Tree nursery establishment

a training manual

Produced by World Agroforestry for the Integrated Natural Resources and Environmental Management Project (INREMP)

Correct citation

Mercado A, Linayao J, and Piñon C. 2020. *Tree nursery establishment: a training manual*. Los Baños, Philippines: World Agroforestry (ICRAF) Philippines, Department of Environment and Natural Resources, Asian Development Bank, Green Environment Facility

Disclaimer and copyright

Editors: Robert Finlayson and Zarrel Gel Noza

Design and layout: Zarrel Gel Noza

Illustrations: Roy Oliver Corvera and Ma. Angela Espinosa

Integrated Natural Resources and Environmental Management Project (INREMP)
Project Number: GRANT 0325-PHI

Contents

ii Learning objectives

iii Introduction

1 Tree nurseries

1 Types of tree nurseries

2 Factors to consider when deciding on the type of nursery

3 Establishment of a temporary nursery

3 Considerations in selecting nursery sites

5 Nursery layout

6 Procedure for nursery establishment

17 Sample nursery layout

18 Actual nurseries established by ICRAF for INREMP

20 Session Guide

22 Glossary

24 Further Reading

Learning objectives

After reading this training manual, trainees should be able to:

- enumerate the different kinds of nurseries;
- explain and demonstrate the steps involved in nursery establishment; and
- discuss and replicate the said process to others.

Introduction

Direct seeding and transplanting are two ways to artificially regenerate forestland. Direct seeding involves planting seeds of the desired tree species directly in the area to be regenerated, while transplanting involves moving seedlings from a nursery and planting them in the area.

Transplanting seedlings from nurseries is preferred because they should have been grown from high-quality mother trees and received proper care. This increases the rate of survival and promotes more vigorous growth. Because of this and the increasing demand for tree seedlings for reforestation projects, proper forest nursery establishment and maintenance is important.

What is this manual about?

This manual outlines various information necessary to successfully establish a tree nursery such as:

- different kinds of nurseries;
- considerations in selecting nursery sites and in deciding on the nursery layout; and
- procedure for nursery establishment, among others.

Who is this manual for?

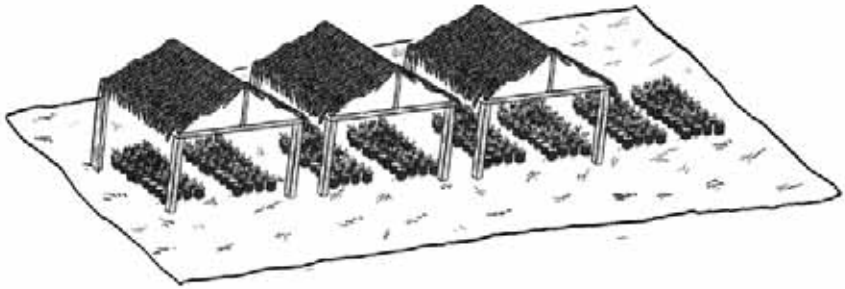
This training manual is created for extensionists working in the agroforestry sector and natural resources management projects, as well as for farmers and members of people's organizations who are interested to learn more and share these learnings to fellow farmers.

Tree nurseries

A tree nursery is a designated area where seedlings and other planting stocks are produced and provided with special care. Other planting stocks include wildlings and vegetatively propagated plants, such as shoots and cuttings.

Quality is important because field conditions can be harsh. Plants can be exposed to drought, fire, grazing, and attack by pests and diseases. High-quality stocks, when properly managed, have higher chances of surviving. Low-quality planting stocks result in flawed seedlings that are likely to have slower growth rates and be more susceptible to infestations, diseases, and growth defects.

These flaws are major causes of deaths of seedlings in the field, which not only cause setbacks to planting plans but also waste time, money, and effort.



Nurseries provide steady sources of stock for continuous planting operations even outside the species' productive (flowering/fruiting) season.

Proper collection and processing of seeds during trees' productive seasons are important.

Maximum attention should be given to plants from germination through to the seedling stage.

Types of tree nurseries

There are two types of tree nurseries: a permanent nursery and a temporary nursery.

Permanent nursery

A permanent nursery, also called a 'central nursery', is built to meet strong demand for seedlings from a single planting site over many years. It is typically large, equipped with high technology production facilities, and usually composed of permanent structures built at the center of the planting site to maximize accessibility. Permanent nurseries normally host the management headquarters of a reforestation project or plantation.

With these characteristics, it is expected that building and maintenance costs will be very high. A permanent nursery is not recommended if there is a need to supply different sites that are far away from each other because transporting the planting materials will increase the risk of injury and stress of the plants. It will also add to transport expenses.

Temporary nursery

A temporary nursery, also called a 'flying nursery' or 'field nursery', is used for a season or a year. In terms of size and production capacity, it is smaller and more limited than a permanent nursery. It is usually built within the planting site using light and low-cost materials and will be closed once the planting targets have been reached. Since it uses low-cost materials and is on-site, it can be built in a short time.

However, with these characteristics, the nursery may not withstand typhoons and natural disasters. It also may not have the technologies that permanent nurseries have.

Factors to consider when deciding on the type of nursery

The three factors to consider when deciding on the type of nursery are:

1. the number of seedlings to be produced;
2. the expected life of the nursery or how long the demand for seedlings is likely to last; and
3. availability of transport.

For small farmers' conservation farming, agroforestry, or commercial tree plantation development, a nursery should be built at a planting site in a short time, at less cost. It should also be easily replicated by other farmers. With these considerations, this manual outlines material and procedures for building a temporary nursery.

Establishment of a temporary nursery

Considerations in selecting nursery sites

Like people, seedlings require the best possible environment to grow with the vigor and sturdiness needed to survive harsh conditions in the field. Since seedlings will start their lives in a nursery, the site of the nursery must be chosen carefully.

Water supply, location, freedom from weeds, exposure and aspect, accessibility, size of the area, ground cover, and labor availability are some of the details that must be considered in selecting a nursery site.

Water supply

Ideally, the nursery should be established near a reliable and adequate water supply (such as a stream). The water can then be directed to the nursery through pipes to ensure a ready supply to the growing seedlings. In case there is no readily available water source, a water tank can be installed.

Location

The nursery should be located near the planting site. This way, the seedlings are exposed to similar environmental conditions as those at the site. Chances of injury during transport will also be greatly reduced.

Freedom from weeds

Weeds should be cleared from the area before establishing the nursery. If left unchecked, weeds will compete with the seedlings for resources. However, it should be noted that weeding is not only done before nursery establishment but also regularly as part of nursery hygiene.

Exposure and aspect

A nursery should be naturally shaded and not exposed to strong winds. The establishment of windbreaks or shelterbelts should be considered to protect the nursery.

An ideal location of a nursery is along the east-west direction to prevent intense sunlight exposure to seedlings and on a gently sloping terrain (5%) to allow drainage without eroding the soil.

Accessibility

Ideally, a nursery should be established at the center of the main planting areas, connected by a reliable road system. Such a strategic location will reduce the need to transport the seedlings, thus reducing the risk of transport-related injuries.

Size of the area

The size of the land to be used for the nursery depends mainly on the number of plants that will be produced. The following should also be considered:

- Spacing (plants in transplant beds and seedbeds)
- Types and number of structures to be established (germination beds, hardening-off beds, general storage areas, wildling recovery chambers, and others)
- Sowing synchronization time (length of time seedlings will remain in the nursery)

Ground cover

The site to be selected must involve the least site preparation cost. The selected site must be fertile and has a good soil moisture regime.

Labor availability

The community should be willing to participate in the establishment of the nursery. It should be emphasized that nurseries not only help realize reforestation efforts that will greatly benefit the environment but can also provide substantial socioeconomic benefits.

Nursery layout

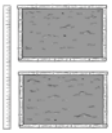
Since there are several steps involved in the production of planting materials—from germination to hardening off—the design and layout of the nursery must be arranged according to these steps. Such design and layout will ensure smooth and efficient production of planting materials that can optimize both the time and effort of the nursery workers and lower the risk of damage to the planting material. Considerations in nursery layout include:

Irrigation

The location of the water distribution system is a very important consideration when planning layout and design.

Topography

The layout should be adjusted to the topography of the land it will be built on for better irrigation, drainage, and access.



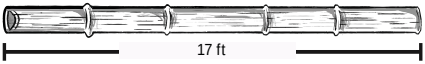
Shape and spacing

The layout should be compact and regular in shape (almost square as much as possible) to minimize workers' travel from one point to another and reduce the length of boundary fences and the expense.

Procedure for nursery establishment

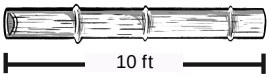
The following materials and procedures are for an easily sourced, simple, and low-cost temporary nursery that would be able to supply planting materials for a planting area of 1 hectare.

Materials:



3 pieces 17-feet bamboo poles

5 pieces 14-feet bamboo poles



6 pieces 10-feet bamboo poles

6 pieces 8-feet bamboo poles

6 pieces 3-feet bamboo poles

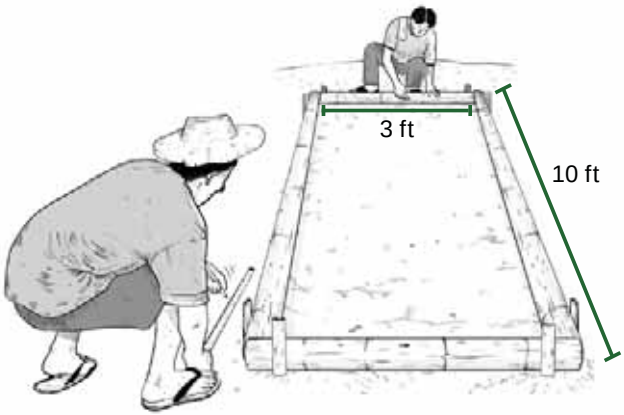
Rolls of thin abaca OR other types of rope (OR any available tying material)

Coconut leaves OR garden net OR any available roofing material

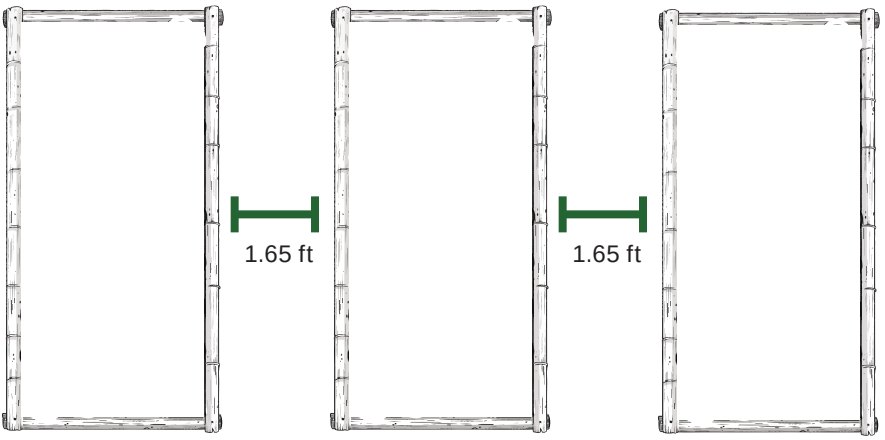
(Note: For planting sites that are more than a hectare, multiply the recommended dimensions above based on the land size.)

1. Construction of plots

The recommended dimension of the nursery plot is 10 x 3 ft (length x width) for a nursery that will supply planting materials for a hectare of land, as shown in the illustration.

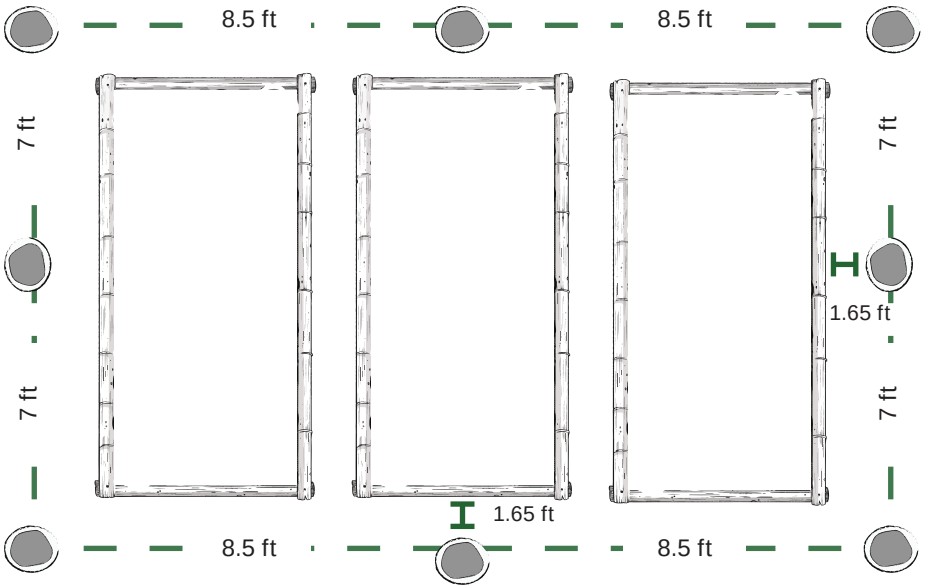


The low-cost nursery shed can accommodate three plots. The spaces on both sides of each plot should be 1.65 ft.

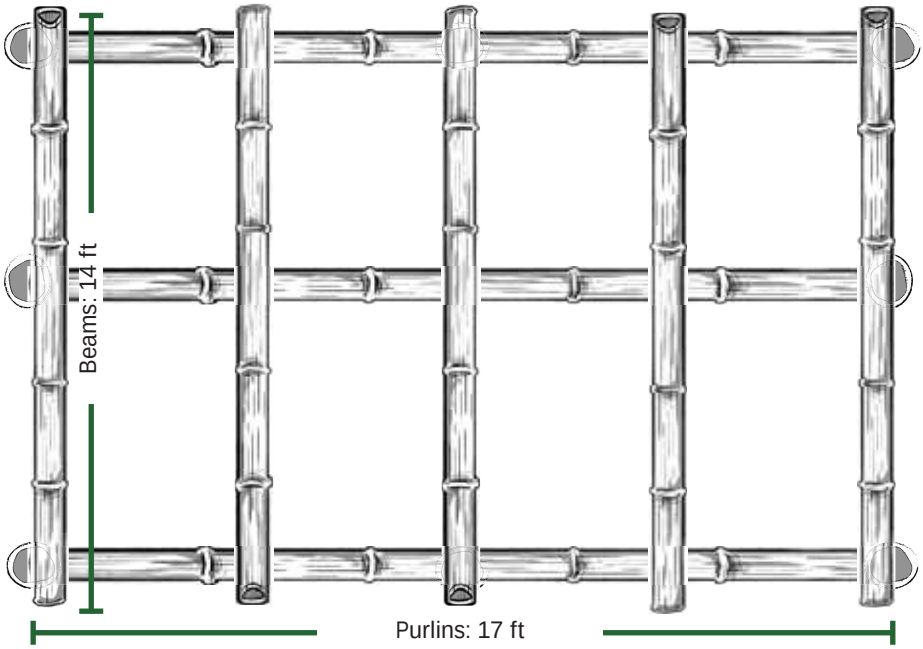


2. Construction of the shed

Prepare six pieces of 8-ft-long poles. Use the plots as a reference for establishing the shed. The posts should be set 1.65 ft away from the plots. From the short side of the plots, three posts are set 8.5 ft away from each other, creating a total length of 17 ft. From the long side of the plots, three posts are set 7 ft away from each other creating a total length of 14 ft.



Set the 17-feet-long beams on top of the poles. Secure the beams to the posts with a tying material, such as abaca or wire. Set the purlins, or the horizontal poles of the roof frame, on top of the beams in a perpendicular direction. Tie the purlins to the beams with the same tying material used previously. Lay the roofing material above this frame.



3. Construction of germination beds

For hardy tree species, it is better to directly sow in containers, but it is more cost effective to raise them in seedbeds. For delicate and small seeds, it is better to raise them in seedboxes.

Seed bed

- Within a plot, dig the soil, loosen any soil clumps, remove weeds and any remaining plant material.
- Make a raised bed with the loosened soil, making sure it is narrow enough for weeding but raised enough so it would not be stepped on.
- Add one shovel of river sand and one shovel of rice hulls for every two shovels of loosened soil, then mix well. The rice hulls will keep the soil moist. These instructions are applicable if the soil is garden or forest soil. If the soil in the area is clay or sand, refer to *Propagation of quality planting materials: a training manual* for more information on the media mixing ratio.
- Level the bed and run a stick lengthwise along the bed, making furrows where seeds can be sown.

Direct sowing

- Mix the same ratio of loosened soil, river sand, and rice hulls.
- Fill the seedling bags with the mixed media.
- Arrange the seedling bags within the plot in straight lines.
- Plant the seeds within each seedling bag.

Seedbox

- Construct a bench from bamboo slats, standing at waist height.
- A wooden tray with holes for drainage can be used as a seedbox.
- Cover the bottom of the tray with pebbles or gravel then fill the tray with the prepared medium.

At this point, find seeds or wildlings to be grown in the nursery.

4. Construction of hardening-off beds

Hardening-off is the process of preparing the planting material for field conditions before planting out. It can be done on a raised bench or a bed.

Since this treatment involves gradual exposure to sunlight and reduction of watering, it needs to be conducted in a different bed from the first growing bed. It can be built in an open area within or near the nursery.

Hardening-off bed

- Create a plot with the same dimension as that of a nursery plot.
- Place the bagged planting material within the bed. Observe proper handling of the seedlings during transfer.

Elevated hardening-off bench

- Construct a bench from bamboo slats, standing at waist height.
- Place the bagged planting material on the bench. Observe proper handling during transfer.
- This is a convenient option that will avoid roots penetrating the nursery floor and will make root pruning easier.

For techniques on proper handling of planting materials, refer to the *Proper tree planting: a training manual*.

5. Construction of a recovery chamber

A recovery chamber can be built if wildlings will be used as planting stock. Materials needed for a recovery chamber are:

- 121 pieces of bamboo cut into the following lengths and widths

Table 1. The bamboo requirements for wildling recovery chamber

Number of pieces	Width/size	Length	Function
6	Whole	10 feet	Plot
6	Whole	3 feet	Plot
50	1-inch wide slat	1 foot	Plot support/stabilizer
6	Whole	8 feet	Post (roof)
3	Whole	17 feet	Beams (roof)
5	Whole	14 feet	Purlins (roof)
9	2 inches	3 feet	Recovery chamber arch support
9	1-inch slat	6 feet	Recovery chamber arch (fresh culm)
15	1-inch slat	10 feet	Vertical arch support
12	2-inch slat	3 feet	Horizontal arch support

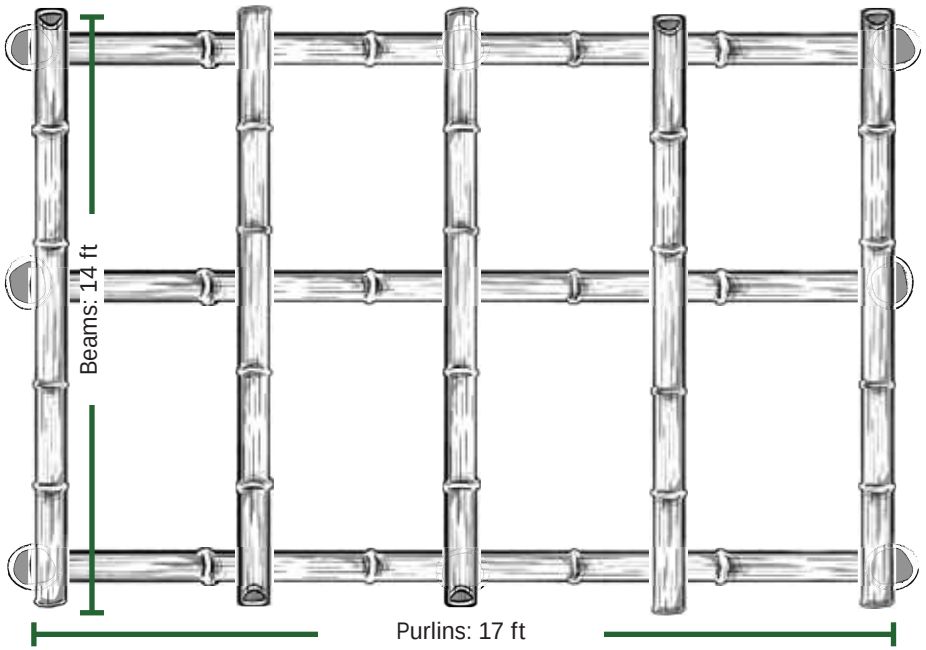
- 3 sheets of UV-treated polyethylene: 19-feet-long per sheet
- Roofing material (garden net with 60% shade rate or coconut fronds)
- 2.5 GI nails (1/4 kg)
- 1.5 GI nails (1/4 kg)
- Rooting hormone
- 5000 seedling bags (2.5 x 2.5 x 8 or 3 x 3 x 8 inches)
- Collected wildlings

(Note: For planting sites that are more than a hectare, multiply the recommended dimensions given based on the land size.)

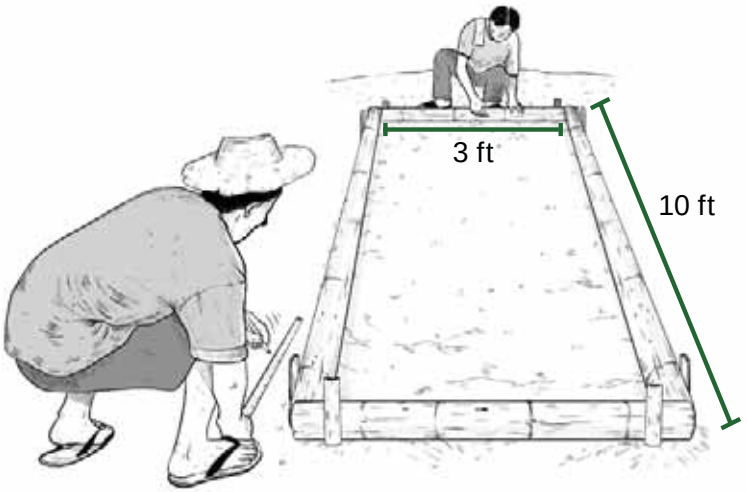
Tools

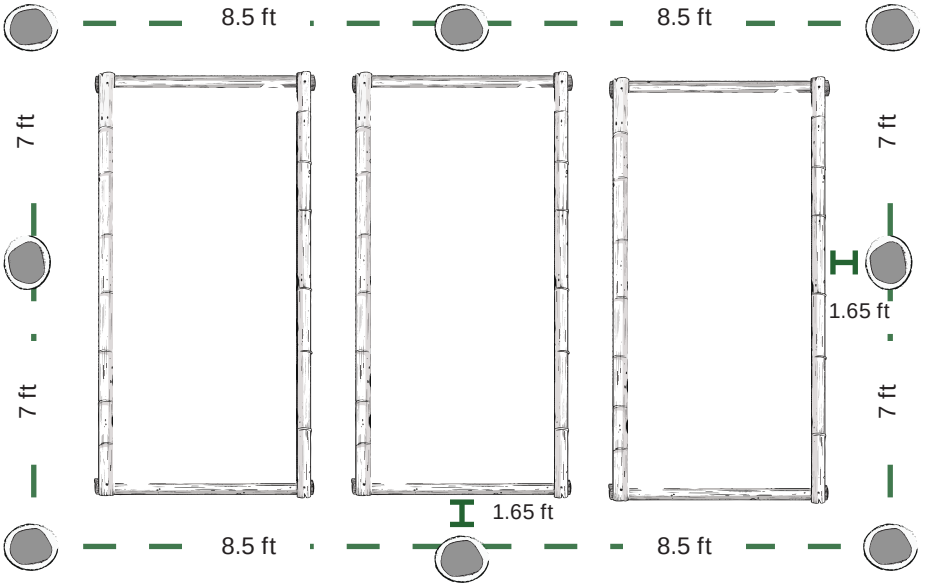
Shovels, bolo, hammer, sledgehammer, steel tape, pick mattock, crosscut saw, a post hole digger, crowbar, pruning shears.

Build a shed with the same dimensions as described above. This will provide overhead protection from damage for the wildling recovery chambers that are made of polyethylene sheets. It will also provide shade that will lessen the risk of the chambers drying out.



Prepare the plots using the recommended dimensions (10 x 3 ft). Allot 1.65-ft-wide spaces on both sides of each plot. Place plot stabilizers at the sides of the plots to hold the frame of the plot in place.





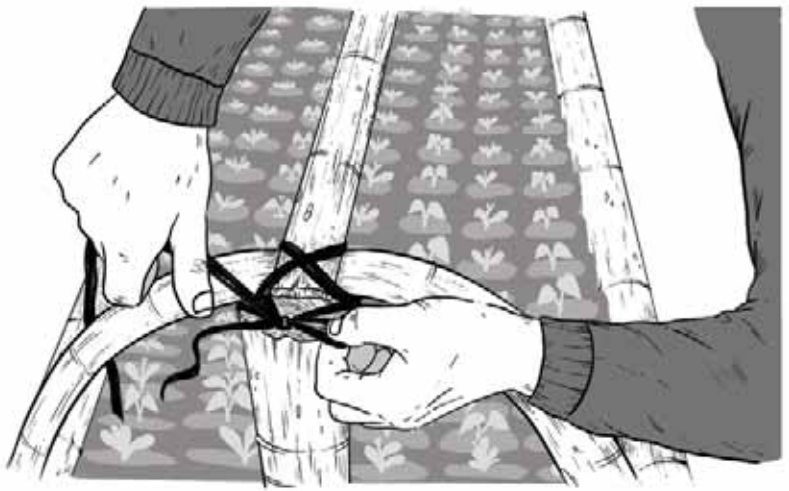
Note: The next steps should be done after preparing the wildlings, preparing and bagging the potting media, and setting the seedling bags within the plots. These processes are laid down in *Propagation of quality planting materials: a training manual*.

Set the three vertical arch supports (3-ft-long) deep within each plot, at equal distances from each other.

Carefully bend each recovery chamber arch (6-ft-long, 1-in-wide) over the vertical arch supports and secure them by nailing on to each arch support.

The strategically placed plot stabilizers (1-ft-long, 1-in-wide) will prevent the bent arches from dislodging the bed.

Lay one bamboo slat (10-ft-long, 1-in-wide) on top of the arches and secure it to the arch using twines. This will hold the bent shape of the arches.



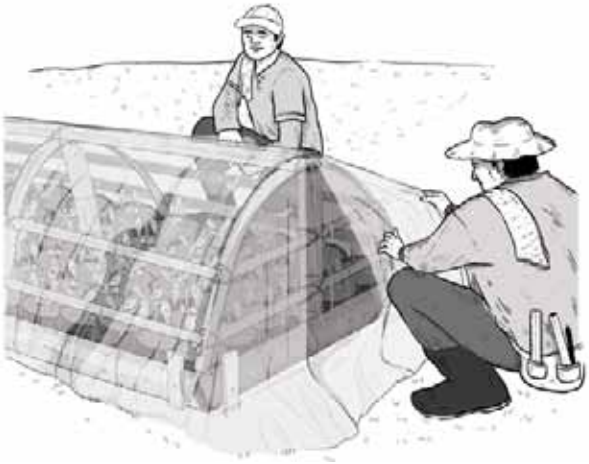
The bamboo slat on top of the arches will serve as a guide in the placement of the other bamboo slats of the same dimension to form the frame of the recovery chamber.

Check and smoothen any sharp corners in the chamber using a crosscut saw, to avoid ripping the polyethylene sheet.

Using a pick mattock or shovel, dig a 1-ft-deep canal around the plot. Make sure that it is close to the plot. Shovel the soil and keep it nearby.

In a separate area that is wide and free from any sharp corners that might rip the sheet, prepare a 19-ft-long UV-treated polyethylene sheet for each plot.

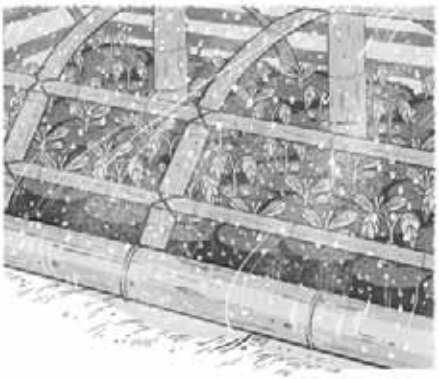
It takes four to six people to carefully place the sheet over the chamber's frame.



Do not drag the sheet over the chamber's frame. This could easily cause damage to the sheet from any sharp edges.

Insert the edges of the sheet in the canal and carefully fold and tuck it towards the chamber to ensure a snug fit.

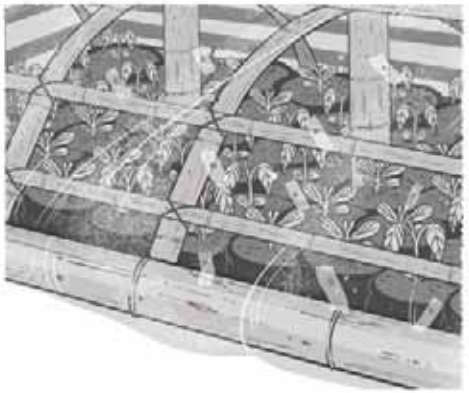
Seal the chamber by covering the canals with the soil dug out from it.



When condensation clings to the surface of the chamber's protective cover a day after sealing, it means the chamber is working properly.

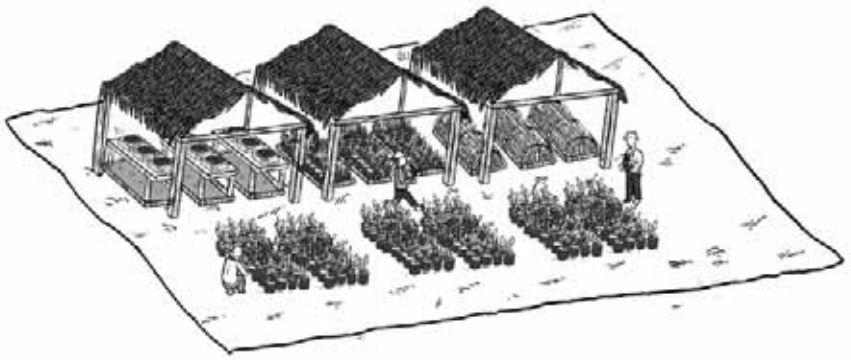
If there are no water droplets formed in the surface, look for any rips or damage on the sheet. If there is no visible tear, lightly run your fingers along the surface of the chamber to feel for any small holes or rips.

Cover any damage with a piece of narrow, clear tape. Do not use a wide tape because it might cause the surrounding surface of the sheet to crinkle over time and create more rips.



The recovery chamber should be opened gradually in the next months. Half of the cover should be rolled up after the first month. The entire cover can be removed after three months. By the start of the fourth month, the wildlings can already be transplanted. The detailed instructions are written in *Propagation of quality planting materials: a training manual*.

Sample Nursery Layout



The one shown in the illustration is a sample temporary nursery where there are three sheds: one for seedboxes, another for directly sown seedlings, and another for wildling recovery chambers. A space is also allocated for seedlings that are ready for outplanting.

Tree nurseries established by ICRAF for INREMP

Photos from the tree nursery established in the Agroforestry Learning Site for INREMP located at Barangay Diis, Kauswagan, Trinidad, Bohol. Photo credits: World Agroforestry/Erwin Albios and Godfrey Buligan

Photos from the nurseries established in the Conservation Farming Learning Sites in (top photo) Barangay San Miguel, Baungon, Bukidnon and (bottom photo) Barangay Dansolihon, Cagayan de Oro City. Photo credits: World Agroforestry/John Philip Mercado

Session Guide

Topic: Establishing a simple and low-cost temporary tree nursery

Logistical Considerations:

Time allotment: ≥ 8 hours
No. of Participants: 20-30 pax (ensure a ≥30% attendance of females)
Venue: A farmer's field

Purpose: For smallholder farmers who are developing their farms into conservation farming, agroforestry, or commercial tree plantation, the most feasible option for a nursery is one that can be built in a short time and less cost with local materials. This training agenda serves as a guide to conduct a training session on establishing a low-cost temporary nursery that can supply the needed planting materials.

Objectives:

By the end of the training session, the participants should be able to:

- explain the purpose of establishing a tree nursery for farm development;
- employ the considerations in selecting a nursery site and planning the nursery layout; and
- build a nursery at less cost in a short time.

Resources:

- Flipchart or tarpaulin with a photo of a completed temporary tree nursery
- Materials required in establishing a tree nursery, listed on page 5 of this manual
- Training evaluation form

Methods:

- Presentation/discussion
- Application/Hands-on demonstration.The steps in building the nursery shed and the plots are enumerated and illustrated on page 6 of this manual. During the training proper, it is highly recommended that the activities involved in building the nursery be done simultaneously to conserve time.

Modifications and variations: It should be noted that the session plan on the next page is only an outline guide for the trainer and that their creativity in conducting the training is still encouraged so long as all the topics in the plan are covered.

If there are uncontrolled events such as sudden change of weather (e.g. rain), it is advised to postpone the nursery establishment and proceed to the wrap-up session. If it is postponed, guidance and frequent monitoring of the progress of the nursery establishment should be done by field personnel. The field personnel should guide the farmer or the people's organization in the actual establishment of their tree nursery on the farm and frequently monitor its progress. Progress reports in the form of photo documentation can be sent to the trainer/resource person.

Key Points	Time	Learning Check
Overview		
Introduction Introduce trainer and training team followed by participants, training title, training objectives, and flow of activities	15 mins	Confirm if participants understood the flow of activities. Check if they have any concerns or anything to add in the training program
Theoretical Discussion Discuss types of nurseries, advantages, and disadvantages of each. ■ Mention that a temporary nursery will be built.	30 mins	After discussing the types of nursery, ask a random participant why a temporary nursery has to be built. After giving their answer, explain the real reason
"Seedlings require the best possible environment to grow" - discuss the considerations in selecting the nursery site (pp. 3–4)		Let random participants (ensure that women and men are called) enumerate one consideration in selecting a nursery site
"Since the site is already chosen, we need to plan our nursery layout" - discuss the considerations when planning for the nursery layout (pp. 5–6) ■ Present a usual nursery layout (seedbed, seedbox, hardening-off area, recovery chamber area)		Let all participants repeat the 3 considerations with the trainer out loud. The trainer shall ask the participants to repeat it on their own. Give compliments as necessary.
Main Session		
Divide the participants into groups, make sure that each PO is represented in each group, and men and women are well-distributed. Quickly go over the steps in establishing the nursery and assign groups in each step (pp. 6-18)	6 hrs	The trainer should make rounds and check if the measurements are correct and the steps mentioned in pp. 6–8 of this manual is followed.
Wrap-up		
Summarize the overview session and activities done in the main session. Mention that sheds and plots of the same dimension can be established as hardening off areas and beds as well as recovery areas	30 mins	Ask if the participants have any questions/clarifications.
Q&A session	15 mins	Ask if the participants have any questions/clarifications.
Evaluation	30 mins	Translate into the local language, if possible.

Glossary

Accessibility. The quality of a site being easily reached with respect to the main planting areas to avoid damaging planting stocks during transport

Arch. A narrow piece of bamboo that is bent in a half curve to serve as the recovery chamber's frame

Beam. A bamboo pole horizontally secured on top of posts, serving as the foundation of the roof of the nursery

Condensation. The water droplets that cling inside the thick sheet covering of the recovery chamber

Exposure. Leaving the planting stocks outside the nursery unshaded or unprotected

Germination. The stage where a seed starts to grow and produce a shoot or seedling when the conditions are right

Germination bed. Raised beds, plots, and containers where seeds are planted or sowed to grow and produce a seedling

Hardening-off. The process of preparing the planting material by leaving it under direct sunlight, wind, uneven temperatures, and reduced watering conditions

Nursery. An area set aside to produce planting stocks up to a certain age

Nursery layout. A nursery's design which includes the arrangement of plots, beds, and other structures within the nursery area

Outplanting. The process of moving and planting the hardened plant in another location away from the nursery

Planting stock. Seedlings, transplants, cuttings, and wildlings for use in planting out

Plot stabilizer. Small pieces of bamboo or any type of wood pinned down at the sides of the plots bed to keep its frames in place

Potting media. Organic and inorganic materials mixed in soil prescribed ratios to make maximize its ability to support plants

Purlin. A bamboo pole that perpendicularly rests on top of a beam, serving as the support of the roofing material for the nursery.

Recovery chamber. A plot bed sealed using a clear and thick plastic sheet (PVC or polyethylene) that is used to condition wildlings to the nursery environment. It is considered a mini-greenhouse since it traps heat and moisture needed to nurture plants within it.

Seedling (*also shoot)*. A small young plant that grows from a seed

Shelterbelt *(also windbreak)*. A row or more of planted trees or shrubs that act as a barrier protecting plants from wind destruction and the soil from erosion

Socio-economic benefits. Positive contributions to the well-being, happiness, and prosperity of a community

Topography. The combination of the highest and lowest points of the land that makes up its physical and natural features. It includes mountains, hills, valleys, plains, creeks, rivers, and seas

Vegetative propagation. The method where parts of an existing plant with desirable characteristics (e.g. fruit taste) are cut and nurtured to produce new plants that carry the same characteristics.

Vertical arch support. A plank or a half-pole of bamboo established within the recovery chamber plot. The highest point of the arch is nailed on it to keep its shape.

Wildlings. Planting stocks that grew within the forest without any human intervention.

Further Reading

Buyinza J, Opolot V. 2016. *Tree nursery establishment and tree management: training manual for community tree nursery operators and tree farmers.* Kampala, Uganda: National Forestry Resources Research Institute. http://www.worldagroforestry.org/output/buyinza-j-opolot-v-2016-tree-nursery-establishment-and-tree-management-training-manual.

Jaenicke H. 1999. *Good tree nursery practices: practical guidelines for research nurseries.* Nairobi, Kenya: International Centre for Research in Agroforestry (ICRAF). http://www.worldagroforestry.org/publication/good-tree-nursery-practices-practical-guidelines-research-nurseries.

Mercado AR. 2019. *Nursery establishment and production of quality seedlings for conservation farming, agroforestry and commercial tree plantation at INREMP Site*. Presentation. Los Baños, Philippines: World Agroforestry (ICRAF) Philippines.

Munjunga MR, Gachuiri AN, Ofori DA, Mpanda MM, Muriuki JK, Jamnadass RH, Mowo J. 2013. *Nursery management, tree propagation, and marketing: a training manual for smallholder farmers and nursery operators.* Nairobi, Kenya: World Agroforestry Centre (ICRAF). http://worldagroforestry.org/publication/nursery-management-tree-propagation-and-marketing-strategy-training-manual-smallholder.