

GUYANA MANGROVE NURSERY MANUAL



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TABLE OF CONTENTS

1. Introduction	4
2. Need for mangrove nurseries	5
3. Selection of site for the mangrove nursery	5
4. Preparing soil for containers	6
5. Nursery containers (bags and rootainers)	6
6. Seed/ Propagule collection and management	7
7. Identification of mature seeds/propagules	8
8. Fruiting season	9
9. Seed sowing in containers	9
10. General cultural techniques	10
11. Seedling preparation for outplanting	13
12. Nursery practices for different species	13
13. Record Keeping and Planning	14
REFERENCE	16
ANNEX 1	17
ANNEX 2	18
ANNEX 3	20

Manual on Mangrove Nursery

1. Introduction

This manual was written for people who grow mangroves seedlings. It was made to help nursery practitioners/managers produce high quality, healthy seedlings which have better survival and growth when out-planted. It is meant to be a practical guide to operating a mangrove nursery. This manual should be able to guide anyone who wishes to embark on a mangrove nursery project.

The seedlings can be planted in rootainers and plastic bags. These containers hold the soil and the seed/propagules together and allow water to drain from them. Seedlings grown in these containers have stronger and healthier root systems.

Seedlings can be produced in a well constructed nursery with shade cloth or can be grown in backyards (coconut branch shade) or close to the restoration areas in the open (ANNEX 3), once the correct practices are employed and the principle for establishment is adhered

Species used for mangrove restoration in Guyana

There are three main species of mangroves in Guyana, *Avicennia germinans* (black mangrove), *Rhizophora mangle* (red mangrove) and *Laguncularia racemosa* (white mangrove). However there is another that needs mention because it is found dispersed along the coast – *Conocarpus erectus* (buttonwood). For restoration purposes only the black and the red are used. Once the black is established it will create conditions for the white to grow in the area.

The following are descriptions of the mangrove species recommended for propagation in the nursery:

The red mangrove is an evergreen tree, which grows to about 25 meters in height and 40 centimeters in diameter at breast height. A single seed germinates inside the conical fruit forming a long narrow first root (radicle), which is green except for the brown enlarged and pointed end up to 1.25 centimeters in diameter. It can grow up to 30 centimeters in length before it gets detached from the mother tree and falls. The roots systems stabilize the trees and act as a first line of defence against wave action; in line with its position on the seaward edge of the system. The species normally grows in soft muddy soils along sheltered river banks and estuarine margins. Flowering and fruiting occurs during the entire year (Hussain 1990)

The black mangrove is locally known as courida or black mangrove. It is the most important and dominant mangrove species in the open mud flats of Guyana. It is tolerant to high saline conditions and the tree grows in the form of isolated groups or woodland formations. The tree is fairly large and may grow up to 20-25 meters in height and 40 centimeters in diameter at breast height. The species flowers

and fruits all year round. This species regenerates and coppices well and can be managed under a coppice system (Hussain, 1990).

2. Need for mangrove nurseries

Mangrove seedlings can be grown in the nursery in black rootainers and black or white plastic bags. These containers hold the soil and the seeds/propagules together and allow water to drain from them. Seedlings grown in these containers have stronger and healthier root systems.



Nursery seedlings of *Avicennia germinans*

The natural availability of seeds and propagules sometimes do not co-inside with the timing of replanting of degraded areas. Hence, the seedlings raised in the nursery can be used for planting in degraded areas in the absence of natural planting material.

The survival rate of nursery raised seedlings in restoration areas is high compared to the direct planting of seeds/propagules (Ravishankar & Ramasubramanian, 2004). This is due to the fact that nursery-raised seedlings have a well established root system before being transplanted in the degraded areas.

3. Selection of site for the mangrove nursery

The site should have the following features:

- access to good quality salt and fresh water
- access to road/waterway to mobilize transport and labour to the planting sites

- be in close proximity to inter-tidal areas (sea/rivers/creeks).
- be securely fenced to prevent grazing by cattle and other animals.
- in close proximity to the restoration site to reduce the cost of transportation of seedlings
- have a water pumping facility
- access to soil with similar salinity of the area chosen for reforestation

4. Preparing soil for containers

Only muddy soil which is clayey should be used for preparing the containers (Ravishankar & Ramasubramanian. 2004; Pastakia, 1991). The soft clayey mud available in the mud flats during low tide should be collected. Any fragments or hard material should be removed before filling the bags with mud.



Clayey soil medium for filling nursery bags

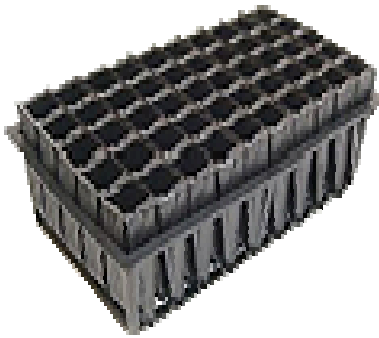
5. Nursery containers (bags and rootainers)

- Black/white polythene bags of 5"x8" or rootainers of similar size should be used to raise the mangrove seedlings in the nursery. This will give the root enough space and not have curled malformed roots after 2-3 months (30-35 cm height) of growth in the containers.



Nursery bags and soil medium

- Small holes should be made at the bottom of the bag in order to drain excess water.
- The rootrainers will have holes for this purpose



- **Rootrainers**
- The filled containers should be kept in the shade to harden.

6. Seed/ Propagule collection and management



Seeds of *Avicennia germinans*



Propagules of *Rhizophora mangle*

Remember seeds/propagules are really delicate living plants and must be carefully collected, cleaned and protected to keep them alive and healthy. The following should be considered when collecting seeds:

- Know the fruiting season for the mangrove species
- Collect seeds from healthy mature trees or under healthy mature trees that are free from pest and diseases
- Collect seeds which are mature and healthy not rotten and with insect damage
- Collect large seeds/propagules - they grow with more vigour than small seeds/propagules
- Collect seeds in the morning and keep in the shade – prolonged exposure to the sun will kill them
- Fallen *Avicennia* seeds should be collected from beneath or from mature parent tree: mature seeds can be easily identified by the light yellowish colour of the seed with cracks on it (Ravishankar & Ramasubramanian, 2004)
- *Rhizophora* propagules should be collected from waterways using nets or baskets
- Place seeds and propagules in jute sacks or appropriate bag for transporting
- Never leave seed or propagule in the rain or wet area for prolonged period they will rot and die
- Never collect seeds or propagules in plastic bags or place many seeds in very large bags. Plastic containers can get warm quickly and the heat can kill the seeds. Many seeds kept together in very large bags can generate heat that may kill the seeds
- Store seeds in large open baskets in a dry, cool and shaded area
- Always label collected seeds stating the following: *species; collection date; location (place) of collected; collector's name.*

Having a good seeds depends on the age of the tree. For example *Rhizophora spp.* is able to produce fruits between the third and fourth years. However, the propagules should be collected from trees at least 5 years old (Wirjodarmodjo and Hamzah, 1984). *Avicennia* seeds should come from trees that are > 5years old. It is difficult to tell the age of these trees so select trees that are >7m tall (Ravishankar & Ramasubramanian. 2004). The quality of the seeds depends on the age of the tree. The more mature a tree is the better quality seeds it produces.

Seeds should be planted within 48 hours of collection, any delay after this reduces the ability of the seeds to germinate.

7. Identification of mature seeds/propagules

The mature propagules of both *Rhizophora mangle* and *Avicennia germinans* can be easily identified



Propagules of *Rhizophora mangle*



Propagule of *Avicennia germinans*

8. Fruiting season

Red mangroves fruits throughout the year, peaking during August – November (Tomlinson, 1971). Black mangroves produce fruits in the latter part of the year October - December (Pastakia, 1990).

9. Seed sowing in containers

Fill containers with soil medium up to 3 cm from the top. Dip seeds/propagules in Mancocide fungicide solution (one teaspoon Mancocide/ 1 gallon of water) in the morning prior to planting to prevent ‘damping off’ a fungal disease.

Black mangrove seeds should be placed in damp jute bags until the roots and shoot appear (pre-germinated seed). This should then be planted in the nursery container. The radicle (root) part of

the seeds must be gently pushed 2cm inside the soft mud of the container. Plant one seed per container.

The root part (swollen part) of the red mangrove propagule should be pushed to a depth of about 7 to 8 cm into the soil in the containers. Small sticks are to be tied to the exposed part of the propagule to provide support. Plant one propagule per container.

Planting too deep can cause seeds/propagule to rot and never germinate. Planting too shallow can cause seeds/propagules to dry out or seeds to splashed out of the container during watering (Josiah and Frantz, 1992).

Sow seeds/propagules in the shade (under nursery shade cloth or coconut branch shade). Allow 30-40% shade. Sowing in the sun can cause the soil to quickly dry out and kill the germinating plants.

10. General cultural techniques

a. Watering

Watering is one of the most important aspects of nursery management.

- Water seedlings with saline water (between 5 -30ppt).
- Water twice daily, in the morning between 6.00am – 7.00am and in the afternoon between 5.00pm -6.00pm (Josiah and Frantz, 1992). Watering time could vary depending on where the nursery is located in proximity to saline water. However, water in the cool time of the day and not in the sun.
- Water using buckets, hose, watercans or sprinklers depending on the type of nursery.
- Water so as not damage or dislodge seedlings.
- Water so as not to create water-logged conditions in the containers. This will cause poor growth and even death of seedlings.

Remember:

- a) Plants growing in the shade (under shade cloth or branches) need less water than plants in the sun
- b) Plants growing in the sun need more water
- c) Plants need more water on windy days – blowing winds remove moisture from plants
- d) Always check soil moisture daily. When the soil is too dry the roots will die and plants may appear wilted or burnt. Too much water can cause poor growth, damping-off disease and root rot.

b. Application of fertilizers

N:P:K fertilizers, 15:15:15, Triple Super Phosphate and Urea can be added if plants appear weak. This would help the seedlings and ensure good root establishment.

Apply fertilizer at 28g (1oz) per seedling 15 days apart. Do not apply more than two times.

c. Sun and shade management

Some shade is good for young seedlings, but too much shade can harm them. Plants growing in deep shade become slender, weak and can be very sensitive to sunlight. In fact, plants that are grown in deep shade can be burnt when suddenly placed in the bright sunlight.

Use either nursery shade cloth alone, plastic alone or coconut branch to shade seedlings. Plastic is best as it controls the amount of fresh water the plants may receive in the rainy season. Too much fresh water make plants weak for planting in the salty areas. Remember the following:

- Put seedling in the sun when they are about 25 cm tall.
- Expose them to the sun gradually, starting with a two hours each day for one week, then four hours for the next two weeks, and then to full (Ravishankar & Ramasubramanian, 2004) daily light.
- Water seedlings everyday before they are put in the sun.
- Never cover black shade cloth with plastic. The dark shade cloth will make the nursery hot damaging or killing the seedlings
- Use green or blue shade cloth with plastic. Not black.
- Use 30 - 40% shade cloth because initial shading protects young plants (seed and seedlings) from rapidly drying out.

d. Grading and Culling

Grading is the selection of good quality seedlings and culling is the removal of dead and weak seedlings and dwarfed seedlings. All dead and weak and malformed seedlings as well as containers without seedlings should be removed. This is done when most seedlings in the nursery are about 25cm tall.

At this time seedlings should be shifted once weekly on the nursery floor to prevent the roots from becoming attached to external soil if on bare ground or becoming exposed if on concrete.

e. Pest Control

Chemical control should be only used when the others are not successful.

There are many techniques used to control insects, diseases and other nursery problems. Prevention is the best way to control any problem in the nursery. Always keep the nursery surroundings tidy (Josiah and Frantz, 1992). Some good practices are:

- i. Remove all trash, bottles, plastic and other garbage from the surroundings
- ii. Keep the grass and weeds short.
- iii. Pull weeds from nursery bags. Weeds harbour pests and diseases.
- iv. Remove diseased plants from the nursery so as not to spread the disease
- v. Allow air to circulate freely in the nursery. Poor air circulation causes disease

Chemical control should be only used when the others are not successful.

Check seedlings daily for pest damage - young seedlings are susceptible to caterpillar damage. Pesticides such as Malathion and Karate may be sprayed on seedlings at the rate of 1teaspoon/ gallon of water every seven days for three weeks.



Caterpillar feeding on *Avicennia germinans* seedling

Damping-off disease is also common in mangrove nurseries. The disease causes underground, soil line, or leaf rotting of very young seedlings caused by several fungi.

Banrot fungicide should be sprayed on seedlings at the rate of 1 teaspoon/gallon of water twice weekly to seedbed, soaking the bed until seedlings are large enough to resist the disease -10cm tall). Mancocide fungicide at one teaspoon/ gallon of water OR 1tablespoon Cardendizin/ gallon of water should be applied to seedlings once /week for two weeks.

f. Hardening-off

Life is harder for the seedlings when they are outplanted. Seedling must be tough to survive. In order to achieve good survival, they must be acclimatized to the harsher conditions in the field. This is called hardening-off. Hardening off is done by:

- Reducing water one month before seedlings are outplanted. This is necessary to prepare the plants for the harsher environment at outplanting.
- Water plants by giving half the amount every other day. Plants should be wet thoroughly one day followed being moist the next day. Be careful not to allow the soil to dry-out and let the leaves dry up (appear burnt).

Do not try to harden plants in a shorter period. It may make it difficult for the plant to adjust to the outplanting conditions and they may grow poorly.

11. Seedling preparation for outplanting

It is very important to prepare your seedlings for outplanting.

- Choose only hardened plants for outplanting
- Water plants thoroughly the day before outplanting.
- On planting day carefully pack seedlings in the transporting vehicle, ensuring that they would not be exposed to the wind during transport. The wind could cause seedlings to dry-out and become burnt.

12. Nursery practices for different species

Nursery techniques differ from one species to another, depending on the salt tolerance level and the ecological zone. In the following pages, guidelines that should be followed for each species are described.

a. Avicennia germinans

Local Name: Black mangrove; Courida

Selection and processing of the seeds

- Mature fruits should be selected and checked for insect borers.
- Seeds should be placed in brackish water overnight to remove the seed coats. This treatment reduces the establishment time by two to three days.
- Seeds should be placed in damp jute bags until the roots and shoot appear.

Sowing into nursery containers

- The polythene bags/rootainers with soil must be allowed to harden (soil moist not hard) by placing them in the sun.
- After hardening, the polythene bags containing mud should be watered, using water hose/buckets/cans/sprinklers.
- The radicle (root) part of the seeds must be gently pushed 2cm inside the soft mud.
- Plant one pre-germinated seed per bag.

Irrigation

Watering is to be done twice daily morning (6.00am – 7.00am) and afternoon (5.00pm -6.00pm) with salt water.

Pest and disease control

Caterpillars are the major pests for mangroves in the nursery in Guyana. When the attack is severe, pesticides such as Malathion and Karate should be sprayed to kill the pest. Damping off fungal disease may affect very young seedlings. This can be treated with one of the recommended fungicides.

Selection of nursery seedlings for outplanting

The recommended specifications of the seedlings are as follows:

Height: 35 cm

No. of leaves: at least 4-6

Duration in nursery: 3 months

The germination period: 6 days

b. Rhizophora mangle

Local Name: Red mangrove

Collection of propagules

Healthy and mature propagules should be collected from the tidal zones, using fishing nets and baskets. Mature propagules of *Rhizophora mangle* are pale green to yellow.

Selection and processing of propagules

Healthy propagules should be selected and checked for insect borers. The propagules should then be planted immediately in the polythene bags. In case of storing, the seeds should be kept in the shade for one or two days, without being exposed to direct sunlight.

Sowing into nursery containers

Polythene bags filled with mud should be prepared. The hypocotyls (root) of the propagule should be inserted to a depth of about 7 to 8 cm in the bags/rootainers. Small sticks are to be tied to the hypocotyl to provide support.

Irrigation

Watering is to be done twice daily morning (6.00am – 7.00am) and afternoon (5.00pm -6.00pm).

Pest and disease control

Caterpillars are the major pests for mangroves in the nursery. When the attack is severe, pesticides like Malathion and Karate may be used. Damping-off may affect very young seedlings. This can be treated with the recommended fungicides.

Selection of seedlings for outplanting

The recommended specifications of the seedlings are as follows:

Height: 35 cm.

No. of leaves: 4-6 leaves

Duration in the nursery: 3 months

The germination period: 20 days

13. Record Keeping and Planning

Maintaining accurate records is one of the most important activities in the nursery. Accurate records can help save the nursery unnecessary spending and assists you making your nursery well-organized. A daily report (*Activities*) form (ANNEX 2.) is a useful tool that assists in record keeping and should have the following information:

Activities

- Species planted
- Seed Source
- Date seed sown
- Germination date
- Date and time of fertilizer application and type
- Date and time of watering (by whom)
- Date of pest or disease attack
- Date of pesticide application (type of pesticide)
- Date hardening process and number of seedlings
- Date seed outplanted and location

Financial

- Dates money was spent
- Amount spent
- Purpose for spending (labour, materials, equipment)

Planning

Number of seedlings to be supplied

Amount of seeds needed

Amount of labour needed

Number of bags required

The record keeping can take many forms and should be simple and easily understood by the nursery operator. This will further assist with the planning process of nursery management.

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APPENDIX 1

GLOSSARY

Air circulation	The free passage of air within the nursery which helps to reduce humidity and prevent disease.
Chemical pest control	Using chemical poisons to kill the pest or disease.
Cultural pest control	Good nursery practices that prevent pests and diseases from damaging seed/seedlings.
Biological pest control	Allowing plants and animals to eat or kill the pest
Damping off	A very serious disease caused by a fungus that kills seed, stem and roots of seedlings at or below the soil surface. This is caused by soil being too wet.
Disease	A sickness that is caused by a bad microbe in the plant.
Germination period	The time it takes for a seed/propagule to initially produce root and shoot
Fertilizer	Foods that plant need to grow and be healthy.
Hardening-off	The process of toughening seedlings to prepare them for the outplanting area.
Insecticide	A chemical used to kill insects.
Irrigation	Watering the seedlings.
Malathion/Karate	Recommended insecticides used to control insects such as Caterpillars.
Mechanical pest control	Removing the pest by hand.
Outplanting	Planting the seedlings in the assigned areas for reforestation.
Polythene bags	Plastic bags.
Propagule	Any plant material used to produce a seedling.

Sanitation (good)
Weeding

Any activity that keeps the nursery clean, neat and well-cared for.
Cutting weeds, including grass from in and around the nursery.

**APPENDIX 2
DAILY ACTIVITY REPORT**

NURSERY..... CONTRACT..... MONTH..... YEAR.....

Date	Seed Source/Location	Species Now germinating	% Germ	Fertilization	Species in the sun	Fertilizer Applied Yes or No? Species	Pesticide Used Yes or No? Type	Species supplied for Outplanting	Amounts Seedlings supplied	Signature

ABNNEX 3
NURSERY LAYOUT AND TYPE

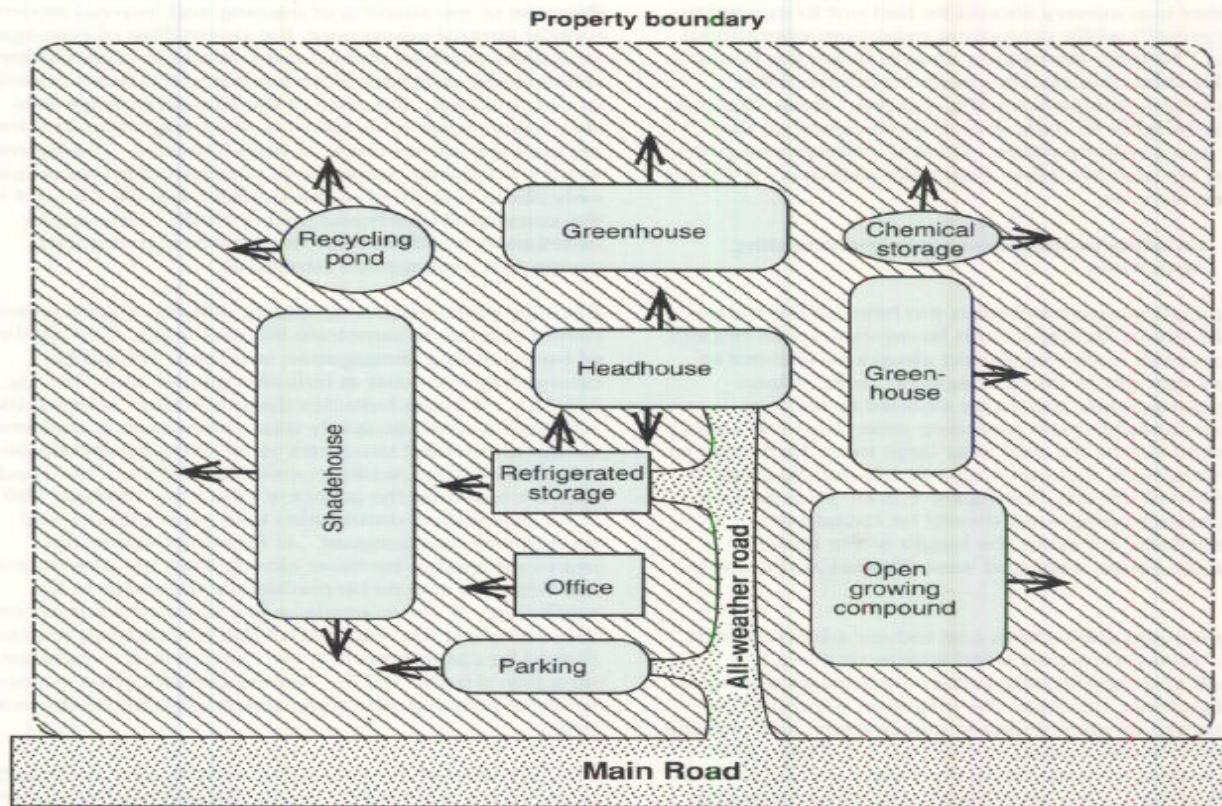
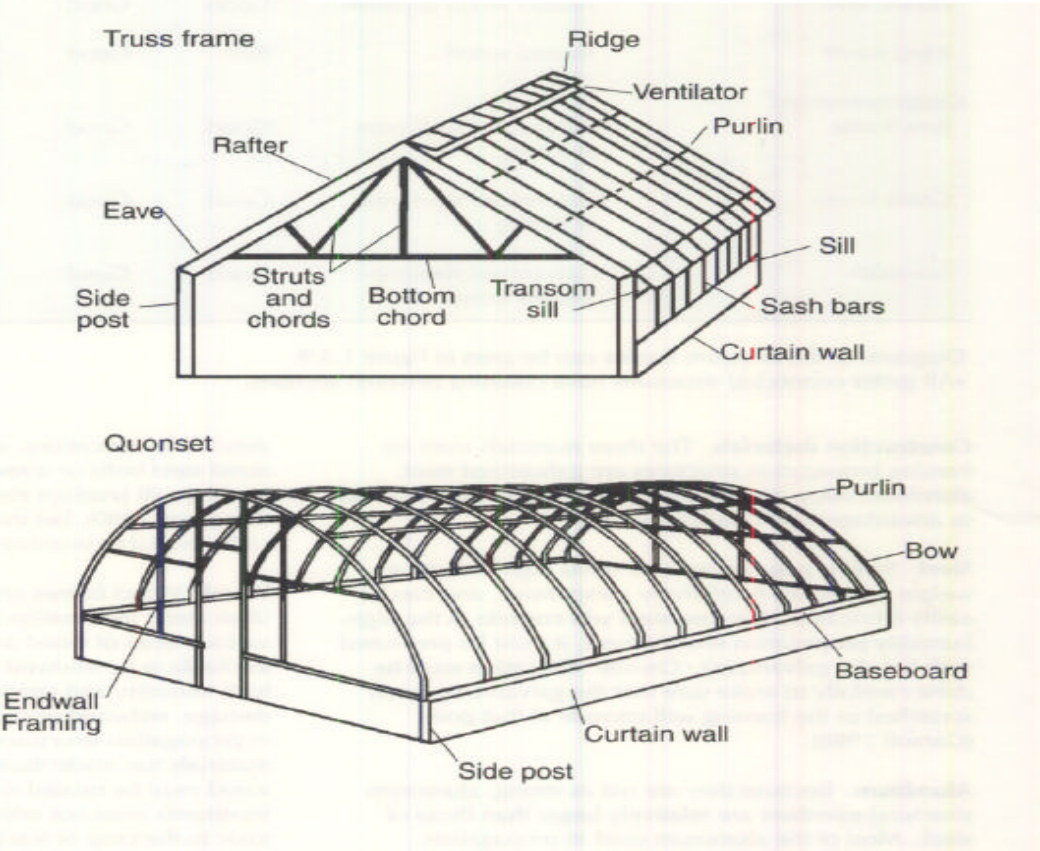


Figure 1.3.34—Nursery developers should make a rough sketch of their nursery site to show the relative location of the various facilities and must also allow adequate room for future expansion (modified from Appleton 1986).

Figure 1.3.12—The frame of propagation structures supports the covering, and the two basic types are the truss frame and the quonset (modified from Nelson 1991, Hummert 1993).





Nursery in the backyard



Nursery with coconut branch roof