery Practices: Practical Guidelines for Community Nurseries, International Centre for Research in Agroforestry. https://books.google.com.pg/books?id=oBKAAAAACAAJ
3. Grading and Hardening of Seedlings in Nursery and Silviculturhttps://synopsisias.com/blog/grading-and-hardening-of-seedlings-in-nursery-and-silviculture-forestry-optional-for-upsc-ifs-category?category_slug=silviculture-general
4. PIP (https://www.pip.com.pg/images/stories/documents/tree-growers-tool-kit/growing/B.1.1._BOOKLET_-_Viles_Neseri_Teknik_Kamarere_na_Akasia.pdf

Need Help? Contact Us!

For further assistance or detailed advice on seedling inspection, feel free to reach out to our experts!

JICA-PNGFA FOREST PROJECT

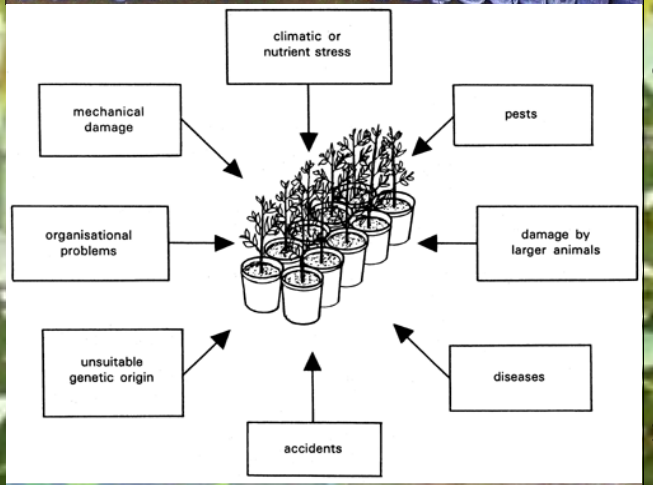
PNG Forest Authority HQ
PO Box 5055
BOROKO, NCD
Papua New Guinea

JICA - PNGFA FOREST PROJECT

Capacity Development Project for Reducing Carbon Emissions from Forest Degradation through Commercial Logging in PNG.

Seedling Inspection Guide - Nursery

Ensuring Quality, Health, and Success in Every Planting Season.



Invest in Quality Seedling,
It is the Foundation of a Thriving Forest.

Seedling inspection

What is “seedling inspection”?

Seedling inspection is the process of examining young plants (seedlings) in a nursery to assess their health, quality, and readiness for transplanting into a field or permanent planting site. This inspection helps determine which seedlings are most likely to thrive in a new environment, ensuring higher survival rates and better growth outcomes.

Why is “seedling inspection” important?

Seedling inspection is essential because it ensures that the healthy and vigorous seedlings are selected for planting, which significantly increases their chances of survival and successful growth in the field. By carefully examining young plants for issues like pest infestations, diseases, root health, nursery personnel can prevent the spread of these issues that could affect entire planting sites. Additionally, the selection of healthy seedlings through inspections, leads to more stable and manageable growth after the seedlings are transplanted. This careful selection process not only reduces mortality rates but also enhances the long-term success and productivity of reforestation and assisted natural regeneration.

Key criteria for seedling inspection

☑ **Leaf Health**: the color, shape, and any signs of damage or disease, like discoloration or spots.

☑ **Stem Condition**: strength and straightness of the stem.

☑ **Root Health**: Healthy roots are usually white and fibrous; brown or mushy roots can indicate rot or poor health.

☑ **Pest and Disease Presence**: Any signs of insects, mold, or other symptoms of disease on the leaves, stems, or roots.

☑ **Size**: Any variations in height or shape that may suggest health issues or environmental stress.

☑ **Polybag Condition**: Nursery polybags are intact and not causing root bounding. Root-bound seedlings can struggle after planting, so selecting appropriate polybags for the species is important.

SEEDLING INSPECTION FLOW

Inspection frequency (when to inspect):

- Weekly during nursery growth
  For the nursery care, refer to the pamphlet "Tree Wilding Collection And Nursery Care."
- Just before field planting

Steps for Seedling Inspection

1. Create and Use a Seedling Inspection Checklist.
   Prepare a checklist with all key criteria for seedling inspection to ensure a comprehensive and consistent assessment.

2. Assess the General Health of the Seedlings.

0 - Dead	1 - Poor	2 - Okay	3 - Fair	4 - Very Good	5 - Excellent

Use the following rating scale to evaluate each seedling.

☑ Leaves - check leaves for color, shape, and texture. Look for any signs of discoloration, spots, or malformations. Healthy leaves are usually green and free from pests or diseases.

☑ Stem - inspect the stem for strength and straightness. A sturdy stem is important for supporting growth in the field.

☑ Roots - carefully remove a few seedlings to examine root health. Healthy roots are white and fibrous; brown or mushy can indicate rot or poor health.

3. Assess the Growth Uniformity of the Seedlings.

☑ Consistency: Ensure seedlings are similar in size and appearance, which indicates uniform growth and proper care.

☑ Irregularities: Look for any variations in height or shape that may suggest health issues or environmental stress.

4. Assess and Identify Pests and Diseases.

☑ Insect Damage: Check for chewed leaves or stems, which may indicate insect activity.

☑ Fungal Infections: Look for mold or rot, appear as soft spot or decolorization on seedling.

Insect attack on Hopea leaf.

5. Assess Pot Condition and Prevent Root-Bound Issues.

☑ Pot/Bags Condition: Inspect nursery pots or bags to ensure they are intact.

☑ Root Bound Prevention: Make sure roots are not circling or bound, as root-bound seedlings may struggle after transplanting.

Common Issues to Watch Out For

* Wilting: may indicate over or under-watering.
* Yellowing Leaves: often a sign of nutrient deficiency or over-watering.
* Stunted Growth: could result from poor soil conditions, low light, or overcrowding.

Hopea leaves wilting as a result of transplanting.

Recommended Actions

⊗ **Remove** unhealthy seedlings to prevent the spread of pests or diseases.

⊗ **Separate** overcrowded seedlings to allow for better air circulation and root growth.

⊗ **Apply** appropriate treatments if pests or diseases are detected in entire nursery, such as natural insecticides. For e.g., the use of garlic or neem seeds with water.

Preparing for Field Planting

The healthy and vigorous seedlings should be planted in the field. Proper inspection ensures the selection of strong seedlings that will adapt well to the new environment, leading to better survival and growth rates.

Tok Pisin - klinim bus na planim Pikinini Diwai

Au lo klinim bus ples na stretim graun

- Sekim gud bus ples weh e bagarap pinis na markim blo planim pikinini diwai.
- Yusim wara or rot, kamapim start lain (baseline) blo ples blo planim pikinini diwai. Markim stik lo 10m space along lo displa baseline.
- Wanwan 10m space long baseline, markim na katim stripline. Stripline em lain blo planim pikinini diwai.
- Long wanwan stripline, katim na clearim bus, rop, grass na ol narapela samting weh bai blokim planim na grow blo pikinini diwai.
- Markim stik lo 5m space along lo wanwan stripline. Dispela em hap mark blo planim ol pikinini diwai.
- Taim yu stretim olgeta pinis, sekim gud olgeta stripline gen long ol binatang na sik nogut, sans blo graun bai buruk, wara pulap na kamapim sampla wei blo stretim dispela.

Au lo planim pikinini diwai

- Givim wara long ol pikinini diwai long bik morning bipo lo taim blo planim long bus.
- Yusim savol or stik, dikim hol long size blo roots bilong pikinini diwai. Rausim graun na putim long sait.
- Holim gud na rausim isi pikinini diwai long polibek. Noken yusim naif, nogut yu katim roots.
- Holim gud pikinini diwai na sanapim stret igo insait lo hol long graun yu dikim pinis. Diwai noken go sait.
- Putim ol graun yu digim igo bek na karamapim bek hol wantem roots blo pikinini diwai.
- Kisim ol dai lip na sting diwai na karamapim gud ass blo pikinini diwai.

Do Not Trespass!

A final precaution when transplanting seedlings: Be sure that you are either on your clan's land or if you are on another clans' land, then you seek permission from the appropriate landowners before you begin transplanting. Trespass is a serious matter. You can avoid it with minimal inconvenience by communicating with each other before you act.

For Further Reading

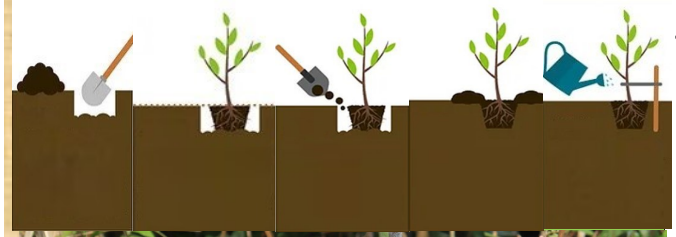
1. Rakotonarivo S, (eds). Understanding forest landscape restoration: reinforcing scientific foundations for the UN Decade on Ecosystem Restoration. Phil. Trans. R. Soc. B, 378;1867
2. Reforestation Guide – Process, Importance, Management, https://nelda.org.in/reforestation-guide-process-importance-management/
3. Stelzer.H (2019), How to Plant Forest Tree Seedlings, https://extension.missouri.edu/publications/g5008
4. https://www.gov.nl.ca/ffa/files/Tree-Seeding-Planting-Instructions-One-Pager-Creative-Version-DM-Approved.pdf
5. Planting and Care of Tree Seedlings, https://extension.unh.edu/sites/default/files/migrated_unmanaged_files/Resource000844_Rep884.pdf

JICA-PNGFA FOREST PROJECT

PNG Forest Authority HQ
PO Box 5055
BOROKO, NCD
Papua New Guinea

JICA - PNGFA FOREST PROJECT

Site Preparation & Planting Guide for Natural Forest



Site/ground Preparation

What is site preparation?

Site preparation involves preparing the land before planting tree seedlings to ensure optimal growth and survival. This includes clearing weeds and unwanted vegetation, improving soil structure and fertility, enhancing moisture retention and aeration, and addressing environmental factors that may hinder seedling establishment. Proper site preparation reduces tree planting mortality and creates favorable conditions for seedlings to establish and thrive by addressing issues like soil conditions, drainage, and weed competition.

Why is it important?

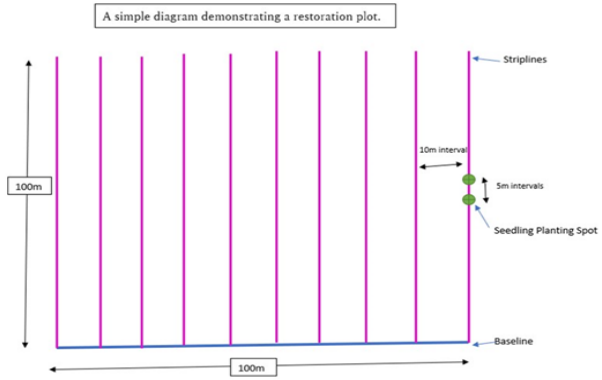
Site preparation directly impacts the success of tree planting by creating optimal conditions for seedling growth and survival. It reduces competition for resources, improves soil structure and fertility, enhances seedling establishment through better root penetration and drainage, and prevents erosion and waterlogging. Overall, site preparation ensures that seedlings are planted in conditions that promote their growth, reducing the risk of failure and increasing the likelihood of planting success.

Key elements to site preparation in natural forest

- ☑ Assess and select a degraded/deforested forest area that needs restoration. Make sure to assess all conditions that are suitable for planting and identify any challenges.
- ☑ Use road/river as a reference point for a baseline. Then establish perpendicular straight lines (striplines) which will guide spacing and layout for the seedlings to be planted.
- ☑ Remove unwanted vegetation such as weeds, grasses, vines and shrubs that could compete for sunlight, water and nutrients. Clear any rocks, branches, or debris that may obstruct planting. All of these task should be done along the marked striplines to minimize disturbances to the natural habitat.
- ☑ Mark and peg where each seedling will be planted, ensuring there is enough space between them for healthy growth. Follow spacing guidelines to promote strong root and canopy development.
- ☑ Use control measures such as herbicides or other safe methods to control weeds and pests if necessary. Use terracing or mulch on slope areas to prevent soil erosion, ensure good drainage to prevent water from pooling around the seedlings, and set up water supply for areas with low rainfall,.

Simple steps to preparing a planting site in natural forest

1. Plan, assess and select your planting site with a greater focus on degraded or deforested areas that need restoration.
2. Establish a “baseline” along a physical feature such as a road or river which can serve as a boundary and point of access as well. Use a line tape and blue ribbon to mark and peg 10m intervals from 0m to 100m along the baseline.
3. From these 10m intervals along the baseline, cut 100m striplines (planting line) perpendicular to the baseline.



4. Clear each stripline and remove unwanted vegetation such as weeds, vines, shrubs and grasses. Clear any other debris as well.

5. Along each striplines, use a line tape and pink ribbon to mark and peg 5m intervals from 0m to 100m. Each of these 5m intervals will be the actual seedling planting spot.

6. Check the stripline area for pest and diseases, erosion probability, waterlogged section and come up with control measures to minimize and stabilize the planting site.

Field Planting of Tree Seedlings

Basic steps for planting seedlings in a natural forest

i. Water the seedlings early in the morning while still in the nursery before transporting them to the field for planting. This helps keep the seedlings hydrated and ready for transplanting.

ii. Using a shovel or stick, dig a hole that is no deeper than the length of the seedling's root mass. The width of the hole should be about twice the size of the seedling’s root ball. Place the removed soil to the side.

iii. Carefully remove the seedling from the polybag without damaging the roots. Tear the polybag along the vertical line to free the seedling, avoiding the use of sharp tools that could cut the roots.

iv. Hold the seedling by the root ball or root collar and gently place it upright into the hole. Ensure the seedling is straight and not leaning to one side.

v. Fill the hole with the soil that was set aside, compressing it gently around the roots to provide stability without over-compacting. The soil should be firm but slightly loose to allow root growth.

vi. Use decaying plant material from the surrounding area as mulch around the base of the seedling. This helps retain moisture and reduces competition from weeds.

Appendix 4-1: Monitoring Area Information Sheet

Monitoring Area Information Sheet

Project Name: _____

1. Basic Information

Item	Details
Logging Company	
ILG	
Clan	
Location (GPS Location)	
Soil Type	
Rain Pattern	
Others	

2. Logging

Item	Details
Set-up / Coupe	
Logging Date (Month, Year)	
Logged Area	
Logged Volume (Total / per ha)	
Number of Skid Tracks	
Number of Log Landings	

3. Planting

Item	Details
Seedling Production Area	
Seedling Producer	
Raising Months	
Planting Date (Month, Year)	
Planting Area	
Planting Species	
Number of Planted Trees	
Planting Method	

Appendix 4-2 Monitoring Record Sheet

Monitoring Record Sheet

Project Name: _____

Monitoring Date: _____

Location: _____

Monitoring Team: _____

No.	Species (Tree Name)	D (mm)	H (cm)	Health Condition (If applicable)	Other Observations (If applicable)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					