CB-NRM Technical Manual

Vol. 1 Seedling Production and Tree Planting Promotion

Prepared by

The Project for Community-Based Sustainable Natural Resource Management in the Democratic Republic of Timor-Leste

From the People of Japan

FOREWORD

Forest degradation and deforestation is one of the critical issues that the Government of Timor-Leste (GoTL) needs to tackle to achieve sustainable socio-economic development in the country. The study made in 2013 shows that approximately 184,000 ha of forest has disappeared between 2003 and 2012 and around 170,000 ha of dense forest has been degraded into sparse canopy forests for the same period.

Community-Based Natural Resource Management (CB-NRM) is an approach to nature conservation by recognizing the rights of local communities to benefit from sustainable management of natural resources (forests, lands, water, and biodiversity) within a designated area. This is an alternative to a top-down regulatory approach, which has not been necessarily effective in many countries, especially when the regulations do not fully cope with the changes in social, cultural, and economic contexts in the countries.

The Project for Community-Based Sustainable Natural Resource Management (the CB-NRM Project) jointly implemented by the Japan International Cooperation Agency (JICA) and the Ministry of Agriculture and Fisheries (MAF), particularly the National Directorate of Forest and Watershed Management (NDFWM), has developed an operative mechanism for CB-NRM in Timor-Leste. The same project has also issued the following manuals over the course of the project to help MAF expand the same mechanism in major river basins in the country.

- Operation Manual for Establishment of the CB-NRM Mechanism at the Village Level
- CB-NRM Technical Manuals
  Vol. 1: Seedling Production and Tree Planting Promotion
  Vol. 2: Sustainable Upland Farming Promotion
  Vol. 3: Income Generating/Livelihood Development
- Manual for Formation of a Watershed Management Council

The CB-NRM Technical Manuals introduce key techniques/skills relevant to sustainable land and forest management as well as livelihood development along with the detailed procedures for provision of hands-on training. They are based on learning from experiences in the field; therefore, we, as representatives of the MAF, strongly recommend that the manuals should be widely used by field practitioners of not only MAF but also other organizations working in the forestry and agriculture sectors as a guiding tool for provision of agriculture and forestry extension services to local communities.

October 2015

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About the CB-NRM Manuals

The CB-NRM Manuals have been developed and published by the JICA and MAF Joint Project named the Community-Based Sustainable Natural Resource Management to provide practical and useful tools for planners and practitioners in the forest sector in Timor-Leste to enable them to protect and manage natural resources in a collaborative and sustainable manner. There are three (3) types of manuals as shown below.

i) Operation Manual for Establishment of the CB-NRM Mechanism at the Village Level
ii) CB-NRM Technical Manuals
    Vol. 1: Seedling Production and Tree Planting
    Vol. 2: Sustainable Upland Farming Promotion
    Vol. 3: Income Generating/Livelihood Development
iii) Manual for Formation of the Watershed Management Council

The Operation Manual is the main document which spells out the standard operation procedures for introduction and establishment of the CB-NRM mechanism at the village level. It is designed for use by planners, field practitioners, and researchers working/studying in the forest sector in Timor-Leste, especially those who engage in forest protection, watershed conservation, and community forestry in the National Directorate of Forest and Watershed Management (NDFWM).

The CB-NRM Technical Manuals supplement the Operation Manual by introducing relevant techniques and skills which can help rural communities use and manage natural resources, especially lands and forests, in a productive and sustainable manner. They will be used mainly by field extension workers (such as MAF municipal staff: namely, municipal officers, extension officers, and forest guards) and NGO staff, as technical references for their field works.

The Manual for Formation of the Watershed Management Council introduces the process to develop a collaboration platform/framework for sustainable natural resource management at the sub-municipal or sub-watershed level, which can also lay groundwork for expansion of the CB-NRM mechanism on watershed scale. As one of the key approaches to improvement of environmental governance at the watershed level by enhancing coordination and networking among local stakeholders, this manual can be of help for those who engage in watershed management.

Furthermore, the JICA and MAF Joint Project has also developed and issued simplified versions of those manuals to help users in the field easily follow the procedures or apply the techniques described in the manuals.

It is hoped that these manuals with their simplified versions will serve as practical references for a wide range of stakeholders in the forest sector in Timor-Leste.

CB-NRM TECHNICAL MANUALS

Vol.1: Seedling Production and Tree Planting Promotion

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Vol.1: Seedling Production and Tree Planting Promotion

1. Introduction

1.1 Rationale for the Techniques

Community-based seedling production and tree planting are crucial activities to achieve the goal of the National Forest Sector Policy issued in 2008. In fact, they are in line with one of the strategies set for one of the key policy objectives of the National Forest Sector Policy, namely "Afforestation and Land Restoration." In the context of CB-NRM, they are also considered as essential activities since they would contribute to not only the realization of a future land use plan prepared in the process of Participatory Land Use Planning, but also the improvement of the long-term livelihoods of local communities.

Techniques introduced by the Project for Community-Based Sustainable Natural Resource Management (hereinafter referred to as "the JICA CB-NRM Project") for seedling production and tree planting have been proven to be effective in the field in terms of financial and technical viewpoints and also applicable to local settings in the target river basins. Hence, the techniques and skills introduced in this technical manual are not from the text books used in other country, but those demonstrated and put to trial in the field over the course of the JICA CB-NRM Project.

1.2 Objectives of the Techniques

The main objective of the techniques for seedling production and tree planting is to promote the production of quality seedlings and the expansion of plantations in rural areas in collaboration with local communities. Specifically, the techniques aim to enable local communities to:

- establish and operate a small-scale community nursery in a proper manner;
- produce quality seedlings collaboratively among communities;
- plant seedlings in a proper manner to ensure high survival and robust growth of seedlings; and
- establish plantations appropriate for species/types of seedling.

1.3 Objectives of the Manual

This manual aims to guide field workers and planners who intend to establish a community nursery and/or promote community reforestation in rural areas in Timor-Leste. Particularly, District Forestry Officers, Sub-district Extension Coordinators, Extension officers, Forest Guards, and field staff of NGOs are targeted as main users.

This manual can be used as guidelines not only for provision of technical assistance by the field implementers (e.g., District Officers, Extension Officers, and NGO staff) but also for monitoring and evaluation of field activities done by the supervisors (e.g., NDF Officers).

2. Approaches to Effective Extension

2.1 Farmers' Field School (FFS) Approach

Farmers' Field School (FFS) is an extension approach prevailingly used in developing countries for agricultural extension. Originally, it was developed in Southeast Asia for the integrated pest management (IPM) in the 1990s. Since then, the concept has evolved owing to its effectiveness, and been applied to a wide range of subjects. FFS employs a non-formal educational method based on the concepts of "experimental," "participatory," and "learner-centered."

FFS aims to create an environment where participants/farmers could learn a specific subject by doing/practicing in the fields, debating results/observations, and periodically working together with other participants/farmers in the same fields. Through a series of FFS sessions, participants/farmers can:

- experience the whole cycle of the subject, such as cropping, forestry development, animal husbandry, soil improvement, and commodity production;
- assess and analyze field situations and consider necessary actions to be taken for improvement;
- empower themselves with knowledge and skills relating to the subject;

The following key elements should be considered in the design of FFS.

Key Element of FFS

Elements	Descriptions
a. Participants of FFS	In general, FFS is designed for 20~25 participants in a group. In the case of the JICA CB-NRM Project, one group is composed of 15~40 members. Ideally, the number of the members should be not more than 30.
b. Field school	FFS sessions should be held in the field. A small scale nursery built at the aldeia level should be used as a venue where the members learn a series of techniques on nursery operations, while a demonstration plot for tree planting should be a venue for FFS sessions on plantation establishment.
c. Curriculum of FFS	The curriculum of FFS should basically cover all the topics/techniques in a cycle of the subject, namely seedling production and tree planting, so that the participants could actually experience in the entire process of the subject in the field. In particular, the members should learn and experience key techniques of nursery operations, namely establishment of a nursery, sowing seeds in seed beds, preparation of media to be filled in plastic bags, transplanting of seedlings into plastic bags, and pest management in a community nursery. On the other hand, designs of plantations and ways for planting seedlings should be introduced to the members.
d. Facilitator	The facilitator who has enough technical background in the subject as well as competent skills in facilitation should be assigned for FFS. He/She will lead the members through the FFS sessions. Ideally, the extension officers (or extensionists) are supposed to be the facilitators with support from District Forest Officers. It is, however, unrealistic that the extension officers could perform as facilitators at present, as their technical and facilitation capacities are still quite limited. Hence, the field staff of NGOs who have facilitation skills as well as experiences in seedling production and tree planting would be the resource persons for the sessions.
e. Core members	The members who can offer his/her lands/farms for a nursery and demonstration plot and play a leading role in the FFS sessions should be selected as core members.

Elements	Descriptions
f. Budget allocation	FFS is not necessarily a low-budget training scheme in Timor-Leste as compared to the conventional extension method since food and snacks should be served for the participants in a session. There is a need to secure sufficient budget for the conducts of a series of FFS sessions.

Source: JICA Project Team (2015)

2.2 On-farm Demonstration Approach

Simultaneously with FFS, the on-farm demonstration approach is to be taken for dissemination of techniques among communities in suco, since the number of the participants in the FFS sessions is limited as compared to the numbers of communities in suco. Hence, a community nursery and demonstration plot are expected to have a dual purpose, namely as i) a venue for training courses of FFS and ii) a model for non-members (or other communities who are not involved in FFS) to observe the results of the techniques applied by the members.

2.3 Farmer-to-Farmer Extension Approach

This may not be the core extension approach under the current circumstances in Timor-Leste, as there are less innovative farmers existing in the field, especially in mountainous areas. It is, however, expected that core farmers might be fostered after the FFS sessions in the demonstration plot and become a role model for other farmers in the future.

In the context of Timor-Leste, farmer-to-farmer extension is might be more effective than the extension by someone from outside since communities generally would not to instantly accept those introduced by outsiders. Observing the performance of neighboring farmers could rather convince them to regard the techniques as worth applying.

2.4 Proposed Extension Method

It is recommended that the following integrated approach shall be taken as a principle extension method to promote and disseminate techniques/skills of seedling production and tree planting at suco level.

Proposed Framework of Extension of the Techniques

Items	Outlines
Duration	2 years
Extension method	Application of Farmers' Field School and On-farm Demonstration Approaches
Target group	20~30 persons in a group at aldeia level
Outline of FFSs 1st year	a. Select tree species for seedling production and decide the number of seedlings to be produced for each species with the members b. Select a site appropriate for a community nursery and that for a demonstration plot for tree planting. c. Develop a curriculum of FFS which comprises a series of hands-on training and follow-up activities in the nursery/demonstration plot. d. Conduct a series of FFS sessions/hands-on training courses at the nursery/demonstration plot to enable the members to practice the procedures for seedling production and tree planting. e. Help the members continue nursery operations using the techniques that they have learned through FFS sessions and maintain seedlings in the nursery

Items	Outlines
	properly. f. In the first year, the main aims of FFSs are to: i) introduce and demonstrate the techniques; ii) give the members opportunities to practice the techniques in the field; iii) give them chances to observe the results of the techniques introduced in the demonstration plot, and iv) help them assess/analyze the techniques based on the results in the demonstration plot.
2nd year	a. Determine tree species and number of the seedling produced based on the results of 1st year's FFS. b. Hold the same FFS sessions as those in the 1st year in the nursery/demonstration plot except establishment of a nursery to ensure that the members could acquire the techniques. c. Help the members maintain seedlings using techniques that they have learned in the FFS sessions. d. Encourage the group members to plant seedlings in the individual plots in a proper manner applying the techniques that they have practiced in the FFS sessions. e. The main focus of the second year's activity shall be put on not only the conduct of FFS sessions at the demonstration plot, but also the facilitation of the members' application of the key techniques to their own farms.

Source: JICA Project Team (2015)

3. Recommended Techniques introduced for Seedling Production and Tree Planting

3.1 Overall View of Techniques

In the FFS sessions on seedling production and tree planting, the following techniques should be introduced in a community nursery and demonstration plot in the form of hands-on training so that the members could actually practice the techniques through the sessions.

i) Nursery establishment
ii) Nursery operations (Seedling production)
    a. Seed preparation and sowing seeds
    b. Preparation of seedling pots
    c. Maintenance of seedlings
    d. Hardening-off
iii) Development of tree plantation
    a. Compost production
    b. Delineation of contour line and staking
    c. Planting
    d. Tending

3.2 Techniques for Nursery Establishment and Operations

The techniques needed for nursery establishment and operations are further described in the following sections. Each section introduces the objectives, procedures for application, and timeframe of the techniques along with some important tips about effective application.

3.2.1 Nursery Establishment

(1) Objective

The main objective of the technique is to establish a small-scale nursery at aldeia level using locally available materials.

(2) Procedures for Application

The following four (4) steps shall be taken to establish a small-scale nursery.

i) Design of a layout of nursery
ii) Selection of a site
iii) Installation of a water system
iv) Development of a nursery

a. Design of a layout of nursery

i) Select the species of seedlings to be planted.

The preferable environment conditions for major species are summarized below.

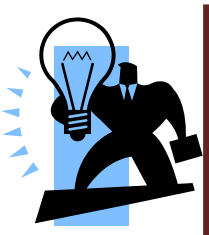
Preferable Conditions for Seedling Production by Species

Species	Altitude (m)	Type of soils	Materials/Methods used for multiplization
Teak	0 - 700	Anything	Seed, Stum
Mahogany	0-1,000	Anything	Seed
Sandalwood	50 - 1,200	Infertile sandy soils	Seed
Casuarina	0 - 2,000	Anything	Seed
Rambutan	0 - 600	Fertile loamy soils	Seed, Graft
Longan	0 - 700	Anything	Seed, Graft
Durian	0 - 800	Fertile silty/clay soils	Seed, Graft
Orange	0 - 1,000	Fertile humus soils	Seed, Graft
Clove	200 - 300	Loamy soils with average fertility	Seed

Source: Halarae Foundation (2015)

ii) Determine the number of seedlings to be produced in a nursery. About 20 % of mortality of seedlings should be taken into account in determination of the total number of seedlings produced in a nursery.

Important Tips

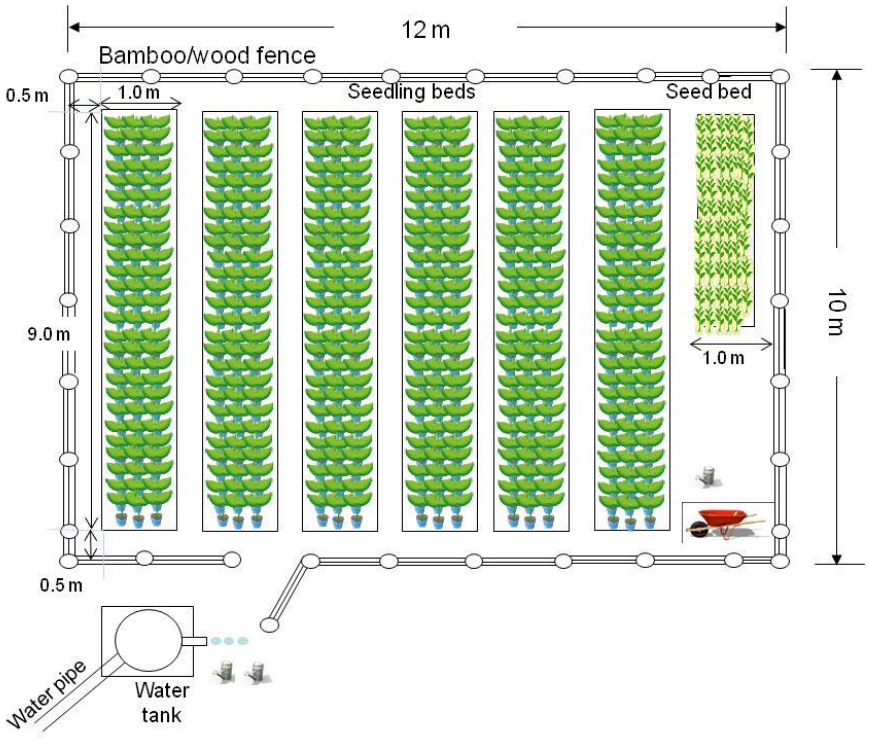


- *The species of seedlings should be selected through a discussion with the participants/farmers to reflect their preference to maintain their interest in the activities.*
- *The number of seedlings should be determined on the basis of participants'/farmers' capacity to plant seedlings. Based on the experiences of the JICA CB-NRM Project, the number of seedlings that one family could plant in a proper manner ranges from 50 to 150 seedlings.*

iii) Design a layout of a nursery which encompasses seedling beds, a seedbed and side paths with the following specifications.

- Seedbed: 1.2 – 1.5 m in width
- Side path: 0.4 – 0.5 m in width
- Seedling bed: 0.6 – 1.0 m in width and 3 – 5 m in length
- 100 seedling pots require the area of 1.0 m^2

Assuming that the total number of seedlings produced in a nursery is 5,400 seedlings (150 seedlings/person x 30 members x 120%), a 10 m x 12 m-sized nursery should be established. A standard layout of the nursery is shown below.



Standard Design of Nursery

b. Selection of a site

i) Select a site for a nursery considering the following conditions: a) accessibility to a water source, b) ground condition (open but less windy), c) terrain condition (flat or gentle sloping), and d) accessibility to the majority of communities' houses

ii) Consult with a land owner of the selected site about the use of the area for a nursery. At the same time, consult with an owner and users of the water source and agrees with them on the use of the water source for seedling production.

c. Installation of a water system

i) Connect a water source (natural source or water tank) to the nursery with bamboo pipes/a hose.

ii) Place a drum can with a capacity of at least 200 litters in the nursery to store water during the night time.

d. Development of a nursery

i) Clear and level the selected site for building a nursery.

ii) Collect local materials (e.g., bamboo or wood poles and palm leaves) for pillars, beams, roof and walls of a nursery. The following table shows materials necessary for establishment of a nursery as large as 120 m^2 which is good for 5,400 seedlings.

Necessary Materials for Nursery Development

Items	Quantity	Remarks
Bamboo poles	40 pcs	For pillars, beams, and fences of the nursery
Wood/Bamboo poles for pillars	12 pcs	3-4 m in length and 20 cm in diameter is desirable.
Wood/Bamboo poles for beams	20 pcs	3-4 m in length and 5 cm in diameter is desirable.
Nalo grasses/palm leaves for thatching	30 bundles	-
Nail	4 kg	7cm in length
Wire	3 rolls	-

Source: JICA Project Team (2014)

iii) Put fences around bamboo poles and thatch nursery's roof with nalo grasses/palm leaves.

iv) In case the site is located in a windy area, install windbreaks made of grasses or leaves.

Thickness of thatched roof should be adjusted according to the site conditions, namely intensity of insolation in the area. If there is an existing shade, the roof should be thin and sparse.

It is strongly advisable to insall windbreaks for producing seedlings intolerant to the wind, such as rambutan.

(3) Timeframe of Application

In the northern part of the country which is under the monsoon type climate with clear distinction between the wet and dry seasons, the establishment of nursery should start in March so that the seedlings can be grown enough to be planted in November in the same year. The standard timeframe of the FFSs on nursery establishment is outlined below.

Standard Timeframe of FFS on Nursery Establishment

Activities	Timing	Duration of the Session
i) Design of a layout of nursery	March	Two to three days
ii) Selection of a site	March	One day for sight inspection and one to two days to discuss with owners of a land and a water source as well as water users.
iii) Installation of a water system	March	Two days for hands-on training
iv) Building of a nursery	March	Four days for hands-on training

Source: JICA Project Team (2015)

3.2.2 Seed Preparation and Sowing Seeds

(1) Objective

The main objective of the technique is to ensure high germination of seeds sown in the seed beds in the nursery.

(2) Procedures for Application

The following steps shall be introduced in the sessions on this topic.

i) Collection of seeds
ii) Pre-treatment of seeds
iii) Making of a seedbed
iv) Sowing and maintenance of seeds at the seedbed

a. Collection of seeds

i) Identify and select healthy mother trees which are large with well developed crowns in the case of timber species or bear large and quality fruits in the case of fruit species.

ii) Collect seeds from mother trees at the respective harvesting seasons as follows.

Harvesting Period of Seeds

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sandalwood	-	-	X	X	-	-	-	-	X	X	-	-
Clove	-	-	X	X	-	-	-	-	-	-	-	-
Citrus	-	-	-	-	X	X	X	-	-	-	-	-
Rambutan	-	-	X	X	X	-	-	-	-	-	-	-
Longan	-	-	-	-	-	-	X	X	X	-	-	-
Teak	-	-	-	-	-	-	X	X	-	-	-	-
Mahogany	-	-	-	-	-	-	X	X	-	-	-	-

Note. X: Harvesting period
Source: JICA Project Team (2015)

iii) In case there is no mother tree found in the area, procure seeds from reliable sources in the country.

b. Pre-treatment of seeds

Pre-treat seeds of the respective species following the methods described below to break seed dormancy and obtain high germination.

Methods of Pre-treatment of Seeds

Species	Methods of pre-treatment of seeds
Sandalwood	1) Soak seeds in cool water from 12 to 24 hours
Clove	1) Remove skin of seeds 2) Soak into water for 1-2 hours
Citrus	1) Mix seeds with ash
Rambutan	Not necessary
Longan	ditto
Teak	1) Put seeds in a rice sack and soak the sack in the cool water for 72 hours. 2) After taking the sack from water, spread seeds in a black-colored container. 3) Expose seeds to sunlight for at least 2 days to dry them.
Mahogany	1) Dry seeds for 48 hours

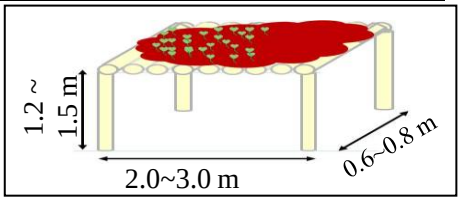
Source: JICA Project Team (2015)

c. Making a seedbed

i) Collect local materials, such as bamboo or woods for a seedbed.

ii) Develop a frame of the seedbed as high as 1.2~1.5 m which is tall enough to prevent damage by chicken.

iii) Mix top soils with sands and compost at a rate of 2:1:1 and fill them in the seedbed.



Typical Design of a Seedbed

d. Sowing and maintenance of seeds in the seedbed

i) Pour water the seedbed one day before sowing.

ii) Sow seeds in the seedbed.

iii) Cover the surface of the seedbed with dried grasses after sowing to maintain the moisture contents and temperature for ensuring high germination.

iv) Water the seedbed twice a day (morning and afternoon) carefully not to dislodge seeds sown.

Important Tips

- *A shallow bucket with a moist soft cloth placed at the bottom could be used as a seedbed for germination of sandalwood seed in case the number of seedlings is limited.*
- *For germination of teak seeds, the seedbed should be covered with a black-colored plastic sheet for 48 hours without watering.*

v) Check if seeds sown germinate in the seedbed periodically. The duration for germination varies with species as shown below.

Required Period for Germination of Seeds

Species	Required period for germination of seeds
Sandalwood	2 weeks
Clove	3-4 days to 1 week
Citrus	1 week
Rambutan	3-4 days
Longan	4-5 days
Teak*	1 month
Mahogany	1 weeks

Note: It is recommendable to use the seeds of teak harvested one year to be sown at the seedbed.*
Source: JICA Project Team (2015)

(3) Timeframe of Application

The FFS sessions on these topics should be held according to the following timeframes.

Standard Timeframe of FFS on Seed Preparation and Sowing Seeds

Activities	Timing	Duration of the Session
i) Collection of seeds and pre-treatment of seeds	Mar.-Sep. (depending on species)	Two days for hands-on training
ii) Building of a seedbed	May/June	One day for hands-on training
iii) Sowing and maintenance of seeds sown in the seedbed	May/June	One day for hands-on training

Source: JICA Project Team (2015)

3.2.3 Preparation of Seedling Pots

(1) Objective

The main objective of the technique is to prepare seedling pots by mixing and filling potting media and transplanting sprouts into the pots in a proper manner.

(2) Procedures for Application

The following four (4) steps shall be taken to prepare seedling pots.

i) Collection of soils and other materials for potting media
ii) Mixing of soils with other media
iii) Filling of potting media into poly bags
iv) Transplanting of sprouts into poly bags filled with media

a. Collect soils and other materials

i) Collect top soils (black soils), sub-soils, and sands in the locality together with the participants/farmers. Top soil should be collected in dense forests or coffee plantations, while sands should be collected in the rivers. Soils underneath the top layer can be used as sub-soils.

ii) Procure compost from external sources (e.g., Dili) especially for the 1st year or 1st round of FFS/seedling production as it might be difficult for the participants/farmers to obtain compost in the locality in the same year.

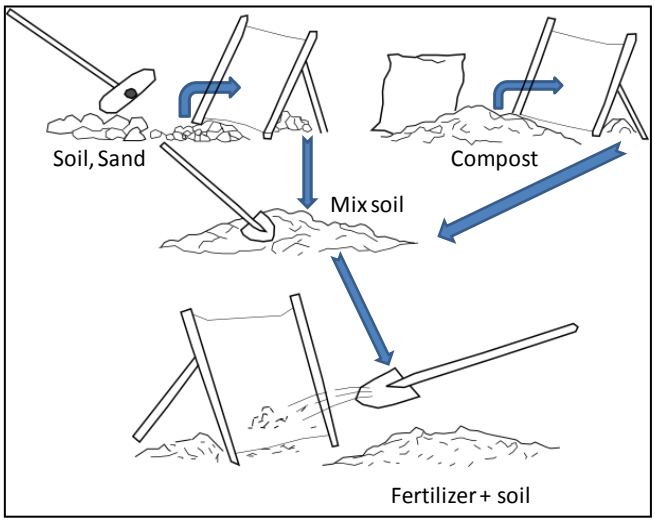
iii) Collect/procure materials for soil amendment, such as rice husk and sown wood dust to improve the physical property of potting media.

b. Mix soils with other materials

i) Sieve soils, sands and compost through a mesh (0.5 cm of mesh is recommendable.) to remove large clods and irregularities including roots and twigs of trees.

ii) Mix soils, sands, and compost at the following rates.

- Timber and fruits: top (or black) soils, sands, and manure/compost at a rate of 3:1:2 (50%: 17%: 34%)
- Sandalwood: top (or black) soil and sands at a rate of 2:1 (67%: 33%)



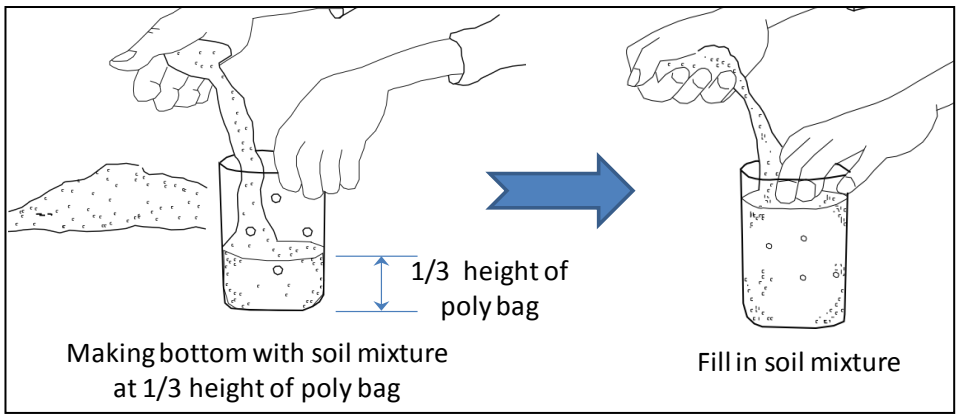
c. Filling the mixture into poly bags

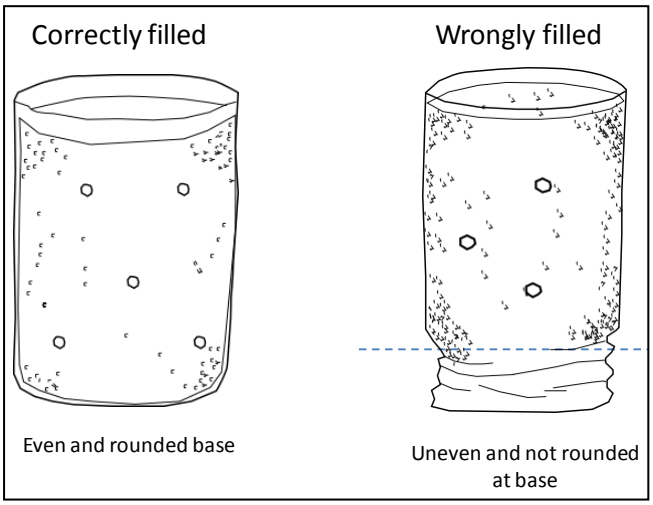
i) Procure poly bags sufficient for the total number of seedlings produced in the nursery. The size of poly bags should be 8 cm in diameter and 22 cm in height for

timber species and industrial plants, while the same for fruit species should be 12 cm in diameter and 22 cm in height.

ii) Fill the mixture (potting media) to one-third of the height of a poly bag and shake it to fill the mixture evenly in the bottom of a poly bags.

iii) Continue filling the mixture into a poly bag.





Poly bags should be shaken up and down at times while being filled with the mixture to: i) compact the mixture at the base, ii) fill the mixture evenly in a poly bags, and iii) avoid leaving air pockets in a poly bag.
If the mixture is evenly filled in a poly bag, the base of a poly bag would become rounded and sufficiently compact.

vi) Put the poly bags filled with the mixture in the seeding beds making a block of 100 pcs (10 x 10 pcs) of poly bags, so that the seedling pots can be easily managed in the nursery.

d. Transplanting sprouts into pots

i) In the case of sandalwood, collect host plants (Alternanthera ficoidea) to be planted together with sprouts of sandalwood into seedling pots.

ii) Water seedling pots one (1) day before transplanting sprouts.

iii) Prick and lift sprouts from the seedbed holding them at the terminal leaf and place them in a shallow bowl of water. The number of sprouts to be lift at one time should be as

many sprouts as the participants/farmers can transplant within 15 minutes to prevent any damage caused by dryness. Pricking and transplanting should be done in the early monitoring or late afternoon to protect sprouts from being exposed by intensive sun light.

iv) Make a small hole each in seedling pots using a small stick. The size of hole should be large enough to put the root system without bending its taproot.

v) Pick a sprout up from a bowl holding it at its terminal leaf and insert its root system into a hole.

vi) Cover and firm the base of the sprout gently and carefully not to leave air pockets arount its root system.

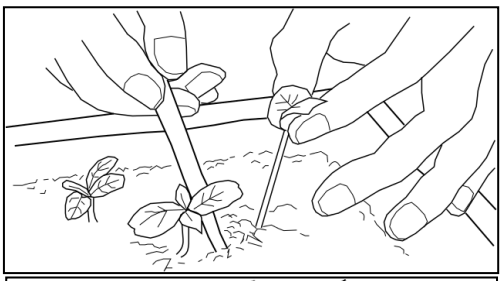
vii) Water seedling pots immediately after planting.

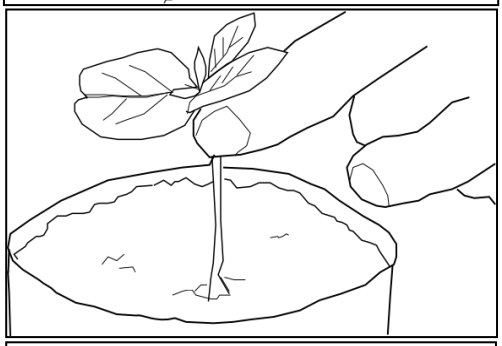
viii) Water regularly to maintain the water contents for the next three (3) days with due care so as not to overwater them.

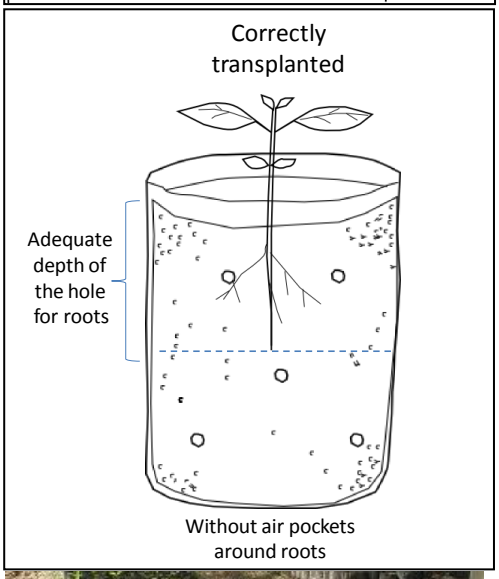
viii) Place them in the unlighted part of the seedling beds for few days.

ix) Relocate seedlings or remove shade to give partial sunlight to them when new leaves emerge.

ix) Put the label with the following information at each block of seedling pots.
- species
- date of transplanting
- Number of sprouts transplanted







(3) Timeframe of Application

Standard Timeframe of FFS on Preparing Seedling Pots

Activities	Timing	Duration of the Session
i) Collection of materials for potting medium	May/June	One day for hands-on training
ii) Preparation of soil mixture and filling soil mixture into pots	May/June	Half day each for hands-on training
iii) Transplanting of sprouts into pots	May/June	Half day for hands-on training

Source: JICA Project Team (2015)

3.2.4 Maintenance of Seedlings

(1) Objective

The main objective of the technique is to grow healthy seedlings with due care in the nursery.

(2) Activities to be conducted

The activities for maintenance of seedlings comprise i) watering, ii) weeding, iii) spacing, iv) preparation and application of liquid fertilizer, v) root pruning and vi) pest control. More details of the activities are described below.

The total maintenance period ranges from six (6) months to nine (9) months depending on altitude of the area: six (6) months (from June to November) in lowlands while nine (9) months (from March – November) in highlands in the country.

a. Watering

Water seedling pots until water penetrates to the bottom of seedling pots using a watering can either early morning or late afternoon in a day.

You should use a water can so that you can avoid splashing muddy water on leaves as muddy water could cause infection of diseases.

Important Tips

- *The frequency of watering varies with species, age of seedlings, and composition of potting media.*
- *The soil permeability in seedling pots may gradually decline during the maintenance period. Micro particles in soil suspension made after watering infill pores in the pots along with water penetration.*
- *If you find molds or mosses in the surface in the pots, they are the signs of poor drainage in the pots. You should break soil blocks in the pots to soften or loosen soils.*

b. Weeding

i) Carefully hand-pick weeds on pots regularly to secure nutrients and sunlight for seedlings.

ii) Weed the nurseries periodically to minimize chances for pests/insects to contact seedlings.

c. Spacing

i) Keep proper distance between seedling pots to secure the sufficient space for seedlings to spread their leaves, or they would bcome spindy.

d. Preparation and application of liquid fertilizer

i) Prepare liquid fertilizer for additional fertilizer application referring Sub-section 3.3.8 of CB-NRM Technical Manual Vol.2: Sustainable Upland Farming Promotion.

ii) Apply liquid fertilizer referring to Sub-section 3.3.9 of CB-NRM Technical Manual Vol.2: Sustainable Upland Farming Promotion when observing any symptoms of nutritional disorder (e.g., discolor of the leaves or poor growth of seedlings).

e. Root pruning

In case roots of seedlings come out from the poly bags, cut the roots with a scissor or knife to prevent them from penetrating into ground.

f. Pest and disease control

Observe seedlings and take necessary measures to control pests and diseases whennever necessary. Some of the major syptoms observed over the course of the JICA CB-NRM Project are shown below with the possible measures to be taken.

Major Symptoms of Pest Attacks to the Seedlings and Possible Measures to be taken

Symptom	Species attacked	Cause of symptom	Measures to be taken
1. Rolling up and discolor of leaves 	Orange	Citrus leaf miner (moth) moving inside the leaf 	Application -Spray water mixed with tobacco leaves (tobacco water) from back side of leaf once a week for 2-3weeks. Preparation of tobacco water - Mix 2 leaves of tobacco (or 8 sticks of dried leaves of cigarette) with 1 litter of water. - Use it 3 days after mixing by diluting 1 cup of tobacco water with 1 litter of water.
2. Spots on leaves 	Teak	Spider 	Application - Spray water mixed with vinegar (vinegar water) or brewed coffee from back side of leaves to kill mite. Preparation - Dilute vinegar with 20 times of water. - Brewed coffee should not be diluted for application.
3. Holes on leaves 	Mahogany	Scarab beetle 	Application - Remove insects.

Symptom	Species attacked	Cause of symptom	Measures to be taken
4. Holes on leaves 	Mahogany , Orange	Grasshopper/ Leaf roller  	Application - Spray decoction of green banana skin. Preparation - Boil 1 liter water and add one handful of green banana skin. Brew it for 30 minutes. Remove the banana skin by filter and apply it to the insects.
5. Leaf shrunk 	Mahogany , Teak	Virus possibly transmitted by mites	Application - Remove diseased leaves from the seedling and separate from healthy seedling. - Apply disinfectant.
6. White-colored leaves (White powdery mildew) 	Orange	fungus	Application - Apply plant ash or splay diluted vinegar with 20-30 times of water.

(3) Timeframe of Application

Standard Timeframe of FFS on Maintenance of Seedlings

Activities	Timing	Duration of the Session
i) Watering and weeding	May-Aug	Half day for hands-on training
ii) Spacing and pruning roots	Sep-Oct	Half day for hands-on training
iii) Preparation of liquid fertilizer	May-Aug	One day for hands-on training
iv) Application of liquid fertilizer	May-Aug	Half day for hands-on training
v) Pests and diseases control	May-Aug	One day for hands-on training

Source: JICA Project Team (2015)

Important Tips

- *When you find the seedlings affected by pests and diseases, immediately isolate such seedling pots from others in order to avoid expansion of the infection.*

3.2.5 Hardening-off

(1) Objective

The main objective of the technique is to adapt seedlings to external environment by exposing them to sunlight and reducing the frequency of water supply before planting.

(2) Activities to be conducted

Hardening-off can be done few weeks before planting seedlings by reducing i) watering, ii) shading, iii) root pruning and iv) fertilizing as described below.

a. Watering

   Reduce the frequency of watering and amount of water applied to the seedlings so that the seedlings could be adapted to the less watering condition.

b. Shading

   Remove thatching roof of the nursery to expose seedlings to sunlight one (1) month before planting seedlings.

c. Root pruning

   Stop cutting roots coming out from the seedling pots one month before planting.

d. Fertilizing

   Stop liquid fertilizer application two to three weeks before planting.

(3) Timeframe of Application

Standard Timeframe of FFS on Hardening-off

Activities	Timing	Duration of the Session
Hardening-off (control of watering, shading, root pruning and fertilizing)	Oct	One day for hands-on training

Source: JICA Project Team (2015)

3.3 Techniques for Tree Planting

3.3.1 Production of Compost

(1) Objective

The main objective of the technique is to produce of quality organic fertilizer made of materials locally available so that the members could apply basal fertilizer when planting seedlings.

(2) Procedures for Application

The same procedures described in Sub-section 3.3.1 of CB-NRM Technical Manual Vol.2: Sustainable Upland Farming Promotion shall be followed.

(3) Timeframe for Application

Compost production shall begin in May and continue the maintenance of compost until the time when it is applied as described in Sub-section 3.3.1 of CB-NRM Technical Manual Vol.2: Sustainable Upland Farming Promotion.

3.3.2 Determination of Layout of Plantations

(1) Objective

The main objective is to determine and design a/ layout/s of plantations suitable for the respective purposes and applicable to the respective site conditions.

(2) Procedures for Application

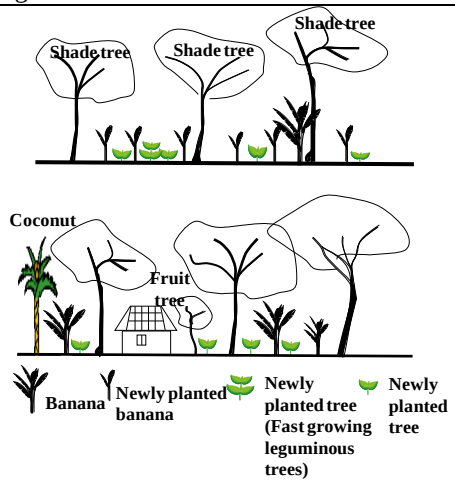
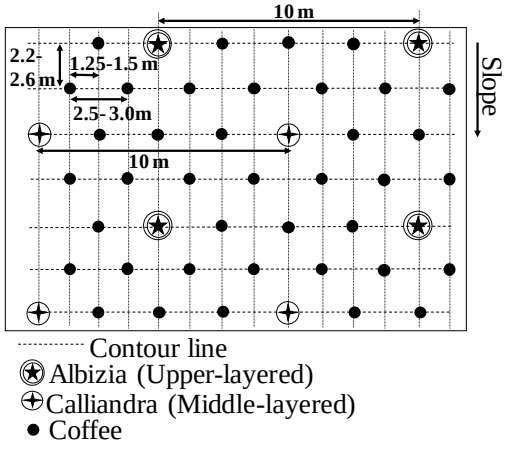
Prior to planting trees in the field, a/ layout/s of plantations shall be designed on the basis of the purposes and types of seedlings planted. In general, plantations can be classified into the following types.

i) Fruit and industrial plant plantation
ii) Coffee plantation
iii) Timber plantation
iv) Regenerated forest in degraded land

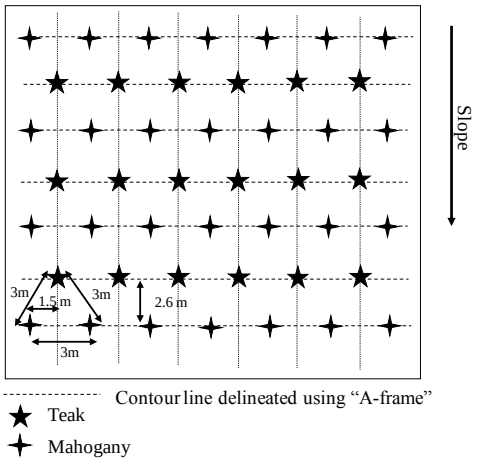
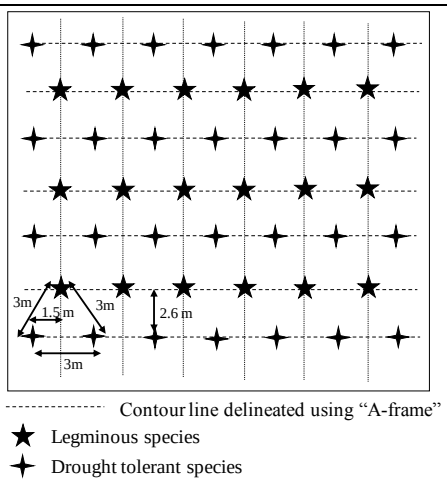
Basic conditions and typical designs of the respective plantations are described below.

Basic conditions and Typical Designs for Tree Plantations

a. Fruit and industrial plant plantation, and Coffee plantation

Type	Fruit/industrial plant seedling	Coffee production
Target site	Home garden or backyard farms with existing standing trees and perennial crops such as banana	Areas for shifting cultivation or farms close to existing coffee plantation
Species to be planted	- Fruit and industrial plants, such as, rambutan, longan, clove, cinnamon and jackfruits - High value timber species, namely sandalwood - Trees which prefer shady conditions in their initial growth - Leguminous trees as living fence and fodder trees	- Coffee - Upper-layered shade trees: Albizia, Casuarina - Medium-layered shade tree: Calliandra
Intervals between seedlings	Random planting among existing trees and perennial crops with following intervals: - Trees: 4 m (e.g., clove)~7 m (e.g., Rambutan) - Perennial crops, e.g., banana: 1~2 m - Leguminous trees: 3~4 m	- Coffee: 2.0-3.0 m x 2.0-3.0 m - Upper/Mid-layered shade tree: 10 m x 10 m
Typical design/ Image of the plantation		

b. Timber plantation and Regenerated forest in degraded land

Type	Timber production	Regenerated forest in degraded land
Target site	Areas for shifting cultivation, especially those with low fertility and/or not suitable for crop production	Degraded forests Open area (wasteland/barren land) Grassland
Recomm-endable species	- Timber wood species, e.g., Teak, Mahogany and other suitable timber species	- Fast growing leguminous species, e.g., calliandra, gamal and lamtro (L-19) - Drought tolerant species, e.g., casurina
Intervals between seedlings	- Timber: 3 m x 3m	- Leguminous species: 3 m x 6 m -Drought tolerant species: 3 m x 6 m
Typical design/ Image of the plantation		

Source: JICA Project Team (2015)

3.3.3 Delineation of Contour Lines and Sticking of Stakes

As most of the potential sites for plantations in rural areas must be hilly or sloping lands, seedlings should be planted along contour lines to minimize the risk of soil erosion. Hence, the layout of plantation should be adjusted with the slope conditions of the plantation sites.

(1) Objective

The main objective of the technique is to make contour lines using a simple tool made of local materials and locate points of planting pits according to the designed layout/s.

(2) Procedures for Application

The following steps shall be taken to delineate contour lines and stick stakes.

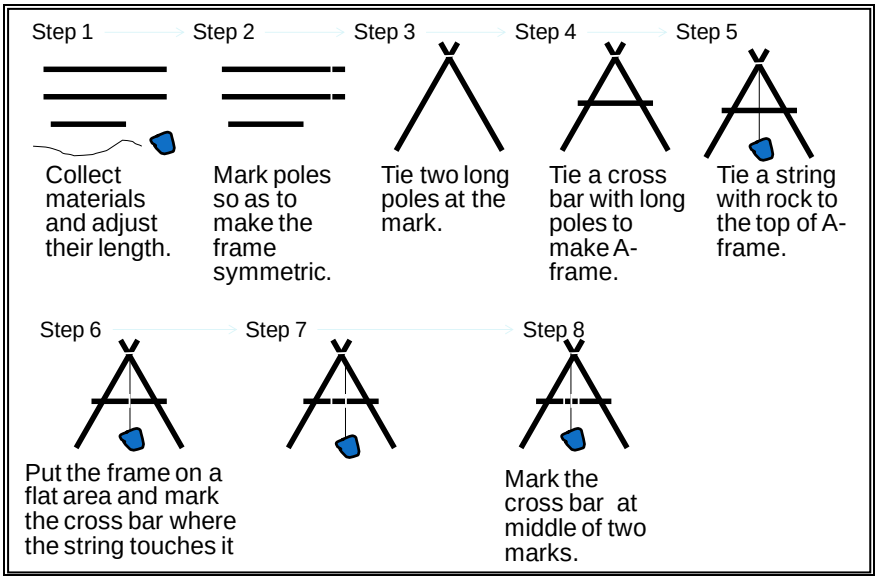
i) Making of A-frames with collection of local materials
ii) Delineation of contour lines using A-frames
iii) Sticking of stakes

a. Making of A-frames using local materials

i) Collect the following materials for making A-frames.

- Materials needed for one A-frame
  - 2 pieces of 2 meter long wood or bamboo
  - 1 piece of 1 meter long wood or bamboo
  - 1 fist-sized rock
  - 2 m of string or thin rope
  - Nails/wires/binding strings
- Tools to be used for making A-frames
  - Hammer/Machete/Saw/Knife

ii) Make A-frames according to the following procedures.

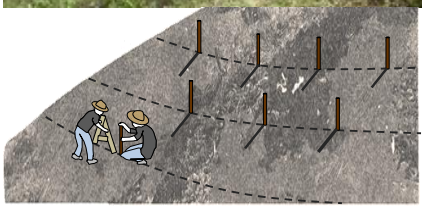


Important Tips

- *You should check if the string sits in the middle mark, because the string does not sit in the middle if the A-frame is not level.*

b. Delineation of contour lines using A-frames

Delineation of contour lines



i) Stick the first stake at the middle edge of the plantation site and put the left leg of the A-frame at the first stake.

ii) Adjust the right leg to make the string pass through the midpoint of the crossbar and stick another stake at the right leg.

iii) Move the A-frame to the right by placing the left leg at the stake where the right leg previously was.

iv) Adjust the left leg again until the string passes through the midpoint, and again stick the stake at the right leg.

v) Follow this procedure up to the other side of the site.

vi) Take another point 2.2 to 2.6 meter downwards or upwards using a measure or other materials (e.g., a rope or stick) which are the same in length. Do the activities from i) to v) to take the contour line.

vii) Repeat the activities i) to vi) until all the contour lines are delineated in the site.

The contour line is not correctly delineated as the lines were taken without clearing the areas.

A one-meter stick should be used to check the vertical distance between contour lines.

Important Tips

- *You should take out all grasses in a farm before using the A-frame, or you cannot delineate contour lines correctly.*

c. Sticking of stakes

Stick stakes at points where seedlings are planted according to the layout/s.

(3) Timeframe of Application

Standard Timeframe of FFS on Delineating Contour Lines

Activities	Timing	Duration of the Session
i) A-frames making with collection of local materials	Sep.	One day for hands-on training
ii) Delineation of contour lines and sticking stakes.	Oct.	One day for hands-on training

Source: JICA Project Team (2015)

3.3.4 Planting

(1) Objective

The main objective of the technique is to plant seedlings in a proper manner to ensure high survival of seedlings after planting.

(2) Procedures for Application

The following four (4) steps shall be taken for planting seedlings.

i) Digging of planting pits
ii) Refilling of pits with soils and compost
iii) Selection and transporting of seedlings
iv) Planting of seedlings

a. Digging of planting pits

i) Dig holes 40 cm each in depth and diameter for timber species and 45 to 60 cm in the same for fruits and industrial plant species.

ii) Put top soils separately from sub-surface soils when digging a hole.

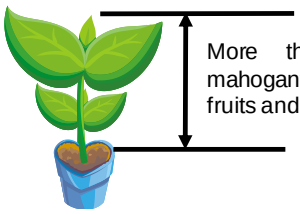
b. Refilling of pits with soils and compost

i) Carry compost to the plantation site and mix it with sub-surface soils.

ii) Refill pits with sub-surface soils mixed with compost first and overlay top soils.

c. Selection and transporting of seedlings

i) Select seedlings ready for planting, which are more than 20 cm in height for timber species (e.g., mahogany and teak) and over 25 cm in height for fruits and industrial plants (e.g., clove and sandalwood).



Ready to be planted in the sites

ii) Pack seedling pots in a portable carrier (e.g., a basket) putting them carefully one by one in a carrier.

iii) Transport seedling pots to the plantation site carefully so that they would not topple over while being carried.

d. Planting of seedlings

i) Dig planting holes as deep as the height of seedling pots.

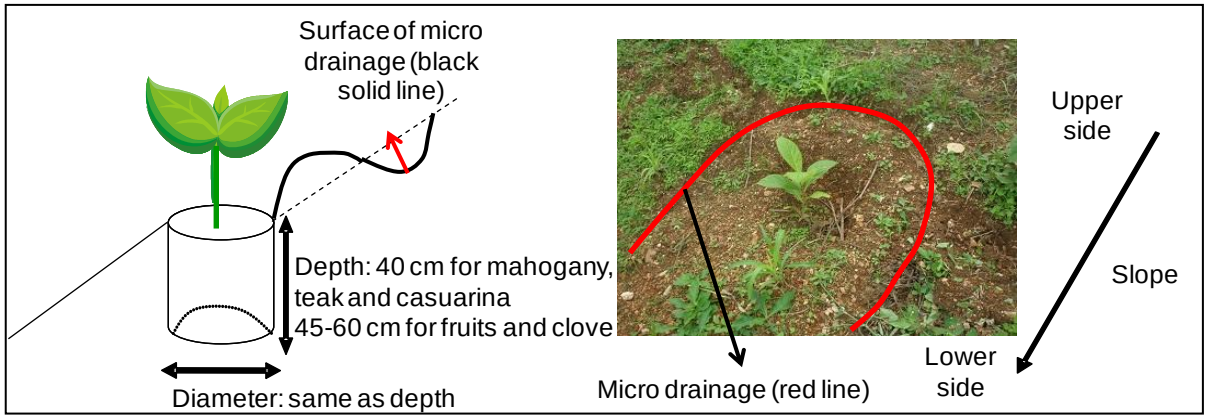
ii) Cut and remove plastic of seedling pots with a small knife.

iii) Plant seedlings in holes.

Important Tips

- *Species which need shade in the initial stage (e.g., sandalwood, clove, and rambutan) shall be planted under the shade of existing plants (e.g., banana and other trees).*
- *Sandalwood shall be planted together with or close to its host plants, such as Ai turi or leguminous trees (e.g., Acacia sp., Albizia, etc). Distance between sandalwood and the host plant/tree should be two (2) to three (3) meters.*

iv) Make u-shaped micro drainages in the upper slope of each seedling to protect it from damage caused by run-off water during the rainy season.



Design of U-shaped Micro Drainages

(3) Timeframe of Application

Standard Timeframe of FFS on Planting

Activities	Timing	Duration of the Session
i) Hole digging	Nov.	One day for hands-on training
ii) Refilling of holes with organic matter	Nov.	One day for hands-on training
iii) Transporting and planting of seedlings	Nov-Dec.	One and half day for hands-on training

Source: JICA Project Team (2015)

3.3.5 Tending

(1) Objective

The main objective of the technique is to properly maintain seedlings for a few years after planting to ensure robust growth of seedlings in the initial stage.

(2) Activities to be conducted

The techniques to be applied are i) weeding, ii) shading, and iii) mulching as described below.

a. Weeding

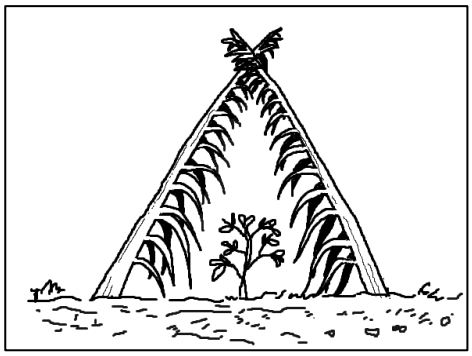
Weed grasses within 0.5 m radius from seedlings every two (2) months during the rainy season and at the end of the rainy season to eliminate weeds which compete with seedlings for water, light, and nutrition.

b. Mulching

Mulch the bases of seedlings with weeded grasses to maintain moisture contents of soils and prevent the growth of weeds.

c. Shading

Put a sun shade made of local materials (e.g., coconut leaves as shown right) if seedlings are planted in an open area (area without any shade of existing plants) and need shade in the initial stage.



Shading made of Local Materials

(3) Timeframe of Application

Standard Timeframe of FFS on Tending

Activities	Timing	Duration of the Session
i) Weeding and mulching	Jan.	Half day for hands-on training
ii) Shading of seedlings (depending on species)	Apr.-May	Half day for hands-on training

Source: JICA Project Team (2015)

4. Standard Training Modules

The following table shows the standard training modules for the respective techniques introduced in Section 3.2 and 3.3. All the training courses will be conducted at either community nursery or demonstration plot as FFSs.

Standard Training Module for the Techniques

Training course	Items	Description
Nursery establishment	Objectives	To enable the members to build a small-scale community nursery by using local materials.
	Timeframe	6 days a. Installation of water system (2 days) b. Development of a nursery (4 days)
	Materials	Farm tools (machete, saw, shovel, hammer), materials for water system (water tank, pipes, hose), props (wood and bamboo poles), roof frames (wood and bamboo poles) and thatching roof (naro grasses, palm leaves), nail, wire.
	Expected Results	A small-scale nursery will be established.
Seed preparation and sowing seeds	Objectives	To enable the members to sow seeds properly in the seedbed and facilitate seed germination.
	Timeframe and process	4 days a. Collection of seeds (1 day) b. Pre-treatment of seeds (1 day) c. Making seedbed (1 day) d. Sowing and maintenance of seeds sown in the seedbed (1 day)
	Materials	Farm tools (machete, saw, shovel, scoop, hammer), materials for the frame of seedbed (wood or bamboo poles), nail, wire and medium for the seedbed (soil, sand and compost), water can, plastic sheet (optional)
	Expected Results	Seeds sown in the seedbed will germinate at a high rate.
Preparing seedling pots	Objectives	To enable the members to prepare seedling pots and transplant sprouts in a proper manner
	Timeframe and process	2~3 days a. Collection of materials for potting media (1 day) b. Mixing of potting media (0.5 day) c. Filling soil of the mixture into pots (0.5 day) d. Transplanting of sprouts into pots (0.5 day)
	Materials	Farm tools (iron stick, shovel, scoop), wheel barrow, stick, shallow bowl, sieve, poly bags, soil, sand, compost, rice husk (optional), wood plate (for label at the seedling block)
	Expected Results	Seedlings will be transplanted to seedling pots
Maintenance of seedlings	Objectives	To enable the members to properly maintain seedlings in the nursery
	Timeframe and process	2~3 days a. Watering and weeding (0.5 day) b. Spacing and root pruning (0.5 day) c. Preparation of liquid fertilizer (0.5 day) d. Application of liquid fertilizer (0.5 day) e. Pest control (0.5 day)
	Materials	Scissor, drum, materials for making liquid fertilizer (weed and water), materials for making pesticide (tobacco, water, etc) and hand spray
	Expected Results	Seedlings will grow in healthy condition in the nursery.
Hardening-off	Objectives	To enable the members to adapt seedlings to external environment similar to that of the of planting site

Training course	Items	Description
	Timeframe	1 day a. Reduction of watering, shading, root pruning and fertilizing (1 day)
	Materials	-
	Expected Results	Seedlings will be ready for planting.
Production of compost	Objectives	To enable the members to produce organic fertilizer (compost) using materials locally available.
	Timeframe	1st training: 2 days a. Collection and chopping of materials (0.5 day/1st day) b. Pitting (0.5 day/1st day) c. Piling of materials (1 day/2nd day) 2nd training: 1 day a. Turning (1 day)
	Materials	Farm tools (Iron stick, machete, shovel), materials for compost (grasses, weeds, stalks, manures, soils/ashes), Banana leaves, Thatching materials (4 pcs of 1~2 m pole and coconut leaves)
	Expected Results	2~3 ton of compost will be produced.
Delineation of contour lines	Objectives	To enable the members to properly delineate contour lines using a tool made of materials locally available.
	Timeframe and process	2~3days a. Collection of materials (0.5 day/1st day) b. Framing of an A-frame (2 hours/1st day) c. Preparation of sticks (1 hours/1st day) d. Delineation of contour lines (1 day/2nd day)
	Materials (for 3 units of A-frame)	6 pcs of 2 m pole, 3 pcs of 1m pole, 3 pcs of 1.5 m string, 3 pcs of handful stones/blocks, wires or nails and machete
	Expected Results	Contour lines will be delineated in the plantation site.
Planting	Objectives	To enable the members to plant seedlings in a proper manner
	Timeframe and Process	2~3 days a. Digging of pits (1 day) b. Refilling of pits with soils and compost (1 day) c. Selection and transporting of seedlings (0.5 day) d. Planting of seedling (1 day)
	Materials	Scale, farm tools (shovel, pickax and iron stick), compost
	Expected Results	Seedlings will be planted in the plantation site according to the layout.
Tending	Objectives	To enable the members to properly maintain seedlings to ensure high survival and robust initial growth of seedlings.
	Timeframe and Process	1 day a. Weeding and mulching (0.5 day) b. Shading (0.5 day)
	Materials	Machete and materials for shading (coconuts leaves)
	Expected Results	Young stands will grow vigorously and healthy.

Source: JICA Project Team (2015)

5. Cost Estimates

This chapter introduces how to estimate the budge required for the conduct of a series of FFS sessions at suco or aldeia level. The estimation of cost is one of the essential skills/techniques to prepare a convincing plan which could ensure financial support from a source of fund. The following sections explain the ways to estimate the budgets per training session as well as per suco/aldeia introducing the major cost items to be considered in the estimation.

5.1 Estimate of Cost for Hands-on Training in FFS

The major cost items for hands-on training are: i) materials used for training sessions, ii) food for the members/participants, iii) transportation cost for facilitators, iv) other miscellaneous cost, and v) cost for facilitators if external facilitators (such as NGOs) are used for training. The cost of each cost item is estimated by multiplying the quantity of the item by the unit cost. The following format can be used in the estimation.

Format for Cost Estimation of Training Session

Standard cost item	Quantity (a)	Unit cost (b)	Cost (a x b)
1. Materials for training (for those which cannot be collected in a village)			
2. Snack and food for the participants			
3. Transportation cost for facilitators			
4. Cost for facilitators (payment to facilitators)			
5. Other miscellaneous cost			
Total cost for one training session (1+2+3+4+5)	-	-	

Source: JICA Project Team (2015)

5.2 Estimate of Cost for Other FFS Sessions

In addition to hands-on training courses, the members may continue sowing seeds and preparation of seedlings pots to produce the target number of seedlings in the nursery. Core and some selected members will work for the follow-up FFS sessions with the technical assistance of facilitators. The major cost times for the follow-up sessions are i) food/snack for the members, ii) transportation cost for facilitators, iii) cost for facilitators, and iv) other miscellaneous cost. The same format shown above can be used for estimation.

5.3 Estimate of Cost for Nursery Operations

Aside from the FFS sessions, one or two member/s shall engage in nursery operations (e.g., watering, weeding, liquid fertilizer application, and pest and disease control) on a daily basis to maintain seedlings in the nursery. The major cost items for the daily nursery operations are i) monthly incentive for the person/s who maintain/s seedlings and ii) materials for operations, such as materials for liquid fertilizer and control of pests and diseases. The following formant can be used for estimation of the cost of daily maintenance.

Format for Cost Estimation of Daily Maintenance

Standard cost item	Quantity	Unit cost (b)	Cost (a x b)
1. Monthly incentive for care taker/s			
2. Materials needed for daily maintenance			
Total cost for one training session (1+2)	-	-	

Source: JICA Project Team (2015)

5.4 Cost Estimate per Suco

The cost for one cycle of the FFS sessions or seedling production and tree planting activities in a village is estimated by summing up all the costs mentioned above. In case that the FFS sessions/seedling production and tree planting activities are carried out at aldeia or group level, the total cost should be estimated by multiplying the number of aldeias/groups by the costs of the respective activities (i.e., hands-on training, follow-up FFSs, and daily nursery operations). Consequently, the following format can be used for the estimation.

Format for Cost Estimation of Training Session in the First Year

Standard cost item	No. of Group (a)	Unit cost (b)	Cost (a x b)
1. Hands-on training on nursery establishment			
2. Hands-on training on seed preparation and sowing seed			
3. Follow-up of sowing seed			
4. Hands-on training on preparing seedling pots			
5. Follow-up of preparing seedling pots			
6. Hands-on training in maintenance of seedlings			
7. Daily maintenance of seedlings			
8. Hands-on training in hardening-off			
9. Hands-on training in making compost			
10. Hands-on training in delineation of contour lines			
11. Hands-on training in planting			
12. Hands-on training in tending			
Total cost for the FFSs on Seedling Production and Tree Planting	-	-	

Source: JICA Project Team (2015)

6. Field Validation of Effectiveness of the Techniques

The results of one round of the FFS sessions shall be validated and evaluated by checking the survival and growth conditions of seedlings planted over the courses of the FFSs, since the members who have engaged in a series of the FFS sessions are expected to plant seedlings produced in the nurseries in their own plots and farms. The survival and growth conditions of seedlings should be checked one (1) year after planting for this purpose to measure direct effects and identify necessary actions taken to improve the growth of seedlings in the plantations if necessary.

A survey of the survival and growth conditions of seedlings (hereinafter referred to as "the survival survey") is also expected to give lessons learned from the activities and useful suggestions that could make the techniques more effective and applicable to a wide range of local settings in the country. It is important to carry out the same survey to evaluate the results of any reforestation/afforestation project one year after establishment of plantations.

6.1. Objectives of the Survey

The main objectives of the survival survey are to evaluate the effectiveness and efficiency of the FFS sessions on seedling production and tree planting activities and extract lessons that can be referred for improvement of the same activities in the following years. To this end, the survey specifically aims to:

i) estimate the average ratio of survival (or mortality) of each type of species planted in the different conditions;

ii) measure the height and stem diameter of seedlings to check the growth conditions of surviving seedlings;

iii) extract lessons which need to be referred for the conducts of the FFSs in the following years; and

iv) identify necessary actions taken to improve the growth conditions of seedlings as well as plantations.

6.2 Method of the Survey

6.2.1 Selection of Samples

(1) Preconditions and Principle of the Survey

A full-scale survey is apparently difficult to carry out as it is time-consuming and labor-demanding. Given the fact that the plantations developed by the participants/farmers would have the following features in general, a plot-wise sampling method is recommended instead.

i) The number of plantations (plots where communities planted seedlings) is many.

ii) The size of plot is small in general.

iii) The plots disperse in a village.

iv) Each household seems to plant seedlings not in a single plot but a few plots in general.

The plot-wise sampling method shall be carried out according to the following principles so that the results of the survey could ensure the statistic reliability.

i) Target of sampling: At least 5 % of the total number of seedlings planted should be selected as samples.

ii) Sampling method: Random sampling should be employed.

iii) Data used for sampling: Samples should be selected by using lists of members and plots.

(2) Procedure for selection of sampling plots

The sampling plots/sites shall be selected according to the following procedures.

a. 1st step: Selection of object members from a/ list/s of members

Several households shall be randomly selected among all the households who planted seedlings in each aldeia. A list of members with the number of seedlings provided shall be used for selection.

b. 2nd step: Selection of survey plots

i) Interviews to the selected object members

Data on plantations developed by the selected object members shall be gathered by directly interviewing the members. The numbers of plots and seedlings planted in each plots shall be collected. Data shall be compiled in a table as a list of potential survey plots.

ii) Selection of survey plots

Several plots shall be randomly selected among all the plots developed by the selected object members so that the total number of seedlings sampled for the survey is beyond 5 % of the total seedlings planted in the area.

6.2.2 Field Survey

A group of surveyors shall i) check the survival of seedlings, ii) measure the growth of surviving seedlings, iii) record the conditions of the survey sites, and iv) take the GPS data of the sites using the survey format shown below.

a. Mortality of seedlings

i) Check the survival or mortality of seedlings using the following criteria for judgment of dead trees.

- There is no branch left in seedling.
- The majority of stem seems dead.
- There is no above-ground part of seedling by either breaking its stem or felling it down.

b. Stem diameter and height of seedlings

i) Measure stem diameter twice from different directions with a caliper and calculate the average.

ii) Measure seedling height with a tape measure or ruler.

c. Site description and location measurement

i) Record the conditions of the survey site, such as vegetation, soil condition, terrain, and history of use of the area.

ii) Take pictures of the site.

iii) Identify the location of the survey site using GPS by taking more than four (4) data points or corner points along the perimeter of the site.

A Format for Field Survey

Anekso-1 Numeru

Formulario Survey Terreno ba Aioan nebe Kuda tuir SPTPP-MP

Suco: Data survey:

Naran grupo benefisariu: Naran Inspektur:

Naran membro grupo benefisariu: Informasaun Plot:

Lokasi plot:

No.	Species	Status Aioan (Moris/Mate)	Medida Aioan nebe Moris		Komentariu
			Diameter Abut (mm)	Altura (cm)	
1					
2					
3					

Source: JICA Project Team (2015)

6.2.3 Data Compilation/Analysis

Data collected from the field survey shall be encoded into entry forms made in MS Excel as shown in the following table.

MS Excel format for calculating survival rate

Tabla 1 Survival Rate no Aioan nebe Kuda tuir SPTPP-MP

No. ID: TF-1

Suco: Talitu Naran grupo benefisariu: Fatukhun Naran membro grupo benefisariu: Filomino Data Survey: 25/07/2014

No.	Status of Species															
	Teak				Mahogany				Casuarina				Sandalwood			
			Medida Aioan Nebe Moris				Medida Aioan Nebe Moris				Medida Aioan Nebe Moris				Medida Aioan Nebe Moris	
	Moris	Mate	Diameter Abut (mm)	Altura (cm)	Moris	Mate	Diameter Abut (mm)	Altura (cm)	Moris	Mate	Diameter Abut (mm)	Altura (cm)	Moris	Mate	Diameter Abut (mm)	Altura (cm)
1					1		7	39								
2					1		6	60								
3					1		5	40								
4					1		7	54								
5					1		6	46								
6					1		12	60								
7					1		10	68								
8	1		4	26												
9	1		8	46												
10	1		4	22												
11	1		4	29												
12	1		5	33												
13		1														
14	1		3	14												
15	1		2	24												
16	1		5	27												
17	1		3	21												
18	1		3	22												
19	1		4	28												
20		1														
Total alive and dead seedlings	11	2			7	0			0	0			0	0		
Total No. of Seedlings by Species		13				7				0				0		
Survival rate		**85%**				**100%**				**#DIV/0!**				**#DIV/0!**		
Average size			4	27			8	52			#DIV/0!	#DIV/0!			#DIV/0!	#DIV/0!

Source: JICA Project Team (2015)

The encoded data shall be further compiled into a summary table per village and species as

shown below.

Example of summary of survival survey

Aldeia	Species	Seedlings surveyed			Survival rate (%)	Groth conditions of seelings	
		Alive (No.)	Dead (No.)	Total (No.)		Diameter (cm)	Height (cm)
Remapati	Teak						
	Mahagony						
	Casuarina						
Manehalo (Turisai)	Teak						
	Mahagony						
	Casuarina						
	Albizia						
Manefoni	Teak						
	Mahagony						
Desmanehata	Teak						
	Mahagony						
Bilmahatu	Teak						
	Mahagony						
Lismori	Teak						
	Mahagony						
Total/Average	**Teak**						
	Mahogay						
	Casuarina						
	Alvizia						
Overall							

Source: JICA Project Team (2015)

6.3 Survival Survey for a Large-scale Reforestation

Different methods shall be employed for measurement of the survival rate of seedlings planted by a large-scale reforestation/afforestation project, as plantations developed by such a project would be large but the number of the plantation developed could be limited. The following box describes one of the sampling/survey methods taken into account toward that end.

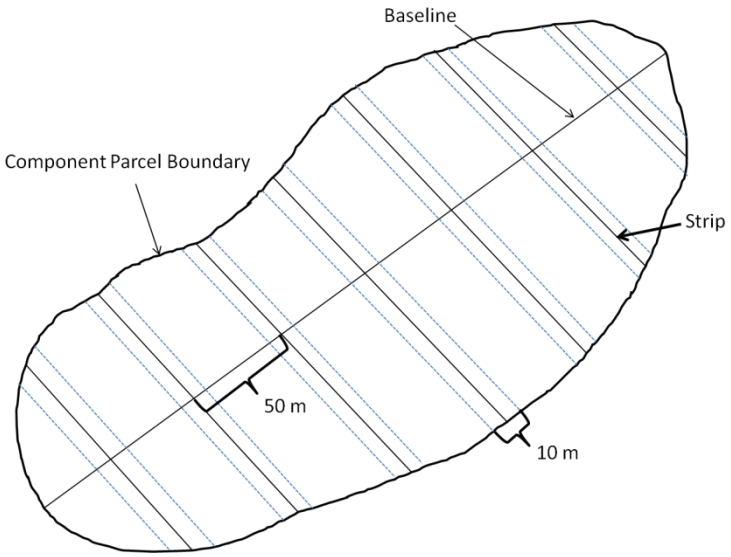
BOX 1: Example of the Survival Survey Method for a Large-scale Plantation

The survival rate in a large plantation shall be measured by the strip sampling method. The procedures for sampling in a large plantation are shown below.

1) Establish a baseline, preferably along the longest section of the site .
2) Establish perpendicular strips 10 m in width along the baseline at 50 m distance between each strip's center (See the following figure.). The first strip shall be located 20 m from the edge of the site.
3) Count all surviving seedlings inside the strips.
4) Calculate the survival rate of seedlings planted in each strip by following the formula below.

$$\text{Survival rate (\%)} = \frac{\text{Total surviving seedlings counted in a particular strip}}{\text{Total No. of expected seedlings planted in the same strip}} \times 100\ \%$$

5) Estimate the survival rate of seedlings planted in the site by calculating the weighted average of all the strips surveyed.



Strip Sampling Design