“TREES FOR SURVIVAL”

PNG NATIONAL SCHOOL NURSERY PROJECT MANUAL

FEBRUARY 2005

This project is sponsored by:

PAPUA NEW GUINEA FOREST INDUSTRIES ASSOCIATION (INC)

NATIONAL CAPITAL BOTANICAL GARDENS

ROTARY CLUB of Port Moresby

SIPEF GROUP

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PNG FOREST PRODUCTS

FOREWORD

"TREES FOR SURVIVAL" The Rotary model for a major PNG national school nursery project — 2004 on

Under the sponsorship of the PNG Forest Industries Association, Galley Reach Holdings, POM Rotary Club, Bulolo Rotary Club, Dept of Environment and Conservation and the National Botanical Gardens POM a major revegetation project is being undertaken involving PNG schools based on the rotary model "trees for survival".

The benefit of the project "trees for survival" is to:

- Allow school children and school communities the benefit of studying environmental concerns, and, particularly, the vital role that trees play in the PNG eco-system.

- Allow school communities and school children to study, understand and recognize the role of agro forestry and the tree component of integrated farming systems in enhancing food security.

The project will involve the development of a plant nursery at each participating school, with the provision of seedling tubes, seeds, and information both written and pictorial on how to raise seedlings and plant them out. Nurserymen to visit schools will be sourced from the various organizations named above.

Plants raised will include trees for all purposes, from food production to timber production.

The project will undertake

- In service teacher training at the National Botanical Gardens Port Moresby

- Production of instruction manuals for both primary and secondary schools through the Port Moresby Rotary club

- Providing seed and up-to-date information through newsletters

- Provision of seedling bags and instructors

For the individual community, the project will be actively developing the theme "make our community a better place to live and work in" by:

- Creating an awareness campaign through the respective community of the need for each member to actively administer their own premises in terms of cleanliness, landscaping, and drainage on their properties.

- Undertake for example, a community garden competition
- Using children power to put pressure on all community members to regenerate the community and stop the use of graffiti to spoil the local environment.

Some of the benefits of the project will include:

- The landscaping of the community
- The development of civic pride which will put enormous pressure on the community to stop vandalism through graffiti on public and private buildings, etc
- Protect PNG's eco-system

The national school nursery project is based on the Australian rotary project "trees for survival". Throughout Australia, over more than 12 years some 320 individual school nurseries were established.

The benefit of the project is to allow school children and school communities the benefit of studying environmental concerns, and, particularly, the vital role that trees play in the PNG eco-system.

The project will undertake

- In service teacher training — to be done by National Botanical Gardens POM
- Production of instruction manuals for both primary and secondary schools — to be done by Port Moresby rotary club
- Providing seed and up-to-date information through newsletters to participating schools

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INTRODUCTION

Growing from a seed to a seedling to a sapling to a mature tree, the normal life span of a tree can vary according to the species. Acacias (wattles) may only last 10 or twenty years, whereas the giant redwoods of USA may live for 3,000 to 4,000 years.

Whatever its life cycle, and however or wherever it grows, the tree will join those others which clothe some 3/5ths of the world's land surface, making it habitable for Man. It will help sweeten the air, landscape the countryside, shelter people and gardens form the wind, shelter the birds, lay the dust, conserve moisture and protect the soil.

Each kind of tree species has developed its own characteristics in the shape of the tree, in the physical nature of its leaves, bark, branches, flowers, fruit etc and the nature of its wood. The wood of each species has definite qualities by which it may be clearly distinguished from any other species.

BUT, each tree is an individual, possessing personality, and in the course of its life, many things affect its growth and nature — the cycle of the seasons, the nature of the soil and climate, latitude and altitude, times of drought and times of plenty (means moisture). These factors materially affect the tree's substance i.e. — wood — and into the grain of its wood is verily written the life story of the tree. These distinguishing qualities of the various species and the variety of grain in individual boards, give to wood such a wide range of usefulness and beauty that it truly becomes the most valuable and most versatile of all the natural substances available to Man.

This manual is designed to help school communities raise their own tree seedlings in their own areas. It provides details on nursery establishment, guidelines on different methods of raising seedlings and other ways to propagate plants.

ESTABLISHING THE NURSERY

Selecting the site

The nursery site is important to ensure efficient production of good quality plants and easy nursery management.

The essential points of a good nursery are

- Shelter from wind
- A good supply of water
- Fine, loose well drained soil
- Fine sand
- Light
- A clear site free of rocks and competing vegetation

The following factors should be considered

Water

Locate the nursery next to a source of water that will be adequate throughout the year e.g. a river, spring, swamp, and dam or well

Soil
The nursery requires a good source of sandy loam or loam soil, preferably forest topsoil. This should be close to the nursery to reduce transport costs. An accessible supply of sand is important for making suitable potting mixes

Topography
The site should be relatively flat with a 1 to 2 % slope. The gradual slope allows for runoff, preventing water logging and erosion.

Microclimate
The nursery site should be sheltered from wind and receive sunlight for the major part of the day.
The site should not be exposed to drying winds e.g. on hilltops or to flooding or severe frost that can occur in valley floors.

Materials
Easy access to supplies of fertilizer, compost, weedicides, pesticides and materials for building shade houses etc

Location
To minimize transportation time and nursery costs, the nursery should be located as close as possible to the planting area

Access
The nursery site should be close to a good road so that the nursery is accessible throughout the year.

Ownership

Identify who owns the land on which the nursery is to be established. A written agreement giving the right to use the land and access to the water should be obtained.

Labour
Ensure there is enough local labour available for nursery construction and from time to time, for soil transportation, potting and weeding.

2 Determining Nursery Size

- The calculation of nursery size is based principally on the expected demand for seedlings and the main plant growing area required.

- It is important to remember overlapping production cycles e.g. seedlings being grown to replace those that die after the first planting.

An example of calculating the size of a nursery required for the following average annual production:

- 12,000 plants in *7.5* cm x 17.8 cm poly pots (black plastic bags)

- 18.000 plants in 10 x 17.8 cm poly pots

- 500 single node bamboo cuttings

- 2000 stump plants

The stumps, bamboos and half of the plants in poly pots require from 12 to 24 months in the nursery

The 12,000 poly pots (7.5 cm x 17.8cm)

- space is required for 12,000 x *1.25*=15,000 poly pots to allow for 25 % loss and culling

- approximately 200 poly pots cover an area of 1 m^2 when spaced out 15000/200=75 m^2

- Half of these plants require twice as much space because they are in the nursery for more than 12 months and need to be spaced further apart to reduce crowding 37.5 m^2 plus 37.5 m^2 x 2) = 112.5 m^2

18,000 poly pots (10 x 17.8 cm)

- Space is required for 18,000 **x** 1.25=22,500 poly pots (to allow for 25 % loss and culling)

- Approximately 115 poly pots cover an area of 1 m^2 when spaced out 22,500/115=196m^2

- Half of these plants require twice as much space, because they will be in the nursery for more than 12 months.
  98 m^2 + (98m^2 x 2) 294 m^2

500 bamboo cuttings

- Space is required for 500 x 1.40=700 poly pots (to allow for 40 % failure in rooting)

- Four cuttings can be planted per square meter
  700/4=175 m^2

- Twice as much space is required because the cuttings spend more than 12 months in the nursery 2x 175=350m^2

2000 stumps

- Space is required for 2000 x 1.25=250 stumps (to allow for 25 % loss and culling)

- Approx 100 stumps cover an area of 1 m^2
  2500/100= 25 m^2

- Twice as much space is required, because the stumps spend more than 12 months in the nursery 25 m^2 x 2=50 m^2

The total area required for the above 4 nursery beds = 806.5 m^2

To allow for paths between beds and for raised beds on slopes up to 2 *%,* multiply by a factor of 1.5 *%.* This means for the main growing area of a nursery, you would need 1,210 m^2.
In addition, space is needed for seed beds, a potting shed, and compost making area, an office and car park. The total area required is likely to be 1700 m^2.

3 Basic Site Requirements

Access roads and paths.

- An all weather road to the nursery should be constructed
- Paths within the nursery should be 60 cm wide to allow for transport, weeding, watering etc

Fencing

- Depending on the site, a 1.5 meter high fence should be built to protect the nursery against browsing and trampling animals.

Shelter for tools, materials and workers

- A simple hut built out of locally available materials is essential for keeping tools and materials and workers dry

Soil dump

- Space should be available for storing the soil, sand, compost etc required for seedling production. These should be close to where the potting mix is to be made and pots filled

Seedbeds

- The soil should be dug and trenched deeply and then formed into beds of uniform level raised 10 to 20 cm high, approximately 1 m wide and 2-5 metres long should be prepared on a well-drained area with a 60 cm path between them. The soil in each bed then should be finely worked, removing all stones etc from the soil.
- Ideally the seedbed should include three layers

  a. Bottom layer *5* cm of gravel
  b. Middle layer 2-3 cm of humus rich soil for holding water
  c. Top layer 2 cm consisting of 1 to 1 mixture of sieved sand and humus rich soil.

Pot beds

- Raised 1 m x 5-10 m pot beds with a 60 cm path between them should be built.
- Frames made of local materials as sawn timber, bamboo should be placed on all sides. If wire mesh/wire netting is available it

should be stretched across the bed so that pots can be placed in it and keep upright.

Shading

- To prevent water loss and excessive build up of heat in seedbeds, containers or pot beds, shade must be provided.
- Shade protects germinating seeds and young seedlings
- Temporary shade for each nursery bed must be built. This is made by placing forked sticks every meter alongside a bed, with light bamboos or other sticks being placed over these sticks lengthwise and across the beds. On top of these sticks are laid coconut fronds which are regulated or removed as required.
- A 50 cm high shade frame can be erected using bamboo or wooden stakes. The shades can be made from bamboo slats, coconut fronds etc.
- Some space should be left between the slats to allow light and air to penetrate.
- Trees should never be planted within a nursery because full light is required for hardening seedlings before planting.

Windbreak

- In areas where there is high prevailing wind, windbreaks of at least two rows of shrubs and one row of fast growing trees on the side of the nursery facing the wind. The trees have to be far enough back so their crowns do not shade the nursery

Compost heaps

- In high rainfall areas, compost is prepared in heaps (1 meter high, 2 meters wide and 2-4 meters long) because pits fill with water.

Seed extraction area

- An area of say 10 m2 should be set aside for drying and extracting seed. The area should be level and receive direct sunlight.

4 Nursery design

Before beginning construction, a sketch plan should be drawn which includes:

- Fencing
- Access paths
- Water storage and distribution
- Seedbeds and pot beds
- Soil storage shelter
- Working area
- Compost heap

The shape of the nursery should be square or rectangular

5 Nursery construction

- Land should be cleared of all vegetation and rocks
- Drains should be built along the top edge and down the sides of the nursery as well as alongside the paths to prevent the paths themselves becoming drains.

6 Tools required for nursery operations

- Pick for braking hard and stony soil
- Hoe for loosening the soil
- Shovel for moving soil, sieving soil and mixing soil
- Flat pronged fork for loosening soil, lifting bare rooted seedlings and turning over compost
- Rake for breaking up and leveling soil
- Sieve for sifting soil for seedbeds and potting e.g. *1.5* cm wire netting fitted to a 1 m by *1.5* m wooden frame
- Funnel for filling pots with soil mixture
- Scoop for filling and compacting soil in pots
- Watering cans for watering seedlings — can be made from bamboo
- Wheelbarrow for transporting potting soil, filled pots , tools, seedlings etc
- Secateurs for pruning roots that grow out of pots
- Bush knife for cutting sticks etc
- Germination tray for germinating small quantities of seed
- Pointed sticks for weeding seedbeds ad potted stocks
- Tools for pricking out — for lifting germinated seedlings into pots e.g. small shovel, flat piece of wood or a spoon.

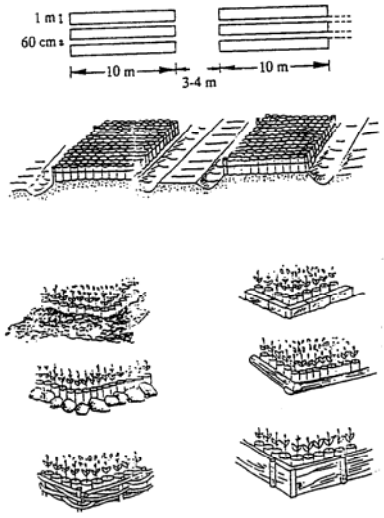


Figure 1.

Normally, potbeds are level with the ground. But in waterlooged areas, they should be raised. Frames can be made of local materials such as stones, bamboo, and sawn timber

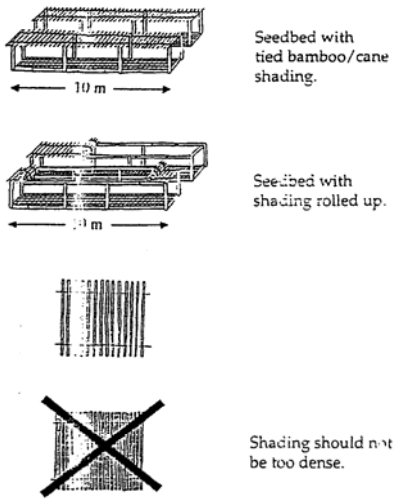


Figure 2.

Potbeds should be shaded to prevent water loss and excessive heat.

SEED HANDLING & SEED COLLECTION

- Seed can be collected locally or obtained from the National Forest Service — tree seed centre in Bulolo or the National Botanical Gardens
- Successful planting is more likely if the seed is:
  - Of a suitable species
  - From an area most closely resembling the planting site
  - Of good quality
  - In sufficient quantity
  - Available at the right time

- Seed if collected locally, should be from healthy and vigorous trees
- Seed should be from ripe fruits

Calculation of the amount of seed required

$$Sw = \frac{1.25\ N}{Pw}$$

Sw	=	seed required in kg
N	=	number of seedlings required for planting
1.25	=	25 % reserve (for filing to germinate, deaths etc)
P	=	germination rate (if known, if not a test is needed)
W	=	number of seeds per kg

Seed extraction and storage

For most species, seeds can be extracted by drying fruits in the sun. Use the following procedure:

- Spread fruits in thin layers on pieces of canvas or trays
- Stir regularly until cones, pods or capsules open and release their seed
- Remove the pulp of fleshy fruits before drying and then separate by winnowing or submerging in water
- Dry seeds in the sun
- Store seeds in a cool, dry, well ventilated and dark place with maintaining storage temperatures as constant as possible
- Some seeds which are moisture sensitive need to be stored in airtight containers
- Other seeds can be stored in wooden boxes or cotton sacks

RAISING SEEDLINGS IN CONTAINERS

Seed pretreatment

Some seeds require pre treatment. Depending on the species (see species fact sheets) the following pre treatments are recommended

Tap water

- Soak seeds in tap water for 12-48 hours before sowing

Boiling water

- Place seeds in cloth bags or used cotton socks, then dip in boiling water (5-10 parts of water to 1 part of seed) and use a stick, stir for 3-15 seconds.

Hot water

- Pour hot water that has been boiled and then cooled for *10-15* minutes into a container in which seeds are places. (10 parts water to 1 part seeds). Let stand for 3-10 minutes or until water has cooled to room temperature. Let seeds soak overnight.

Mechanical scarification

- Nick off seed coat using a knife
- Sandpaper or a file can also be used to roughen the surface of the seed coat.

Sowing seeds

- Seeds can be sown directly into pots or seedbeds/seed trays depending on the species.
- Seedbeds/seed trays should be used when seed viability is low (less than 40 %); germination takes a long time, seeds are very small or seeds are very scarce or expensive
- For sowing seeds in pots, two or more seeds are placed in each pot
- For sowing in seedbeds, it is recommended that seeds be put in rills running across the bed, making weeding easier.
- In both cases, seeds should be placed at a depth equal to one to two times their diameter.
- Watering should be done using cans with fine nozzles
- The time of sowing is determined by calculating the time it takes for germination to take place and the time required for seedlings to reach the size and quality suitable for planting at the beginning of the rainy season. E.g. for a species that requires 2 weeks to geminate and 12 weeks to reach out planting size, seed should be sown 14 weeks

before the start of the rainy season.

Pots

- The most commonly used containers are plastic bags. They are available in different sizes and holes in the bottom of the bag for drainage. (if no holes use a simple office puncher to make drainage holes)

Potting mixture

- The potting mixture generally consists of 30 % sandy loam, 40 % river sand and 10 % organic matter by volume. A chemical fertilizer as NPK (12:24:12) can be added to the potting mixture.

Making compost

Compost can be made from almost any organic matter such as weeds, litter, crop residues, animal manure etc. In heavy rainfall areas it is better to make it in a heap. The height should be 1 to 2 metres

- The bottom layer should consist of old branches, rocks etc to ensure good aeration
- Alternate 20-30 cm layers of organic matter and good loamy soil are then added
- Cover the heap with a large plastic sheet to keep it moist but not too wet
- The heap should be turned after 2 -4 weeks
- Water the heap from time to time to keep it moist

Filling pots

- Pots can be filled by hand or with a funnel
- When filling the pots, the lower third of the pot should be compacted firmly to prevent the mixture from falling out.
- The upper two thirds of the mixture should only be compacted a little so that roots can easily penetrate

Transplanting to pots

- When seedlings have developed a first pair of true leaves, they should be pricked out from seed trays and planted in pots

- Before pricking out, seed trays and pots should be well watered
- Seedlings should be lifted with a trowel or flat piece of wood
- To prevent seedlings from drying out, work should be done under shade and seedlings kept moist
- Dibble holes should be wide and deep enough so that the roots will not bend. Holes can be closed by gently pressing the soil around the plant with fingers
- Plants should then be watered and placed in a shaded area in an upright position

Care and Tending of Seedlings

Shading

- Initially, seedlings should be in about 50 % shade.
- They should be gradually exposed to higher and finally full sunlight some 2-3 weeks prior to planting

Watering

- If the upper part of the containers are dry, they should be well watered in the mornings using a fine spray
- To induce hardening off, watering should be gradually reduced 1 week or so prior to planting out.

Weeding

- Careful manual weeding is recommended rather than using herbicides

Grading beds

- To prevent larger seedlings from shading smaller ones, seedlings should be constantly graded. The larger seedlings should be placed at one end and the smaller seedlings at the other end of the bed.

Pests and fungi control

- In nurseries, damping off and root rot are common diseases caused by fungi.

- Dampening off causes seedlings to look pale and weak, finally collapsing at the rot collar.

- Dampening off can be prevented by

  - Changing the soil in the seedbeds every two to three years
  - Remove plants immediately if they are affected by fungi or attacked by pests
  - Avoid excessive watering
  - Allow for good drainage
  - Ensure good air circulation
  - Weeding
  - Thinning seedlings in the bed
  - Reduce nitrogen content of fertilizer i.e. less manure/and less fertilizer
  - Use coconut husk as a potting medium

- If the nursery receives a fungal attack, fungicides as bitox or dithane can be used *(25* g fungicide to 5 litres of water). It is applied with a sprayer twice a week

Root pruning

- If potted seedlings are placed on plastic sheets, root pruning may not be necessary. However the plastic may become too hot for the seedlings during the day
- If the pots are placed in wire mesh and are standing on bare soil, it is necessary to regularly prune the roots coming out of the drainage holes.

Preparation for planting out

Hardening

- Remove seedlings from shaded area two to three weeks prior to planting out
- Prune roots
- Reduce the amount of watering 1 week before planting out

- Do not apply fertilizer in final stages before planting out

Culling

- Plants should be sorted according to their suitability for planting out
- Good seedlings have
- A shoot one to two times the length of the root (pot)
- A sturdy woody stem with a strong root collar
- A symmetrical dense crown
- A dense root system
- A healthy green colour unaffected by insect or fungal attack

Packaging and transport

- Water seedlings well before transportation
- Pack in wooden or plastic boxes
- Do not pack loosely
- Avoid any wind damage during transportation
- At planting site, place seedlings in a shaded area until planting together with watering them each day until planted.

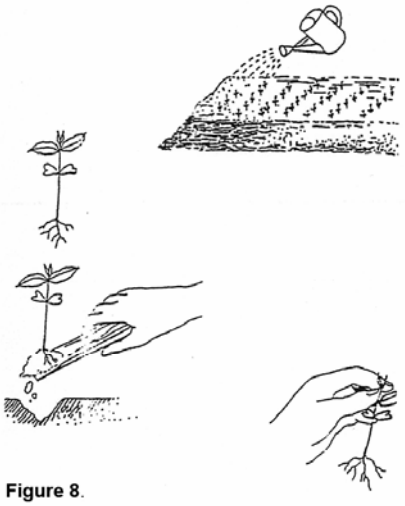


Figure 8.
When seedlings are ready to be planted into pots, water the seedbed and lift the plants with a small shovel of a flat peice of wood.
Do NOT touch the roots!

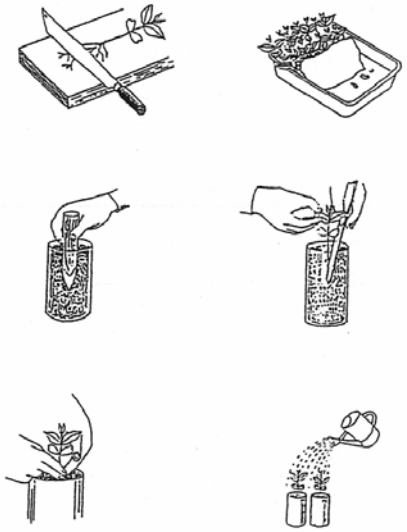


Figure 9.
Potting involves root pruning, keeping the seedlings under moist cover, makng a dibble hole that is the right size for placing the seedlings upright in the dibble hole, and firming the potting medium around it before its being watered.

Figure 10.
Roots of seedlings should be pruned regularly if containers stand on bare earth.

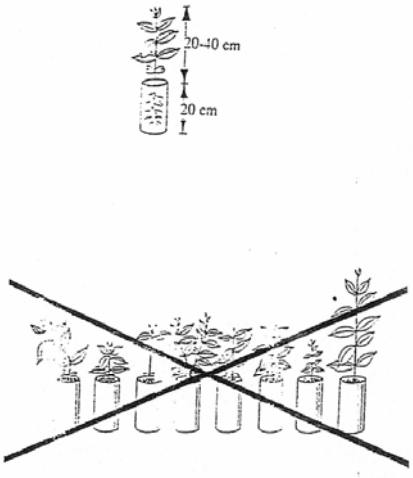


Figure 11.
Plants should be sorted according to their suitability for outplanting. a good seedling (top drawing) has a shoot twice as long as its taproot. The ones in the bottom drawing are not good for outplanting.

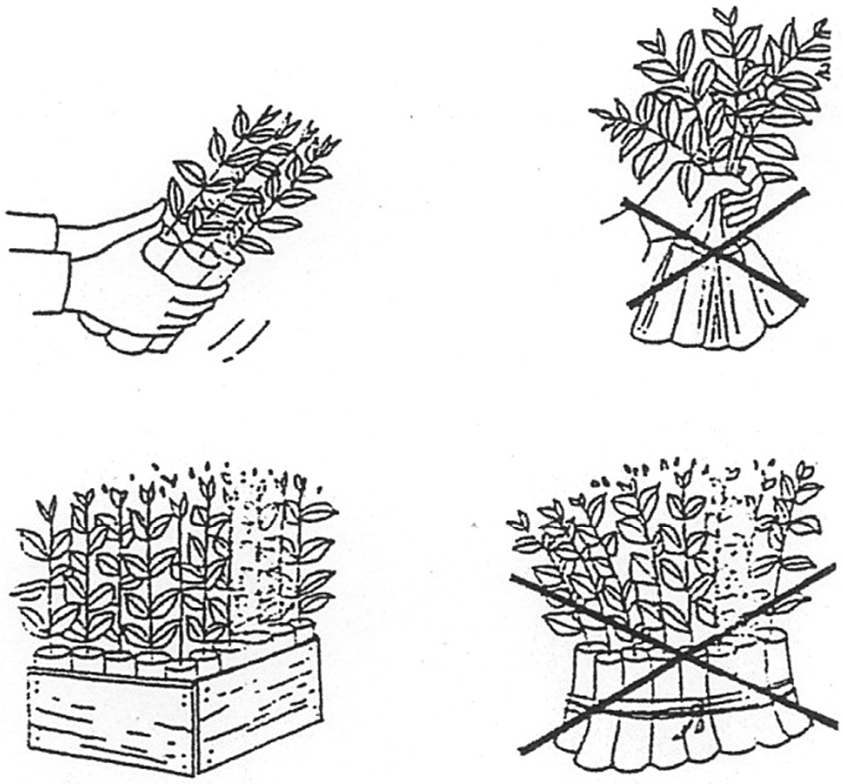


Figure 12.

To avoid damage during transportation, seedlings should not be packed too loosely, or carried by theri stems.

OTHER METHODS OF PLANT PROPAGATION

BARE ROOTED SEEDLINGS

These are seedlings raised without the use of any type of container E.g. cassia, gmelina, spp. In producing bare rooted seedlings, remember

- Soil — as the seedlings grow directly in the nursery soil, soil quality is critical

- Bare rooted seedlings require a larger nursery area from sowing and in the transplant beds there are 50 to 100 plants per m2 of bed area e.g. plants are 5-10 cm apart and rows are 20-25 cm apart. Plants are transplanted from seed beds into main beds when they are approx 6-8 cm high and with a tap root 4-6 cm long. Again use a dibble stick to transplant seedlings

- Root pruning — use a wire pulled horizontally 20 cm below the bed to cut tap roots
  Lateral roots are cut using a sharp spade

- Root pruning may need to be done every 6 weeks

- Lifting - use a spade or fork inserted vertically some 10 cm from the plant and pushed deep enough to lift the entire root system of the plant

- Packing — after grading and root pruning, seedling s should be packed such that roots are well protected against drying. Sacks, banana leaves etc can be used

STUMPS

Stumps are seedlings that have had most of their shoots and side roots removed so that only a 20-25 cm length is left. Species as teak, rosewood, and gmelina are propagated by stumps

To produce stumps;

- Grow bare rooted seedlings until shoots are 60-90 cm high

- Lift seedlings and cut shoots 2-5 cm above the root collar

- Trim tap root and side roots

- Dip into a mud puddle, bundle and wrap in material as a banana leaf

VEGETATIVE PROPAGATION

• Vegetative propagation is the production of new plants with

• There are many different methods of vegetative propagation including rooting cuttings, grafting, budding, air layering, planting tubers, planting suckers, separating plants and tissue culture.

• Tree species vary greatly in their ability to be propagated vegetative.

A number of key processes need to be followed to produce rooted cuttings:

Cutting hedges

• To produce rooted cuttings you first need to collect shoot material from plants specifically grown for this purpose (called mother plants) or in pots close to the nursery and village. These mother plants should be cut back regularly and are called hedges.
• For a large nursery, an area is normally set aside in which the mother plants are established in hedges (or orchards) regularly pruned and provided with moderate shade from trees as leucana. Care must be taken not to over shade the hedges or compete with them for water and nutrients.
• In general the size of a hedge to the planting area is in the ration of 1:100 i.e. a hedge area of mother plants of 1 hectare will produce enough cuttings to plant 100 hectares.

Preparation of Cuttings

- The type of cutting material used is critical to rooting success. The most suitable material varies between species and needs to be tested carefully. Some species root better using soft stems and tips whereas other species will root only from woody stems.

- It is necessary to reduce the leaf area by removal and trimming to limit transpiration

- In general, the following steps should be followed for producing rooted hardwood cuttings:

    - Prepare cuttings in the morning

    - Cut shoots into lengths of *12-25* cm using pruning shears. There should be one to two pairs of leaves on each section that is cut.

    - Place harvested shoots in a bucket of water, making sure that their bases are completely covered.

    - Reduce leaf area by cutting the leaves in half

- Dip the bases of the shoots in a rooting hormone (if available) such as indole butyric acid (IBA) at 500ppm. (These can be purchased as a prepared powder or gel.

- The use of rooting hormones with species as *Eucalyptus camaldulensis* (red gum), Acacia *mangium* and *Acacia auriculformis* greatly assists in setting their cuttings.

- Root cuttings in poly pots or in previously prepared beds. The potting mixture should be sandy loam or a loamy soil (i.e. a soil that contains at least *50 5* sand)

- The beds and/or pots must be placed in areas of high humidity, reduced sunlight, constant temperatures and protection from wind, rain pests and diseases.

- Plants can be kept moist using simple misting techniques under shade shelters.

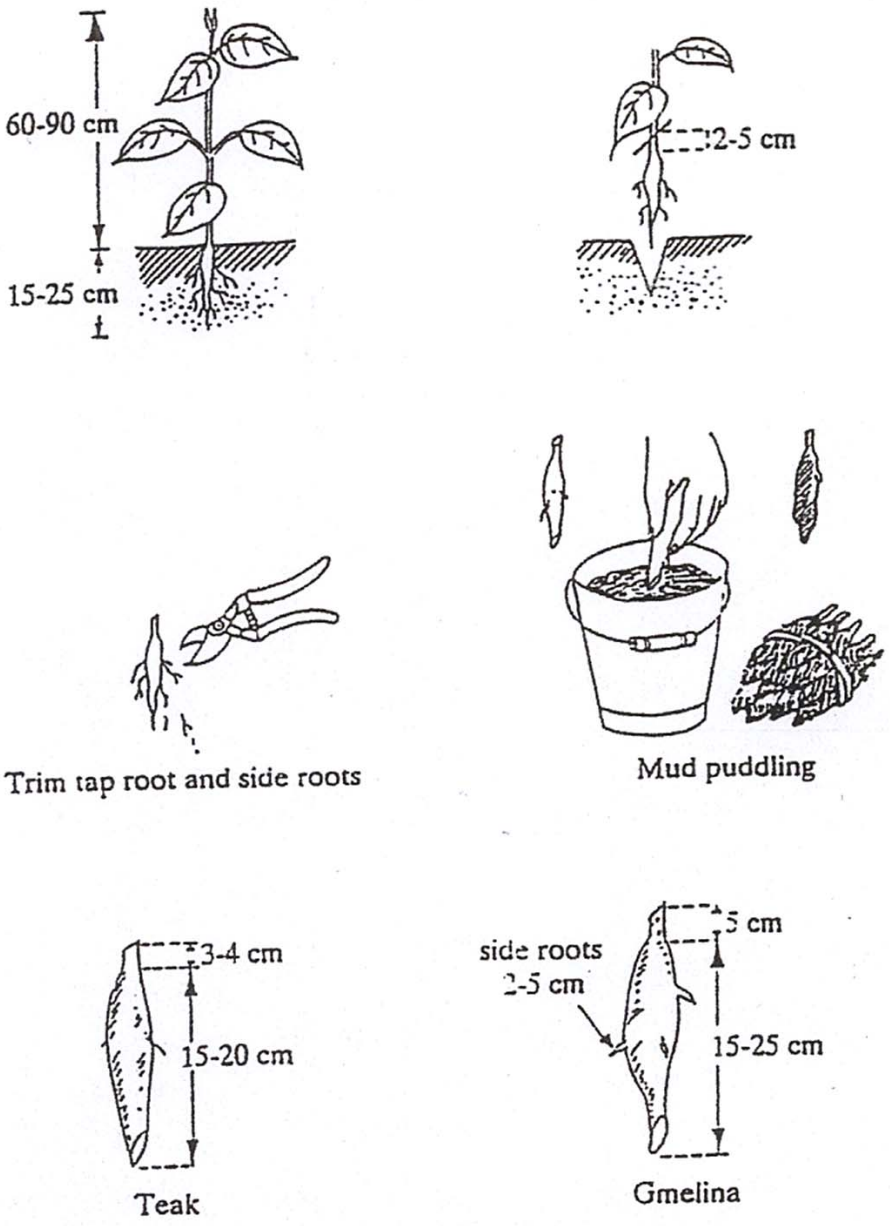


Figure 14.

For some broadleaved species, the use of stumps is an effective propagation technique.

NITROGEN FIXING ORGANSISMS AND MYCHORRIIIZAL FUNGI

Nitrogen fixation

- Tropical soils, especially those in grassland, tend to have poor fertility. This makes for poor seedling growth and high mortality in the field.

- Nitrogen fixing organisms such as *Rhizobia* and other microbes can enhance growth in seedlings of leguminous species.

- The reason is nitrogen-fixation by the organisms into ammonia that the plant can use for its growth. The organism forms root nodules with the plant from which it converts atmospheric nitrogen into ammonia.

- It is important to remember that if a leguminous tree species is introduced into a region, it may not find the soil organism needed to allow it to grow vigorously.

- The way in which nitrogen fixing organisms can be introduced to the plant is by collecting soil from under trees of the leguminous species that are growing well because the organisms are present there and mixing that soil with the nursery soil that is to be used to grow those seedlings.

Mycorrhizae

- The same principles of soil inoculation also apply to mychorrhizae. These are fungal type soil micro-organisms that live in as symbiotic relationship with the roots of nearly all coniferous and broad leafed trees.

- The roots supply energy in the form of excess carbohydrates and other foods for the fungi. In return, the fungus supplies soil nutrients to the tree, especially phosphorus.

- As with nitrogen fixation, the most frequently used method for ensuring mychorrhizal activity in tree roots is to use local forest soils rich in mychorrhizae.

NURSERY MANAGEMENT

Operational plan

- An operational plan is essential because all aspects of running a nursery are closely interrelated.
- The operational plan must specify the resources that are needed. These are:
    - Infrastructure — sheds, shelters, roads, paths, fencing, water supply etc
    - Tools and equipment
    - Supplies e.g. soil, compost, fertilizer, poly bags etc. The quantities of poly pots, sand, soil and organic matter that are required must be estimated. Arrangements must be made to make sure these are available at the time of the year they are needed
    - Labour — permanent and temporary
    - Seed supplies - seed acquisition must be carefully planned. The quantity of seed required must be calculated, sources identified, arrangements made for collection and costs estimated

Production schedule

Since the deadline in the planting season (i.e. the start of the wet), planning for nursery activities has to start from that time and work backwards, as follows.

- Date of planting _____
- Minus number of days needed for growing from pricking size to planting size (depends on species) _____
- Minus number of days from sowing to germination _____
- Equals sowing date _____

A calendar showing the duration of these stages for each important species is helpful and can be obtained from the Botanical Gardens or the NFS.

Labour

- Trained and reliable labour is essential for a successful nursery operation
- Sowing, pricking, culling, preparing soil mixes requires some experience and skill. Filing pots can be done by workers with less experience.

Record keeping

- Record keeping is essential in the nursery for things such as:
  - Date of sowing of seed and number of seed
  - Germinative capacity of different batches and species of seed
  - Date of setting of cuttings and number of cuttings
  - Date of transplanting of seedling batches and number of seedlings transplanted
  - Dates of watering, weeding, culling and lifting
  - Date when planted out, number of seedlings planted out and location of plants when planted out

Raising Plants from Seed

This is a general guide to a method of propagation that is successful for many native and introduced plants. Some variations, particularly with soil mixes, may also prove successful.

Seed collection

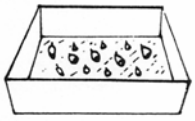
The seed of woody plants is found in seed cases such as gumnuts, wattle pods and pine cones.

These seed cases must be collected before they open. For most species the best time is early summer. Most nuts, pods or cases are brown when ripe. If green, the seed may still be immature.

Collect and identify seed cases

Seed extraction

Seed can be extracted by gentle warmth. Seed cases left in a paper bag or wooden tray in a warm position will open in a week or so. Do not dry the seed cases in metal containers exposed to the sun as the seed may be damaged by high temperatures.



Spread seed cases to dry and collect seeds

Seed storage

The seed can be cleaned by sieving and gently winnowing in a light breeze. Place the seed in a container with a tight lid and store in a cool, dark place.

Store seed in sealed containers in a cool, dark place

Seed treatment

Certain seeds need treatment before sowing. Seeds with hard, waxy seed coats such as species of *Acacia, Cassia* and *Hardenbergia* require treating by pouring boiling water over the seed and leaving to soak overnight. When the seeds are swollen they are ready to sow. Retreatment of the non-swollen seed may be necessary. Some cold climate species, such as snow gum, should be refrigerated at 2-4° for 6 to 12 weeks.

Sowing the seed

Spring is generally the best time to sow seed.

Soil

A suitable soil mix comprises:

4 parts coarse sand 1 part peat moss 1 part loam

Thoroughly mix the soil before use.

Containers

Containers for seed sowing must have adequate drainage holes in their bases. A 12 cm pot can be used to raise up to 20 seedlings. A 30 cm x 50 cm seed box will provide space for several hundred seedlings.

Sowing

Level and firm the soil surface and scatter the seed evenly. Mixing the seed with fine dry sand will aid even distribution. Cover the seed to a depth of no more than twice its diameter with fine sieved soil.

Sow seeds evenly

Tending

Keep the seed bed moist but not wet. Water with a fine rose spray. The box should be placed in a warm, shaded area. It may be covered with glass or hessian to prevent disturbance. The cover should be removed when the seedlings appear. The shade can be reduced gradually as the seedlings develop.

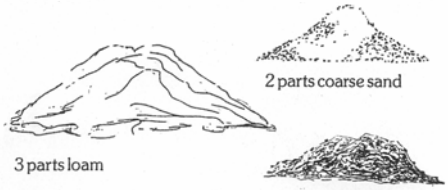
Keep seedlings moist

Transplanting

When the seedlings develop four leaves or are 3-5 cm high, they should be transplanted into individual containers.

Seedlings ready for transplanting

Soil
A suitable soil mix comprises:



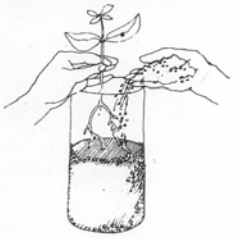
2 parts coarse sand

3 parts loam

1 part well-drained animal manure or compost

Containers
Tubes 4-5 cm in diameter and 15 cm high are recommended. Tubes can be rolled from wood veneer and tied with rubber bands or stapled.

Transplanting
Slide a flat trowel along the bottom of the seed box and carefully lift the seedling with roots intact. Quarter fill the tube with soil and tap firm. Hold the seedling gently with the roots hanging free and fill in the soil around the roots. Tap the tube firmly on the bench to settle the soil. Fill with soil to within 1 cm of top of tube.



Gently hold seedling, fill in soil around roots

Tending
Place the plants in a shady place, such as under trees or in a shade house, and keep them well watered. The shade can be gradually reduced. The plants should be hardened off at the end of the growing season by removing all shade and reducing the amount of water they are given.

Fertilising
If the plants are tardy in growth and of poor colour, the application of fertiliser is recommended. A soluble fertiliser may be applied regularly or a slow-release fertiliser can be added to the soil mix.

Planting out

The seedlings are best planted out during winter and early spring. Soil should be well worked up and grass competition removed around the planting site. Plants 20 to 30 cm high are ideal for planting and will often outgrow larger plants.

Plants 20-30 cm tall are ideal for planting

Growing on

Seedlings can be transferred to larger containers for growing on. The same soil mixture as used for transplanting will be suitable.

Further Information

Visit our web site at: www.fiapng.com

Manual prepared by:

McCARTHY & ASSOCIATES (FORESTRY) PTY **LTD**
National & International Forest Consultants

RICHARD B. McCARTHY
Managing Director
B.Sc. (Forestry) M.Sc. (For. Man.) M.I.F.A. M CF.A.

11 Jessie St. Westgarth
Melbourne, Victoria 3070
Australia.

Phone: (03) 9481 1398
Fax: (03) 9481 1398
Email: rbmccarthy©bigpond.com.au