FRUIT TREE NURSERY
ESTABLISHMENT AND MANAGEMENT

A Training Manual

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ICRAF 2003
SELECTION OF SUITABLE FRUIT TREES

1. Introduction

There are many different types of fruit trees grown in different areas in this country. Deciduous or temperate fruits (peaches, apples, plums etc) are found growing in the colder parts of the country. Tropical and subtropical fruits (mangoes, avocado pears, lemons, oranges bananas) are grown in the warmer parts of the country.

The success of growing any fruit crops in any one area will depend on a number of factors described in the following section.

2. Factors affecting selection of fruit trees for planting

Any individual grower who plans to establish an orchard should think about all the factors affecting growth of fruit trees before choosing varieties to grow.

The major factors affecting selection of fruit trees are discussed below;

Soil

A good soil should support the tree and should drain well. It should also have organic matter and should respond well to fertilizer and manure.

Climate

Deciduous or temperate fruits grow well in cool climates.
Tropical fruits grow well in warmer climates.

Different climates will support the production of different fruits.

Water

The availability of water is an important factor to consider in growing fruit trees.
The total amount of water a tree receives will affect its cropping and fruit quality.

Irrigation is necessary in the dry seasons and during drought.

Planting material

It is important to plant varieties suitable for your particular area.
It is also important to have healthy planting material – the success of the orchard depends on this.

Market

For commercial purposes, this is very important.
A grower should be able to satisfy the demands of the market.

Question

Where can you successfully grow

1. Masawu ____________________________
2. Mazhanje ____________________________
3. Apples ____________________________
4. Oranges ____________________________
5. Mangoes ____________________________

Can you explain why?
THE NURSERY

The nursery is a place where plants are raised with special care until they are ready or large enough for transplanting into the field.

Every nurseryman should aim at producing healthy uniform plants that will be able to establish in the field quickly. For commercial purposes it is important to consider some of the following factors;

Site selection
1. A good transport network must be available for easy transportation of inputs and plants
2. The area should be level and protected from wind.
3. The land must be reasonably well drained to avoid problems that arise from water logging.
4. The site must be free of stones.
5. Should have a nearby reliable source of water.
6. Should be fertile.
7. Sites with well-drained soils, which are free from diseases should be selected.

Propagation section
1. The propagation area should provide correct growing conditions for the seedlings and plants.
2. Every plant must be easily accessible for daily operations.
3. Plants must be able to be moved easily.

Planning
1. There should be adequate store and tool sheds.
2. Hardening sheds should be near the propagation area.
3. Potting benches should be well positioned.
4. Every nursery should have a media preparation area.
5. Fencing is required to protect the nursery from animals and to minimize unauthorized entry.
6. High quality material should be used in constructing nursery structures.
7. Footbaths should be placed at entrances to all propagation sites and facilities.

Questions
1. What is a nursery?
2. What factors are important to consider when selecting a site to establish a nursery?
NURSERY FACILITIES

Nursery Design and Layout
In the design of a commercial nursery, all the necessary structures and other facilities are arranged to ensure a constant flow of activities. The layout of the nursery depends on:
- Climatic and environmental conditions.
- The type of scheme in operation.
- The type of propagation structures in use.
- The resources available.
- Other factors unique to each individual situation.

The figure below is a ground plan of a simple commercial nursery showing some of the major structures and facilities.
STOCKPLANTS

The nursery plants from which material for propagation is obtained are called stockplants. Material for propagation includes cuttings, suckers and budwood for grafting and budding. By establishing stockplants near the propagation area, a nurseryman will be able to supply enough and the right type of material needed in other processes.

Stockplants are required for
1. producing many shoots quickly in order to get plenty of cuttings.
2. to reduce the need to travel.
3. to have them near so that cuttings can be collected and set on the same day.
4. for easier protection.
5. planning and management of operations is easier

STOCKPLANT MANAGEMENT

Stockplant pruning
Stockplants need pruning to keep them producing shoots.

Stockplant watering
Stockplants need water
   1. to ensure rapid and successful establishment
   2. to encourage them to grow quickly and produce more cuttings
   3. to enable them to produce cuttings all year round

Stockplant nutrition
Trees need nutrients or food to support fast growth. Rapid growth is desirable for
   1. production of plenty of shoots to give good cuttings
   2. to replace nutrients lost by pruning

Nutrients are supplied by mulching, interplanting with nitrogen fixing plants and application of fertilizer and manure.

Questions
1. What are stockplants?

2. What do stockplants require for the production of good propagation material?

3. Why are stockplants important?
NURSERY SUBSTRATES

Good nursery plant growth and development requires a soil substrate that may consist of several components such as site soil, forest soil, sand, well composted organic matter or certain materials like sawdust or vermiculite that may enhance the quality of the mixture.

Characteristics of a good substrate

A good nursery substrate has the following properties;
- It is light in weight to facilitate transport
- It holds cuttings and seedlings in place and does not shrink or swell in a way that damages the plant.
- It has a good water drainage capacity
- It retains water but allows proper drainage and aeration of the roots
- It contains the necessary nutrients to allow plant growth and development.
- It does not contain pathogens (weed seeds, fungi, bacteria, insects) and can eventually be sterilized without changing its characteristics.

Such substrate is usually a mixture of site or forest soil, well-decomposed organic matter and some other material that will enhance its physical characteristics. As a rule of thumb the following ratios can be proposed;

For heavy soils; 1 soil: 2 sand: 2 well decomposed organic matter
For medium textured soils 1 soil: 1 sand:1 well decomposed organic matter
For light textured soils 1 soil: 0 sand: 1 well decomposed organic matter

NURSERY TOOLS

The tools used in the nursery should be simple but of good quality. Sometimes it is worth spending a bit more on their purchase than having to replace low quality tools. Their proper maintenance is one of the main activities of a good nurseryman. Knives, secateurs etc should be kept clean and sharpened at all times.

It is also important that the tool handles are not too big or too small and that they are made from smooth material so that the nursery workers can work more comfortably and injuries minimized.

Watering cans or hoses with nozzles or sprinklers should be used to apply water evenly to the plants.
Below is a list of the basic equipment needed for a standard nursery

<table>
<thead>
<tr>
<th>NURSERY TOOLS</th>
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<td>For working the soil</td>
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<td>Hoe</td>
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<td>Shovel</td>
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<td>Fork</td>
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<td>For layout</td>
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<td>For soil preparation</td>
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<td>Sieve</td>
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<tbody>
<tr>
<td>For watering</td>
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<td>Watering cans or nozzles</td>
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<td>Watering hose with nozzle</td>
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<tr>
<td>For transport</td>
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<td>Wheelbarrow</td>
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<tr>
<td>For tending the seedlings</td>
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<td>Pruning knife</td>
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<td>Trowel</td>
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<tr>
<td>Secateur / pruning shears</td>
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<td>Knife</td>
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<td>Pointed wooden stick</td>
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COMMON PROBLEMS IN THE NURSERIES

The goal of a good nurseryman is the timely and cost effective production of healthy uniform plants that will be able to get established in the field quickly. Very often this goal is not met for a number of reasons.

The factors listed below could be some of the reasons;
- Lack of reliable water supply
- Delays in supplies e.g. chemicals, tools etc
- Insufficient nursery hygiene
- Inadequate planning

Some of the problems are infrastructure related and can only be alleviated with substantial financial and labour inputs, most of them however are simple management related problems that can be taken care of with a few changed routines.

NURSERY MANAGEMENT

Quality planting material requires quality nursery management! Most people neglect this very important fact. Quality seedling production is necessary for quality tree production. Planting material produced under poor conditions will never perform too well when they are established in the field.

Common Problems in Tree Nurseries

The goal of a good nurseryman is the timely and cost efficient production of healthy, uniform plants with a strong and fibrous root system that will enable the plant to get established quickly in the field. However this goal is not reached for a number of reasons.

Below are some of the problems encountered by nurseryman during seedling production;
- Lack of reliable water supply
- Low quality equipment
- Poor potting soil
- Insufficient nursery hygiene (fungi, bacteria, insect attacks)
- Inadequate planning

The Table below lists some possible reasons for poor plant development

<table>
<thead>
<tr>
<th>Cause of poor plant development</th>
<th>Suggested solutions</th>
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</thead>
<tbody>
<tr>
<td>Inadequate light conditions</td>
<td>1. Protect young plants from direct sunlight with light shade  2. Gradually reduce shade before putting plants into the open for hardening off. 3. Plant at low enough density to allow for enough light in the propagation bed.</td>
</tr>
<tr>
<td>Inadequate watering</td>
<td>1. Water early in the morning or late in the evening to avoid burning the plants. 2. Water the roots in the pots and not the plants. 3. Use a nozzle or water pressure that is low enough not to spill soil out of the pots. 4. Ensure good drainage of the containers.</td>
</tr>
<tr>
<td>Overgrown plants</td>
<td>1. Ensure that nursery plants are graded into 3 groups, first quality, second quality and rejects. 2. Only plant out or distribute the first and second groups.</td>
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Planning

Proper planning is essential; for successful nursery operation. When plants are needed at a specific time, all nursery operations need to be timed taking this delivery period into account. If the number of plants required is known, the amount of seeds or other planting stock, as well as the amount of nursery substrate can be calculated and planned for.

Timing

The most crucial event determining the right time for planting out is the availability of sufficient moisture. Unless irrigation facilities are available, this is usually at the onset of a rainy season.

Another point for consideration is the use of seedlings or vegetative material. Cuttings often require less time in the nursery until they have the sufficient growth.

Feedback

Many times the trees leave the nursery manage cannot follow up on their further development. However, nurserymen need to have more interaction with the persons who are using the trees so that they can see for themselves how the trees are performing in the field.

Questions

1. What are the most common problems in tree nurseries?

2. How can these problems be solved?

3. What are the causes for poor plant development?

4. Describe a good substrate

5. What can you use in preparing a good substrate?
6. What are the other things necessary for running a good nursery?
PROPAGATION OF TREES

There are 2 major methods used for propagating trees.

1. Vegetative or asexual means
2. Seed or sexual methods

1. Vegetative propagation

Vegetative propagation refers to the propagation of new plants directly from existing ones and not from the seeds. There are many different methods used in vegetative propagation. Some advantages of vegetative propagation are;

- To get trees with desired properties quickly
- To get trees to mature and fruit quickly

Grafting or budding

This involves the joining of a piece of stem of bud (the scion) to another plant (the rootstock) to provide root systems for detached pieces from a selected plant. Grafting and budding may be done for the following reasons;

- To propagate tree varieties that cannot be readily propagated by other means as cuttings or layers.
- Obtaining the benefits of the rootstock
- Changing the cultivars of existing plants
- Hastening the reproductive maturity of a plant
- Repairing damaged parts of trees

Scion

This is a short piece of the shoot containing several dormant buds which when united to the rootstock will comprise the upper part of a grafted tree.

Rootstock

This is the lower part of the graft, which develops into the root system of the grafted tree.

Layering

This is a propagation method where roots are caused to form on a stem whilst the stem is still attached to the parent plant. The rooted stem is then detached to become an independent plant growing on its own roots. Layering is mainly used for the following

- Propagation of plants whose cuttings do not root easily
- Production of large sized plants in a short time
- Production of plants with the minimum propagation facilities
- Production of plants that reproduce naturally by layering (blackberries, black raspberries)

Rooting of Cuttings

This is usually done by encouraging roots to form on a piece of stem. The rooted cutting will later become an independent plant. Cuttings can either be softwood or hardwood. Softwood cuttings are taken from softer shoots; these dry up faster and they need to be kept in a humid poly propagator or under mist until they root and can take up sufficient water.

Hardwood cuttings or leafless cuttings are larger and of firmer wood, they do not dry up fast and can survive in moist soil till roots are formed. It is easier to root leafless cuttings. Pieces of stems are just pushed into holes dug in the ground, preferably in moist lightly shaded conditions. If necessary, coarse sand, sawdust or vermiculite may be worked into the soil to improve rooting and simple temporary shading could be placed over them in hot dry weather.
Quick; rooting of cuttings depends on several factors, the following factors are important

1. Turgid cuttings root better than wilted cuttings.
2. Rooting media must be moisture retaining but open and well drained.
3. Most cuttings root more quickly when given bottom heat.
4. Shade to reduce transpiration until rooting begins.
5. Use rooting hormones and tree sealants.

Making and Inserting the cutting

1. Use sharp tools.
2. Two thirds of the cutting to be inserted into the media.
3. Bottom of cuttings to be cut flat and the top to be cut at an angle.
4. Water every time, mist irrigation most suitable.
5. When the cuttings have rooted (as indicated by shoots elongating) they must be transplanted to nursery media in pots for further development before they are transplanted to their final place.

Seed Sowing

1. Use sterile soil or media in trays, pockets, or seedbeds.
2. The trays or pockets must be filled and leveled
3. Lines should be marked in trays and seedbeds and the seeds should be sown thinly.
4. If the seed is too small, mix it with an amount of fine sand to ensure even distribution.
5. Cover seed lightly but do not use very fine compost as this might cause caking surface.
6. Water the trays, pockets or beds
7. You can cover the trays, pockets or beds with grass mulch.
8. Great care must be taken when watering.
9. Use a fine rose
10. As seedlings begin to appear, remove grass covering.

Pricking out seedlings
Pricking out involves moving seedlings from a seedbed or containers where they have germinated in large numbers. The purpose of this operation is to have seedlings grow singly per container. This helps to produce healthy seedlings that grow vigorously because of the removal of competition. This operation has to be carried out under shade or in overcast weather conditions.

1. As seedlings grow large in seedbeds, pockets or trays they should be pricked out into larger pots in order to develop well.
2. If delayed, plants become over crowded and lose vigour.
3. Seedlings are transplanted or pricked when the first 2 leaves are open.
4. Seedbed and pots should be thoroughly watered the day before pricking out to facilitate the operation.
5. Seedlings are lifted with a flat piece of wood or a planting trowel. Only healthy, well-developed seedlings are pricked out and unsatisfactory ones are discarded.
6. Always hold the seedlings by their leaves and never by their stems, which are delicate.
7. In case of long roots they are cut using your fingernails or a sharp knife.
8. Use a stick to make a hole in the soil in the receiving containers.

Make the holes deep enough and wide enough to accommodate the roots. The roots should not be bent or point upwards. The hole is closed gently by pressing the soil around the plant with a finger. Do not leave air space around the roots. Water the plants and shade them immediately after transplanting.
Questions

1. What is vegetative propagation?

2. What are the advantages of using vegetative propagation over propagation using seed?

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<tr>
<th>Seed</th>
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3. Name the different methods of propagating trees.

4. Explain the following

Scion

Rootstock

5. Which method would you use for propagating the following trees?

Gum trees

Mango trees

Mazhanje trees

Matamba

Bananas

Oranges

Mawuyu

Masawu

6. Draw a diagram to illustrate how you make a good cutting
ROUTINE NURSERY OPERATIONS

1. Potting
   1. The nurseryman has the choice of raising his plants in any type of pots and sizes.
   2. Size of the plant before field planting is also important.
   3. Too small pots result in plants being root-bound.
   4. Moisten the pot and fill the pot, top it on the bench or ground to settle the pot mix.
   5. Place the plant at the right depth in the new pot.

3. Watering
   Water is important for seed germination and plant growth.
   Seedlings raised in contains are watered using watering cans, tins or buckets. The water used should be clean. Impure or dirty water may cause toxicity, extreme pH changes, poor drainage and aeration, which can have adverse effects on plant growth and development. Frequency of watering will depend on the prevailing weather and soil conditions. Generally in the initial stages of growth plants need to be watered 2-3 times a day. As the plants grow the frequency is gradually reduced as plants get prepared for field conditions.
   1. Amounts of water vary with stage of development and time of the year and type of pot.
   2. It's equally harmful to over water as it is just harmful; to allow a plant to wilt.
   3. Quality of the marketable plant is largely determined by the way it has been watered.

3. Feeding
   1. A good pot mix should feed the potted plant without the need to supplement
   2. Gross feeders and plants, which stay in the pots for longer periods may exhaust nutrient in pots and supplementary nutrients, must be added.
   3. Some nutrients also lost through leaching because plants are watered from the top.
   4. Plants in small pots are starved earlier than those in big pots, so they tend to need more feeding.
   5. It is cheap to apply liquid feed as opposed to granular fertilizers.

4. Root Pruning
   Root pruning is the removal of roots that have grown out of the pot and into the ground. This is done to avoid seedlings establishing themselves permanently in the nursery since they still have to be planted out in the field.

Pruning methods
Lifting
Pots or containers are lifted and put back in their original position. This is called shocking.
Cutting / shearing
This can be done using secateurs, sharp knife or a pair of scissors. Pots are lifted and protruding roots are cut off using one of the above listed tools.
Trowel / spade method
The trowel or spade is moved underneath the containers or pots to break the roots that have grown into the ground.
Wire method
Where there are large numbers of seedlings properly arranged in standard beds a wire can be used. The wire is passed under the pots and moved along the whole arrangement.
Hard surface / plastic surface
When a hard surface such as concrete slab or plastic is used surface roots cannot penetrate into the ground.
**Suspended nursery**
The containers are placed on a suspended platform. In this case roots that grow out of the pot and are suspended in the air will automatically die off because of lack of a growing medium.

**5. Hardening off**
This is a process of gradually adapting seedlings to harsher field conditions as compared to the very favorable conditions that seedlings are exposed to in the nursery. It involves exposing seedlings to full sunlight and a gradual reduction of watering frequency starting one or two months before planting out.

Hardening off will achieve the following;
- Stems become hard and woody
- The crown becomes relatively short but vigorous and
- The root system becomes compact and well developed.

This process needs careful monitoring to avoid permanent wilting and deaths of plants.

**6. Grading**
When preparing for planting out it is important to select healthy seedlings with the following attributes.
- A shoot between one and two times the length the root (i.e. the pot)
- A sturdy woody stem with a strong root collar
- A symmetrical, desirable crown and
- A root system with many thin roots in addition to the taproot.

**7. Pest and disease control**
Several diseases and pests attack plants in nurseries. Pests harm plants eating away parts of the plant sucking plant juices. This can weaken and sometimes kills the plants.
Common nursery pests are;
- Termites
- Crickets
- Cutworms
- Locusts
- Semiloppers
- Bugs
- Aphids

Insect pests can be picked and crushed by hand when in small numbers. However if severe infestation occurs appropriate chemicals can also be used with recommendations from the suppliers. Chemicals are also available for disease control. They must be used carefully and appropriately. It is wise to consult with suppliers and other experts in order to purchase the right chemical to use.
GENERAL NURSERY MANAGEMENT ROUTINES

Generally around a nursery it is recommended to have a firebreak against the risk of externally started fires. This is important because even the slightest heat from a flame can cause a lot of damage to tender seedlings in the nursery.

It is advisable to keep the nursery clean and neat to facilitate operations and avoid the harboring of pests by weeds and other forms of rubbish.

It is advisable to wash nursery tools after use and store them in cool dry places.

A very important aspect of nursery management is the keeping of records on all activities of the nursery. This information will help in planning, monitoring and decision-making.

Some of the important records to be kept include;
- Dates of planting
- Operation or activity schedules
- Products targets
- Labeling
- Germination
- Observations
- Disease and pest control measures
- Distribution of output and many others.

8. MARKETING
Main important factors are;
- 1. General appearance of the plant in pots.
- 2. Consistency in quality and grade.
- 3. Do not let plants wilt at the market.

10. LABELLING
- 1. Salesman are not always horticulturists, therefore labeling of all plants can be a good investment.
- 2. Labels should show – Genetic name of the plant and common name of the plant and the address of the producer.

Questions

1. List all the important nursery operations

2. Why is root pruning important?
3. Why should suckers be removed also from the developing trees?

4. What are the most troublesome pests and diseases in a tree nursery and how may each be controlled?

5. How important are labels in the nursery?
Seed Orchard Production Guidelines and Protocol- Notes for farmers

(Compiled by P. D Dhlwayo and Ester. M. Bhebhe ICRAF – Zimbabwe)

The International Centre for Research in Agroforestry (ICRAF) in Zimbabwe has operated agroforestry projects since 1991. To meet the seed needs of their extensive planting programs, ICRAF and its collaborators produce and distribute seed of 9 tree crop species. Seed production focuses on multipurpose species with strong demands. All the 9 species are nitrogen fixing leguminous trees, which produce large quantities of leafy biomass. They are commonly used to produce fodder, green manure or mulch.

Community-based forestry and agroforestry programs around the world reforest denuded lands, protect valuable watersheds and produce indispensable tree products for soil improvement and fodder. These programs begin planting operations with a commodity of small size but great importance-seed! Adequate supplies of high quality seed are necessary to grow high quality seedlings. Unfortunately, shortages of seeds are common and limit the success of many community-based tree planting programs. Any discussion about tree seed production must consider the saying “garbage in garbage out”. If you plant junk seeds you will inevitably harvest junk trees.

Local Seed Production
Organisations and individual farmers can overcome the “seed problem” by “growing their own seed. Seed production serves organization and individuals in several ways;
1. Less time is spent searching for seed sources and less money is spent on seed purchases. The time and money saved can be allocated to other activities.
2. Locally produced seed has a proven genetic quality for local environmental conditions.
3. Organisations and farmers also realize a financial benefit when seed is sold. Seed sales increase income and decrease economic risk by diversifying farm production and targeting new markets.

Meeting long-term seed needs

Seed Orchards
A seed orchard is an area where seeds of particularly valuable genotypes are produced to obtain seed as quickly and economically as possible. This is a specialized plantation of selected species, which are isolated to avoid contamination, and managed to produce frequent, abundant, and easily harvested seed crops. Orchards can be used for genetic improvement and production of large quantities of seed for operational planting. Generally, the benefits of orchards are the production of seed with improved disease and insect resistance growth wood qualities, adaptability and tree from.

Relatively few organizations are willing or able to make the long-term commitment necessary to establish orchards for the tree seed production. If the decision is made to establish seed orchards a long term plan is very important. Several years of planning are required before the first tree is planted. A number of issues must be considered before establishment. Some relevant issues include
- Are there sufficient financial resources and have land tenure issues been resolved?
- What type of orchard is appropriate for the tree species of interest?
- Are there locations where tree species will flower early and heavily
- Does the organization have the expertise to manage the seed orchard successfully
A seed orchard is an area where seeds of particularly valuable genotypes are produced to obtain seed as quickly and economically as possible. This is a specialized plantation of selected species, which are isolated to avoid contamination, and managed to produce frequent, abundant, and easily harvested seed crops. Orchards can be used for genetic improvement and production of large quantities of seed for operational planting. Generally, the benefits of orchards are the production of seed with improved disease and insect resistance growth wood qualities, adaptability and tree from.

Seedling seed Orchards
Seedling seed orchards are plantations with known family identity that are managed for maximum seed production. They consist of a population of open (naturally) pollinated families of selected trees. Often they are “first-generation” orchards that are the result of species and provenance trials. Typically they result from rouging, a process of removing the trees with less desirable genetic potential. Most multi-purpose tree seed orchards are of this type.

Site Selection Criteria
An ideal site will have;
- good soil structure, drainage and fertility, with protection from high winds.
- Seed orchards also require level or gently sloping terrain with easy access and good security.
- They should be located near the nursery or farm offices so that equipment and personnel are readily available. This will aid in overall orchard efficiency by reducing travel time to the site.

Generally, abandoned agricultural lands make good sites. It is important that site environment characteristics encourage early and heavy flower production. Site requirements differ depending on the tree species of interest.

Seed orchards size depends on seed production objectives. Generally, if average rate of seed production per tree is known, then calculating the number of trees needed to reach the production per tree is known, then calculating the number of trees needed to reach the production objective is straightforward. An orchard where insects are controlled and soil fertility is well managed will yield seed of higher quality and quantity than an unmanaged orchard.

1. Orchard Establishment and Management

Land Preparation
- Ripping to eliminate soil compaction should be considered on abandoned agricultural land.
- Soil pH should always be tested and nutrient levels amended as required to promote growth and flowering.
- Generally the elements of importance are nitrogen for growth and phosphorous for flowering. However, a deficiency of any macro or micronutrient can effect seed production.

Planting
- Orchards should be established with planting material of high quality.
- Containerized seedlings have worked well in most tropical conditions.
- Weed control is very important and can be achieved through chemical, mechanical or manual means.
- Planting seedlings of high quality and reducing weed competition are the first steps to developing a successful orchard.
• Tree spacing in a seed orchard is wider than timber plantations. Actual spacing will be determined by the canopy shape and size of each specific species. Often seedlings are replanted at closer spacing. After a few years, inferior trees are removed to achieve the desired spacing.

Cultural practices

Irrigation
Irrigation will improve establishment success and help maintain growth and vigor of the seed orchard. On arid sites, it may be possible to induce flowering by timing of irrigation. There is some indication that flower induction is promoted by moisture stress in some tree species.

Ground covers
Ground covers should be considered between rows to suppress weeds and conserve moisture. The orchard floor will be protected from wind and water erosion while soil nutrients and soil moisture will be retained for longer periods.

Pruning
The size of the canopy of the tree will influence flowering and seed production. Generally, the larger the canopy, the greater the seed production. Pruning and coppicing can be used to modify tree form to increase sunlight penetration and canopy size. Both modifications enhance flowering, seed production and ease of seed harvest.

Each tree species responds to pruning differently, so prune with care until the tree responds as desired. Pruning and coppicing must be timed to disrupt seed production as little as possible.

Most tropical legumes will benefit from management to increase seed production. A word of caution, poor timing or lack of care in applying these practices will affect seed production and may take a season or more for the trees to recover and produce the next seed crop.

Pests and Diseases
A major factor to determine whether a seed orchard is economically viable will depend upon success of controlling orchard pests. There are two categories of consequential orchard pests, those that attack the flowers and seeds and those that attack the tree. Monitoring and control measures are important strategies for improving seed yields.

Record keeping
Record keeping will provide a reference of orchard performance and give insight into productivity and corrective actions that should be taken if problems develop.

Records of importance include
• Age at first flowering
• Months of flowering, production level and flowering
• Complete weather records and historical data will aid in seed orchard management and help in planning future orchards.
• Recording fertilizer rates and formulations as well as dates of application are important.
• Irrigation quantity, frequency, and dates will help to establish relationships between flowering and seed production.
• Insect and disease management records of material used, dates and rats applied, method of application and results are also very important.
• Silvicultural treatments such as pruning and thinning should be recorded.
• Site maps should be updated when trees are removed.
• Records of adverse environmental conditions such as droughts, high winds, floods and heavy rains and hurricanes should be noted and the effect these events had on flowering and seed production.

2. Techniques of Seed Harvesting and Handling

When the seed of most tree legumes is mature and ready to harvest, pods will become dry and change colour. This indicates that the seed embryo is mature and can be harvested without loss of germination ability. Harvest windows are fairly narrow about 2 to 4 weeks in duration. It is important to stay on top of harvesting. Late harvesting can result in yield loss due to pod shatter and pest predation, so correct harvest timing is essential.

Dry seed pods are usually collected by hand picking. Extraction of seeds can be accomplished by beating the pods with a flail, walking over them, or rubbing them through a screen. For larger operations, commercial threshers are more practical.

Cleaning infested or bad seed using floatation will work with seed having hard seedcoats i.e. *Leucaena*. Fill a container to about 25% with seed and pour in clean water until the container is 75% full. Good seeds will sink. The poor seeds, trash, and insects will float to the top where they are removed. Stir the water and continue to skim off the trash. Slowly pour off the water by tilting the container at a slight angle. The water treatment may need to be repeated several times to remove the bulk of poor seeds. Seeds are removed from the container and spread out on a drying rack until dry then stored. Air sorting is another method that can be used to blow off chaff and empty seeds.

Proper storage is necessary to maintain seed viability. Most seeds with hard seedcoats store for 1-2 years with little loss of viability. The factors that will affect seed viability are;
• moisture content of the seed
• humidity
• temperature

For long term storage a moisture content of 4 to 6% is ideal. Storage should be about 4.5-10degree C with relative humidity no higher than 70 but preferably below 50. Seed sorted for extended periods should be sealed in airtight moisture resistant containers. This will protect seed against insects disease and mould.

➢ The layout specifications for the seed orchards should have intra row and inter row spacing of 1m by 1m for the same species.
➢ Each plot should be 10m by 10m, as we need to plant 100 trees per species and there should be a pathway of 3m to separate the different species.
➢ The arrangement of species in the plot is flexible and can be altered to suit your particular area, however a plot size of 10mx10m and the inter and intra row spacing must be maintained.
➢ At planting, the depth must be just enough to accommodate the seed pocket (the plastic must be removed at planting!).

4
- Planting must be carefully done taking care not to expose any roots. Also ensure that the soil around the seedling well firmed and compressed so as to remove air spaces.
- It is a good practice to water soon after planting and regularly thereafter to ensure good tree establishment.
- The orchard must be kept weed free, therefore it is important to get rid of them before the plants are overgrown.
### Seed Orchard Plan

<table>
<thead>
<tr>
<th>SPECIES 1</th>
<th>SPECIES 2</th>
<th>SPECIES 3</th>
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</thead>
<tbody>
<tr>
<td>Intra row and inter row spacing of 1m * 1m</td>
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<thead>
<tr>
<th>SPECIES 4</th>
<th>SPECIES 5</th>
<th>SPECIES 6</th>
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<th>SPECIES 7</th>
<th>SPECIES 8</th>
<th>SPECIES 9</th>
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20m 3m

*Thinning will be done to leave the stand at a planting distance of 2m x 2m after one season of establishment. The inferior plants will be removed during thinning.*
Checklist for Monitoring Seed Orchards

Background Information
Name of Interviewer________________________________________
Date of Interview__________________________________________
Name of Institution________________________________________
Category of Institution______________________________________
Name of Respondent________________________________________
Respondent position at Institution_____________________________

About the Seed Orchard
Site GPS reading______________________________________________
Soil type____________________________________________________
Planting date________________________________________________
Size of area planted___________________________________________
Plant spacing________________________________________________

Management practices
Type of labour used___________________________________________
Who supervise the labour_______________________________________

<table>
<thead>
<tr>
<th>Management Practice</th>
<th>Frequency</th>
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Constraints
List any constraints you have experienced or you are experiencing in this activity
________________________________________________________________________
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<table>
<thead>
<tr>
<th>Species</th>
<th>Stand Count</th>
<th>Pests/Diseases</th>
<th>Tree Height</th>
<th>General Observations</th>
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