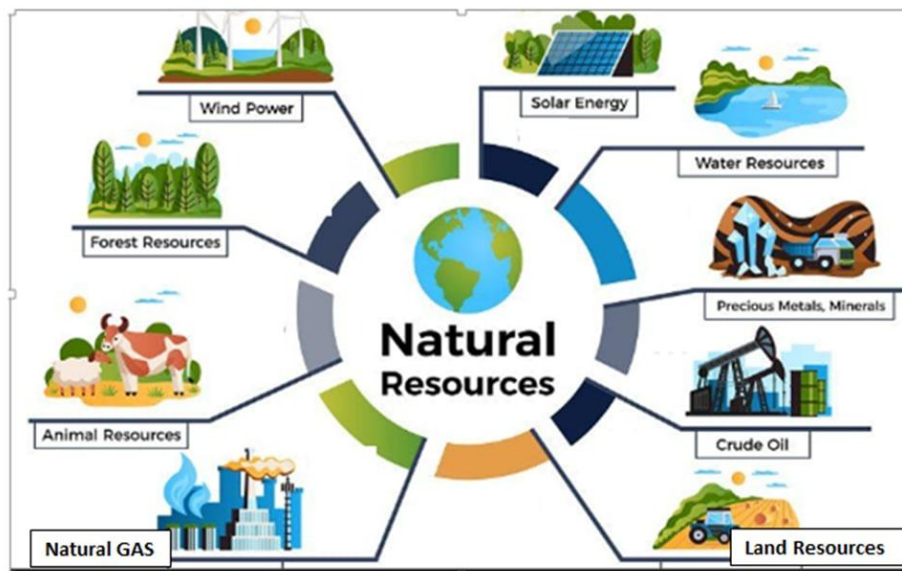


Natural Resources Conservation and Development

Level – I

**Based on March 2022, Version one Occupational
standard**



**Module Title: - Collecting and Processing Planting
Materials**

LG Code: AGR NRC1 M03 LO (1-8) LG (7-14)

TTLM Code: AGR NRC1 TTLM 0922v1

September, 2022

Addis Ababa, Ethiopia.

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Introduction to the Module

This module covers knowledge, skills and attitude required to manage provenance of mother trees; plan and implement seed and planting materials collection; processing; storing and dispatching activities.

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LG #7

LO #1- Identify mother trees

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Identifying and assessing provenances
- Selecting and checking equipment
- Planning site selection activities
- Establishing and maintaining communication based on OHS requirements
- Planning of mother tree identification based on environmental condition
- Identifying and assessing type and quality of mother trees
- Assessing genetic variation and seed sources

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify and assess provenances
- Select and check equipment
- Plan site selection activities
- Establish and maintain communication based on OHS requirements
- Plan mother tree identification based on environmental condition
- Identify and assess type and quality of mother trees
- Assess genetic variation and seed sources

Learning Instructions:

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1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets1
4. Accomplish the Self-checks 1
5. Perform Operation Sheets 1
6. Do the “LAP test”1

Information Sheet 1

1.1. Identifying and assessing provenances

The term **‘Provenance’** and **‘origin’** simply as defines ‘the place in which any stand of tree is growing’ or ‘The locality in which there is a population of trees of a given species possessing distinct genetic characteristics and evolved under the local environment, site or origin of seed from trees with such characteristics is known as the provenance.

When dealing with seeds, this means the geographic location and environment where the immediate mother trees are growing. This must be distinguished from the **‘origin’** which is the place where the original progenitors grew in natural forest stands.

Describes the provenance as:

- Being composed of community of potentially interbreeding trees of similar genetic constitution, and of a genetic constitution that is significantly different from other provenance.
- Being large enough for the collection of reproductive material in sufficiently large quantities for forest practice
- Being defined by boundaries that can be identified in the field.

Different genetic constitutions between provenances are the results of interaction between provenance and environment. In simple terms, overtime, the environment influenced by climate, geology and geography (and sometimes human), forms the present composition of genotype of a provenance by eliminating non-adaptable individuals and leaving those that are fit.

The phenotypic characteristics of the seed tree represent only the maternal (mother tree) contribution to the seed collected. The phenotypic characteristics of the father tree cannot be directly evaluated, because the father tree is unknown. However, a reasonable estimate of father tree characteristics can be determined by evaluating the trees (of the same species) that surround the seed tree (mother tree), because those trees are the likely source of pollen that pollinated the flowers of the seed tree.

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To increase the possibility of collecting good quality seed, seed trees should be selected in stands that consist of good quality trees. When many good quality trees surround a seed tree, its progeny will demonstrate good characteristics. Even when a few poor quality trees are near a seed tree but most trees are of good to fair quality, most progeny will demonstrate good to intermediate characteristics. When possible, the poorer quality trees in the stand should be thinned from the stand. If a seed tree is selected in stands where most trees are of poor quality, the seed collected will very likely produce poor quality trees.

Genotype: Genetic constituents of an individual tree which, in interaction with the environment, largely controls tree performance and is inheritable by its progeny. Generally, trees with good genotype produce good progeny.

Phenotype: The observed characteristics of a tree, which result from the interaction of the genotype and environment.

Plus trees (Selected trees) or mother tree: Superior phenotypic trees from which seed is collected.

- Some of the benefits of growing seeds locally include:
 - ✓ Seeds are adapted to local environmental conditions.
 - ✓ Seeds are available locally when the right growing conditions occur (i.e. before the rainy season).
 - ✓ Dependence on foreign sources of seeds is reduced or eliminated.
 - ✓ Seeds no longer get lost or damaged during transportation from distant places.
 - ✓ Creates the potential of generating income by selling extra seeds or by implementing bee keeping activities around flowering trees.
 - ✓ Seed stand trees can provide services such as shade, soil and water conservation.

1.2. Selecting and checking equipment

The list depends on species; mode of collection, distance from roads and/or vehicle capacity may limit certain equipment types. The number of individual items depends on number of members of the team. It is advisable to bring spare pieces of items like hand pruners, which tend to get lost

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during field operations. A repair kit should include appropriate spares (bolts, blades etc.) as well as all-round repair material (strings, rivets etc).

- Equipments mainly used in this topic include:
 - ✓ Seed containers (field): Cotton bags, canvas sacks
 - ✓ Tree markers: plastic tape
 - ✓ Climbing equipment: Foot spurs ladders, Safety belt, safety ropes, and safety helmets.
 - ✓ Seed cutters: cone hooks, cone rakes, pruning shears, secateurs (hand).
 - ✓ Plastic sheeting (heavy gauge): for protection when storing fruits, extracting seed
 - ✓ Binoculars: for studying tree crowns, fruit development, etc.
 - ✓ Insecticidal and fungicidal powders for seed protection (use with care).
 - ✓ Axe, saw, machete, knife, Rope, string, labels, felt marking pens.
 - ✓ Rope of different types (for safety lines, tool line etc.)
 - ✓ Shooting equipment (gun, bolt, ammunition, cleaning equipment, rifle case, ear muff)
 - ✓ Repair kit (special spares, plus rivets, straps, strings, screws and etc).
 - ✓ Spurs (pairs)
 - ✓ Safety harness / belt
 - ✓ Extended pruners
 - ✓ Hand pruners (secateurs)
 - ✓ Saw pruners
 - ✓ Shaking devices
 - ✓ Tarpaulins
 - ✓ Flexible saw
 - ✓ Tree bicycle
 - ✓ Ladders

1.3. Plan site selection activities

Site selection is important and the first step in seed orchard establishment. Seed orchards are long-term investments.

- Appropriate sites should meet all of the following criteria:
 - ✓ Environmental conditions – rainfall, temperatures, elevation, and soils – must be appropriate for the target species.
 - ✓ Not vulnerable to natural disasters – floods, volcano, earthquake, landslide and frequent wildfires.
 - ✓ Secure from wild and domestic animals.
 - ✓ Isolated to avoid pollen contamination. The recommended isolation distance is 200m.
 - ✓ Easy to access.
 - ✓ Land tenure or land use rights are secure.
- In order to maximize tree survival and seed production, it is important to select the right place where to locate the seed-producing tree stand. Some desirable characteristics for the site include:
 - ✓ Good location with easy access and proximity, as much as possible, to the area where the seeds are going to be stored or used so as to avoid transportation problems.
 - ✓ The terrain should be level or gently sloping.
 - ✓ There should be good amount of sunlight and protection from strong winds.
 - ✓ Soils have to be fertile and have good structure and drainage:
 - ✚ Soil pH should be tested to make sure it is within the range needed by the species that will be planted.

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- ✚ Nutrient levels should be evaluated, especially nitrogen levels (for growth) and phosphorous levels (for flowering)
- ✚ Soil compaction especially in abandoned agricultural lands can be a problem because it prevents root growth and can restricting water flow

1.4. Establish and maintain communication based on OHS requirements

Communication has been variously defined as the passing of information, the exchange of ideas, or the process of establishing a commonness or oneness of thought between a sender and receiver. This definition suggests that for communication to occur there must be some common thinking between two parties and information must be passed from one person to another (or from one group to another). This may include technical report writing, use of telephone, notice board, personal communication and using other communication facilities, which may:

- Use appropriate communication and interpersonal techniques with colleagues and others.
- Communicate ideas and information in simple language to confirm work requirements, convey information and requests to colleagues and report and record outcomes of seed collection, treatment and storage.
- Include verbal and non-verbal language, constructive feedback, active listening, questioning to clarify, confirm understanding, use of positive, confident and cooperative language,
- Use of language and concepts appropriate to individual social and cultural differences, control of tone of voice and body language.

OHS is a cross disciplinary area concerned with protecting the safety, health and welfare of worker and workplace. It provides a means for workers to take a proactive role in addressing work place safety and health.

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Safety can be defined as a freedom from danger: protection from, or not being exposed to, risk of harm or injury.

Safety in work place: effort to prevent work place accidents and injuries. Which includes:-

- efficiently and safely carry out seed collecting procedures
- Use of personal protective device and clothing
- Proper wearing of overall dressing (boot, “tuta”, helmet, eye glass, safety belt, mask, gloves)
- Preparing and knowing appropriate application of first aid materials.
- All tools should be hung or otherwise in fixed or safe place in the nursery store where can be readily available.
- Safe work procedures (including required actions relating to fire, manual handling including shifting, lifting and carrying)
- Working ethics
- Safe working environment (environmentally sound, socially acceptable and economically viable)
- Organizing working tools and equipment
- Well knowing of all tools and equipment manual
- Understand the appropriate use and handling of tools and equipment in processing and collecting seeds (ergonomics)
- All safety precaution must be observed in tools and equipments used for processing and collecting seeds.
- Firefighting equipment
- hazard and risk control
- elimination of hazardous materials and substances
- handling of chemicals used in the treatment

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1.5. Plan mother tree identification based on environmental condition

Environmental conditions may include ground growth, ground slope, gullies, water courses, seed trees, habitat trees, ground hazards and obstacles coppice forests are renowned for providing a fast return to a flora and fauna friendly biodiversity

First of all, environmental conditions of the site – rainfall, temperature, elevation, and soils – must be appropriate for the target species.

- When selecting mother trees, look for characteristics that you would like your trees to have:-
 - ✓ If you are collecting seeds for species that will be grown for firewood, gather seeds from individual trees that have demonstrated to grow fast and are easy to coppice
 - ✓ Cutting down young trees to the ground level in order to allow many new shoots to re-grow and be cut down in subsequent years.
 - ✓ If you are planting trees to obtain timber, gather seeds from trees that have a good height, a straight stem of good diameter and good quality timber.
 - ✓ If you are planting trees for fodder, pick seeds of individuals that have high productivity of leaves and pods, have many branches and multiple stems and are easy to coppice.
 - ✓ To reduce problems of **low genetic diversity** try to **avoid**:
 - ✓ Collecting seeds from single stands of trees where the origin of the mother tree is not known, since they may have been planted from seeds coming from one or only a few individuals.
 - ✓ If you only have access to trees from one specific site, it is possible to use the seeds from this site if the trees of the stand have proven to be successful (healthy, big, well spaced, uniform in size and cross-pollinating) and they are growing in an area with similar environmental conditions to the site where the seed stand will be established.

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- ✓ If there isn't a good supply of local mother trees, it is recommended to purchase the seeds from reputable seed distributors that can guarantee genetic diversity and the physiological quality of the seeds.

1.5.1. Criteria for mother trees selection

Mother tree selection criteria differ for various tree types. We shall select mother trees according to their desired purpose:-

A. For Timber tree:-

- Above average tree height and stem diameter
- Straight stem form
- Long, clear merchantable bole
- Uniform crown, without heavy branches or double-stem
- Free of pests and diseases
- Good quality timber
- Mature tree that produces ample quantities of seed

Table 1. Criteria and corresponding parameters measured to assess the physical quality of the mother trees

Criterion	Parameter
Stem growth	Total height (m)
	Diameter at breast height (cm)
Stem form	Stem straightness
	Forking
	Circularity of the stem
Health	Tree health
Branching characteristics	Branch angle
	Branch thickness
	Branch persistence

B. For Fodder trees and living fences:-

- Rapid/ fast growth
- High leaf production and pods preferred by local animals

- High nutritive values of leaf
- Good coppicing ability/ grow new leaves quickly after fodder harvesting.
- Tree stature and shape that fits the intended planting system and site
- Free of pests and diseases
- Drought resistance
- Mature tree that produces ample quantities of seed

Remember: Trees which have leaves all year round produce more fodder than those which lose their leaves part of the year.

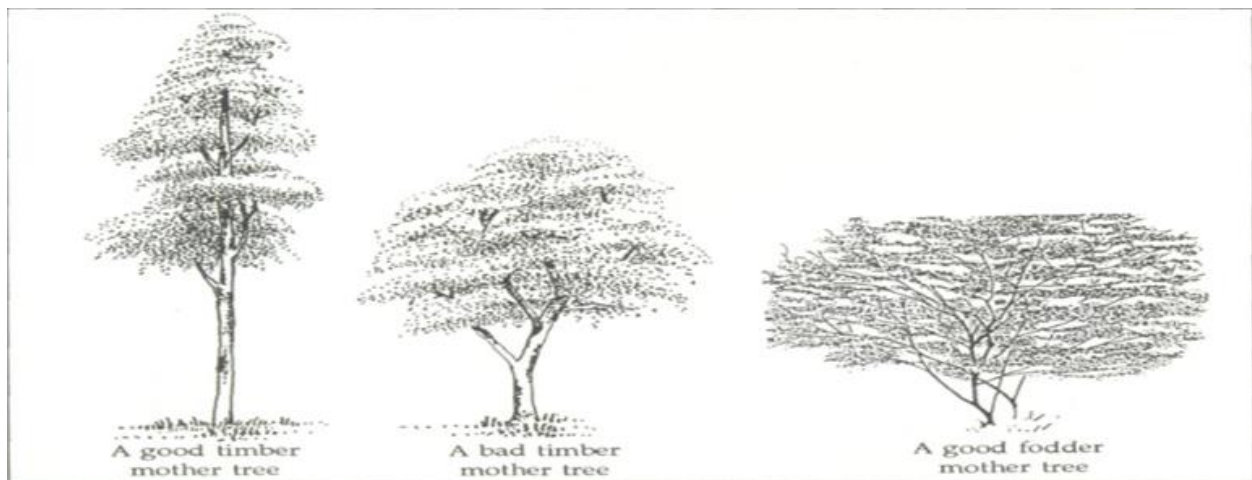


Figure1.1. various types of mother tree

C. For Fruit trees:-

- Good growth
- Abundant, sweet, and big fruits
- Uniform crown with low branches
- Free of pests and diseases
- Mature tree that produces sufficient quantities of seed

D. For firewood:-

- Demonstrated to grow fast and are easy to coppice
- To allow many new shoots to re-grow when cutting down and be cut down in subsequent years.

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Figure 1.2 Good firewood tree and Bad firewood tree

Most tree species are preferentially out crossing – female flowers of one tree are fertilized by pollen from the male flowers of a different tree. However, most tree species have a mixed mating system – they can produce seed by out crossing or self pollination. In order to maintain genetic diversity, seed should be collected from a large number of trees - at least **30 trees**. Out crossing among a large number of trees maintains a broad genetic base, which will maintain adaptability to a wider range of environmental conditions. A broad genetic base reduces the possibility of inbreeding, which often causes growth depression and susceptibility to pests and diseases in the progeny. As mentioned previously, a common problem is that often only small numbers of seed trees are available on farm or public lands, as few as 10 trees in some cases. Seed should be collected only from the best of these trees.

Distance between mother trees

Spacing between trees is an important consideration when selecting seed trees. Seed trees should be spaced at a distance greater than that associated with seed dispersal. Seed dispersal distances vary by tree species and environmental conditions of the site. In general, the distance between selected seed trees should be at least 50 m. Trees spaced closer than 50 m have a higher possibility of being closely related, i.e. share common parents or earlier ancestors. The genetic variation will be reduced when seed is collected from closely spaced trees.

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1.6. Identifying and assessing type and quality of mother trees

Prior to seed collection, you will need to select and mark good mother trees. These are the trees you will use as sources of high quality seed. Here are the major characteristics that determine a good mother tree:-

1. Healthy and free of diseases and insects
2. Nearly mature
3. Good producers of the desired product
4. Growing in the midst of a healthy stand of the same species.

To choose the right mother trees, remember this simple rule:

A tree's off-spring will usually resemble its mother.

Therefore:

- If you want straight trunks, choose a straight-trunked mother tree.
- For a multi-trunk fodder tree, select multi-trunk mother trees.
- For trees which tolerate drought, or flooding, enough seed producer, select good looking mother trees from dry or flooded sites, etc.

1.6.1. Appropriate selection of mother tree

Genetic factors combined with environmental factors determine the characteristics of the young tree as it grows. Seeds from straight and vigorous trees will most likely produce straight and vigorous trees, while twisted or stunted trees may produce the same deformities. Thus the selection of good mother trees is important.

Selection of mother trees should be related to the intended use of the trees to be grown. Shrubs or trees that produce particularly dense or thorny branches are best for fencing, whereas fast-growing and straight trees are best for poles and timber. Trees that produce palatable, dense foliage and/or pods are best for fodder.

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If seeds are collected on a large scale, it is important to collect them from several trees in order to provide genetic variation in the new generation of trees. For small-scale collection for local use this is less important, however.

Mother trees shall be selected in the natural forest or forest plantation, because the seeds from trees that grow alone mostly have disease, slow development and bad shape. We shall select mother trees with a smooth, straight shape, few branches, without any holes, and free from disease.

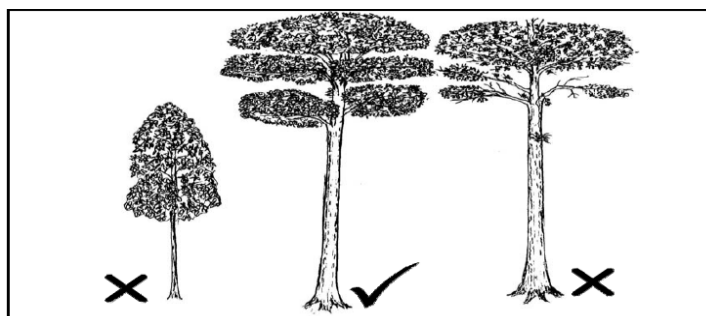


Figure 1.3. Selection of quality of mother trees

1.7. Assessing genetic variation and seed sources

1.6.2. Genetic variation

Genetic variation is the number of different genotypes within a population. It determines the survival and reproductive capacities in a given environment.

High genetic diversity is a decisive factor in the success of any tree-planting project. If a mother tree has desirable traits (such as vigor/fast growth, pest and disease tolerance/resistance, and quality products/services) there are good chances that its seeds will produce offspring with similar characteristics. Seeds of good genetic quality that are grown in the right environment and managed in the right way usually generate trees with desirable traits. Additionally, good genetic variability will increase a trees' capacity to adapt to local environmental characteristics (i.e. rainfall, light, humidity, temperatures and soil characteristics).

If possible, mother trees should be growing in sites with similar environmental conditions as to where the seed stand will be established (altitude, temperatures, rainfall).

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1.6.3. Seed source

Individual trees or stands from which seed is collected are called **seed sources**.

The four types of **seed sources** are:

- ✓ Seed orchards,
- ✓ Seed production areas,
- ✓ Seed stands, and
- ✓ Seed tree

- i. **Seed orchards:** Seed orchards (SOs) are stands established for the specific purpose of seed production. They usually consist of families of superior genetic quality and are planted at a regular spacing and specific design. Seed orchards should be established from a minimum of 30 families from seed (a seedling seed orchard) or vegetative material (a clone seed orchard).
- ii. **Seed production areas:** Seed production areas (SPAs) are stands of trees in either natural forests or plantations that are improved for the specific purpose of seed production. Improvement consists of selective thinning to achieve optimal spacing for seed production and to remove poor quality trees, including those that have been attacked by pests and diseases.
- iii. **Seed stands trees:** Seed stands are groups of trees, in either natural forests or plantations, identified as having superior characteristics - such as straight stem form or rapid growth. Seed stands are managed for seed production, but only seldom benefit from selective thinning or other management intended to improve the quality of seed produced from the stand.

Stands having a certain pattern, spacing, age and minimum area are fulfilling the above criteria.

The size of the stand should ensure that enough trees participate in the mating process to ensure genetic variation (**usually 2 ha**). The area should give us a minimum of **30-50** seed trees (**mother trees**). A minimum distance of **300-1000** meters is maintained between two seed stands depending on pollination style and wind direction.

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- iv. **Seed trees:** Seed trees are individual trees from which seed is collected. They should have superior characteristics - such as straight stem form or rapid growth. They may be in either natural forests or plantations.

Potential seed sources are identified in the planning phase; actual seed trees are often only selected during the seed collection. A seed source should yield an appropriate quantity of seed with a high physiological and genetic quality which matches the plantation site and purpose.

Hence, in general the seed trees should be good phenotype, neither juvenile nor over-mature and good seed producers. For special planting purposes, for example conservation or provenance seed stands, special consideration on sampling for the capture of genetic diversity may be included. For plantations not intended for future seed production, genetic diversity is usually of less importance, but collection should avoid inbred seed and inferior parent trees, which may affect the performance of the plantation. If, however, the plantation is envisaged to become a seed source itself sometime in the future, appropriate measures should be taken to assure reasonable genetic diversity. Information on seed source is very important for seed documentation. For each species in a seed-procurement programme a list of potential seed sources should be identified, mapped and regularly surveyed.

The purpose of such listing is partly to be able to deliver seed of a particular species from a desired provenance, partly to assure that several alternative sources are available in case of crop failure in part of the population. In addition to biologically determined crop failures mentioned above, it often happens that seed sources simply disappear due to cutting.

Selection of superior single trees; when we restrict our collection to individual trees within selected seed stands. We select a minimum of **30-50 seed trees**, at a **minimum distance of 50 meters** between two trees and marked them.

- **A seed source should guarantee quality seeds that:-**

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- ✓ come from a stand large enough to insure **interbreeding** of a great number of trees (wide gene pool),
- ✓ Come from sufficient **number** of trees located at prescribed minimum **distance**,
- ✓ come from trees **performing well** from a phenotypic point of view
- ✓ Are **healthy** and **vigorous**.

Selecting the seed source is therefore an important step. The participation of a botanist is preferable, and selection is made according to the countries ecological zone.

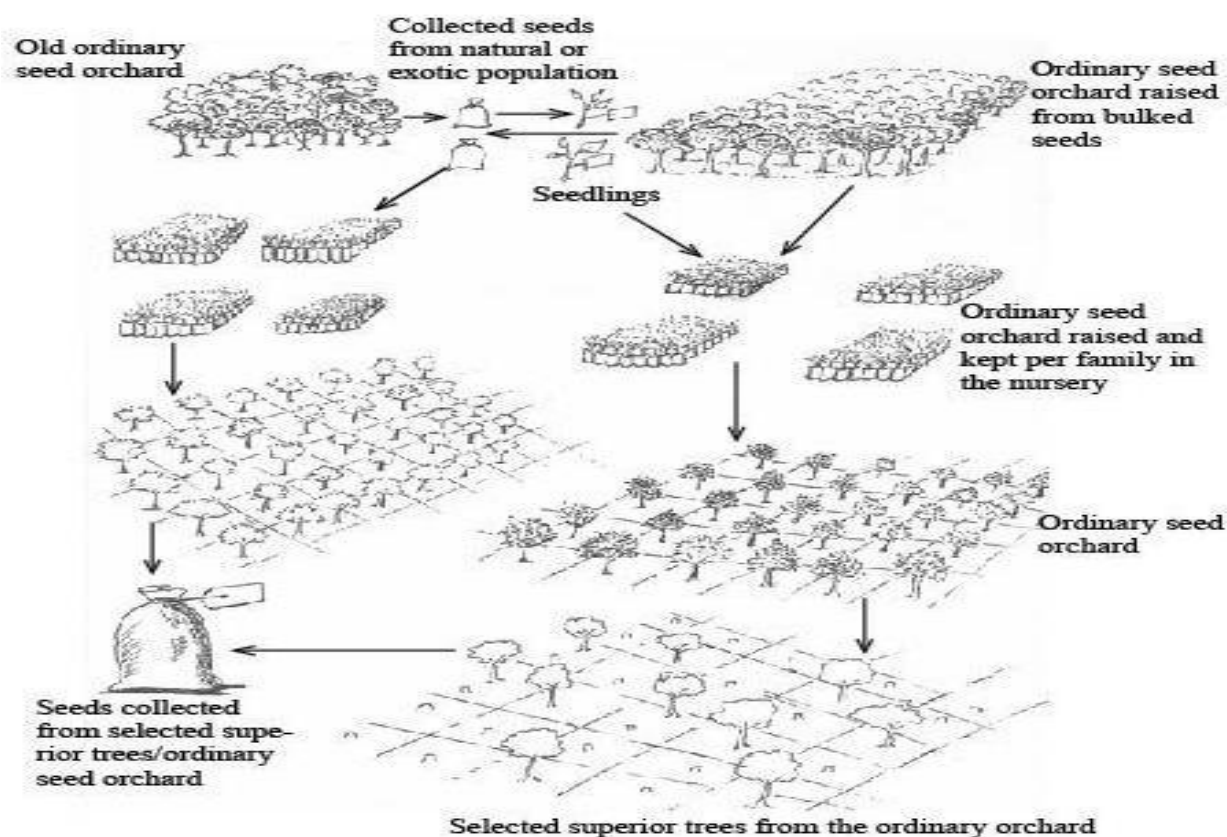


Figure1.4. Seed collection from Seed orchards

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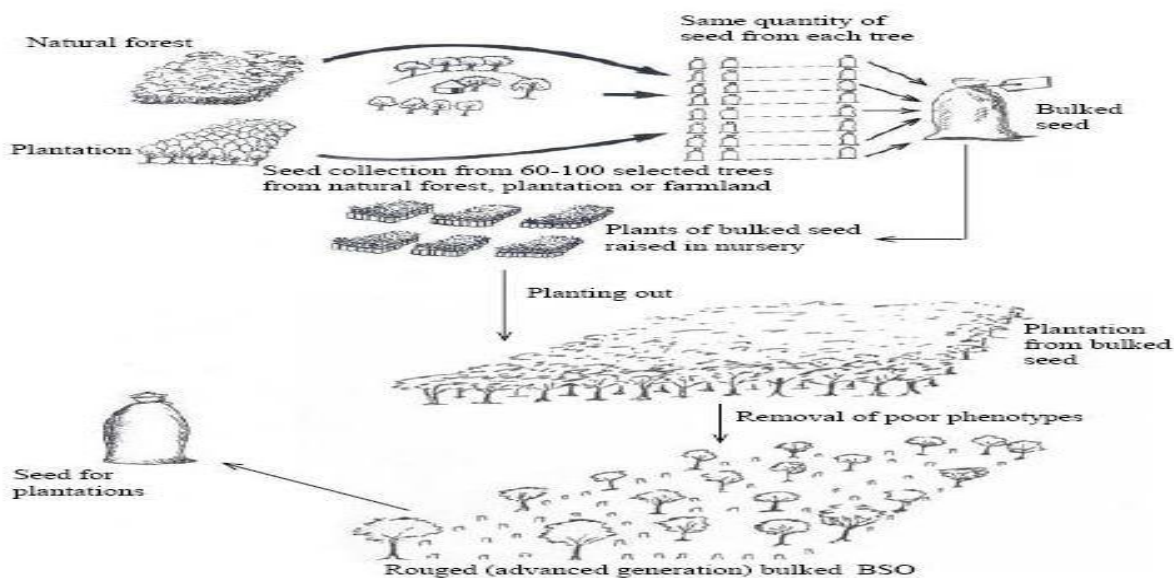


Figure1.5. Seed collection from seed-production area

1.6.4. Seed source description format

Total area: hectares _____, No. of trees per hectare: _____, No. of trees in the stand: - _____

or target species only: No. of trees per hectare: _____, No of trees in a source: _____

Height range (m) _____, Diameter range (cm): _____

Maturity of stand: _ Young, _ Mature, _ over mature

Species composition: _ One species _ Mixed species, (Associated species), pls.

Indicate:

Genetic base (for family/clonal seed sources only):

Number of families before thinning _____

Number of families after thinning _____

Number of clones before thinning _____

Number of clones after thinning _____

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Self-check 1	Written test
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Name..... ID..... Date.....

Directions: Answer all the questions listed below.

Test I: Choose the best answer (25point).

- From the following which one is the seed source?(3)
 - Seed orchards
 - Seed stands
 - Seed trees
 - All
- Which one is a benefit of growing seeds locally? (3pt)
 - Seeds are adapted to local
 - Seeds are available locally
 - Seeds no longer get lost
 - All

Test II: Short Answer Questions

- Define genetic variation.(4 pts)
- From where may you get seed for collection?(2pts)
- What criteria should fulfill the tree to be a good mother tree for seed collection? (3 pts)
- What are essential materials for seed collection?(5 pts)
- Define provenance. (5pts)

Note: Satisfactory rating - 25 points and Unsatisfactory - below 25 points.

You can ask you teacher for the copy of the correct answers.

Operation Sheet -1

1.1 Methods of selection of quality mother trees for timber.

A. Tools and equipments

- Binoculars
- Tree markers
- PPE

B. Procedures/Steps/Techniques

1. Identifying above average tree height
2. Select free of pests and disease
3. Identify long bole
4. Determine Straight stem form and uniform crown
5. Select few branches without any holes
6. Select mature tree that produces ample quantities of seed

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LAP TEST-1

Performance Test

Name..... ID.....Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1:30** hour. The project is expected from each student to do it.

Task-1 Perform quality mother tree selection for timber.

LG #8

LO #2- Plan seed collection

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Analyze sowing and/or planting program and identify seed characteristics implementation issues
- Identifying seed collection opportunity and determining and documenting suitable area
- Seed collection
 - ✓ Selecting method of seed collection
 - ✓ Determining and documenting quantity, cost and impacts on provenances and species
- Identifying sought/required approvals
- Determining and documenting measurable performance indicators, specifications & targets
- Documenting and communicating seed collection plan and appropriate personnel

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Analyze sowing and/or planting program and to identify seed characteristics implementation issues
- Identify seed collection opportunity and determine and document suitable area
- Collect seed
 - ✓ Select method of seed collection
 - ✓ Determine and document quantity, cost and impacts on provenances and species
- Identify sought/required approvals

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- Determine and document measurable performance indicators, specifications & targets
- Document and communicate seed collection plan and appropriate personnel

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets 2
4. Accomplish the Self-checks 2
5. Perform Operation Sheets 2
6. Do the “LAP test” 2

Information Sheet 2

2.1 Analyze sowing and/or planting program and identify seed characteristics implementation issues

The best sowing for a given species being raised in a nursery depends on:

- The anticipated date of planting, itself dependent on seasonal climate
- The time needed in the nursery for planting stock of that species to reach the right size for out-planting.

Only rarely does best sowing date coincide with the best date for seed collection. More often it is necessary to store the seed for varying periods which may be

- Up to one year when both seed production and a forestation are regular annual events, but it is necessary to wait the best season for sowing.
- 1 – 5 years or more when a species bears an abundant seed crop at intervals of several years and enough seed must be collected in a good year to cover annual a forestation needs in intermediate years of poor seed production.
- During plan for sowing, the point that we should consider:-
 - ✓ Species /provenance choice
 - ✓ Seed procurement
 - ✓ Seedling production
 - ✓ Site preparation
 - ✓ Planting
 - ✓ Tending (weeding & fertilizing)
 - ✓ Pruning and thinning
 - ✓ Harvesting

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- Wider spacing between seed trees and other trees enhances seed production by exposing more of the seed tree's crown to sunlight and pollination.

2.1.1 Seed trees management

Active management of trees will improve on-farm seed production. Management options include: planting seed trees; weed control near seed trees; fertilizing seed trees; removing poor quality trees and trees that inhibit seed trees; pruning dead and non-productive branches from seed trees; maintaining a clean understory to facilitate seed collection (and reduce fire hazard); and implementing pest and disease protection measures. At the farm- and community-level these operations can be implemented in a cost-effective manner. However, labor is often a limiting factor for farmers. The potential positive impact of these management operations must be compared to the opportunity costs of individual farmers. Seed characteristics may include provenance, potential growth characteristics, forest types, optimum time to collect, physiology/biology, dormancy and species

2.2 Identifying seed collection opportunity and determining and documenting suitable area

2.2.1 Seed collection opportunities

There are a great variety of opportunities available for collection of fruits and the choice depends on a number of factors. These are:

Characteristics of the fruit: size, number, position and distribution of fruits; resistance of peduncles to shaking, pulling, breaking or cutting; interval between ripening and opening.

Characteristics of the tree: diameter, shape and length of bole, bark thickness; shape of crown; size, angle, density and resistance to breakage of branches; density of foliage and depth of crown.

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Characteristics of the stand: distribution and stocking of trees (e.g. isolated trees, open or dense stand), density of understory and ground vegetation).

Characteristics of the site: slope, accessibility.

Availability and transport of equipment

Seeds on lower branches are easy to harvest but they are not good quality. Seeds from the upper branches are good but they are difficult to harvest. Therefore, we should collect seeds from both the lower, middle or upper branches and Seed collection opportunities may be identified from field observation, organizational and other relevant information.

- **Important consideration in quality seed collection:**

The major aim in seed collection and handling is to get good quality seeds in sufficient quantities and quality. **Quality** entails:

- ✓ the right **species** and **provenance**
- ✓ **genetic** and **physiological quality**
- ✓ reliable **seed source**

Species choice:

This is an important consideration determining the success of any a forestation effort. Species choice depends on ones objective/ purpose, site characteristics and species requirements. Nearly all of the plantations in tropical countries are established from introduced seeds.

It is important to learn as much information as possible about different plant species. This will eliminate a bad seed collection due to miss-identification, seed immaturity and seed damage from disease or insects. The second step is to locate collection sites. When a desired plant is found, make notes or record GPS readings to ensure the plant can be found later. Collection sites need to be undisturbed areas such as woods, power line and railroad right of ways and known prairie remnants. Avoid areas that may have been commercially planted in the past such as roadsides and highway medians. Next, the collection site needs to be monitored. With the information learned in step one, determine the optimal collection time. Seed collections can be ruined if seed is harvested too early or too late. A general rule is that most seed will mature

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within 4-6 weeks after bloom. The final step is to collect the mature seed. A good seed collection will come from at least 30 different plants, although more is even better. Seed collections should consist of as much mature seed as possible, but always leave some seed so that reseedling can occur in the area. Once seed is collected, it should be air dried and placed in a paper bag or seed collection envelope. Seed should not be stored in a plastic bag as this can cause mold and rotting of the collection. Paper bags or envelopes work the best for storing the collection. The seed should then be sent to the plant materials center or organization that is making the collection. Upon arrival at the plant materials center, a unique accession number will be assigned permanently to each collection and testing can begin.

2.3 Planning for Seed collection

One important aspect for planning for seed collection is to have enough information on the species to be collected; phenology (crop assessment report), costs and location of seed sources. Seed source bearing and maturity of many tree species is sometimes irregular. Seed collections are the first step in an extensive process that brings new plant materials to address individual resource concerns. Taking the time to identify superior plants and collecting the seed is crucial for solving these resource concerns. Seed collection involves four steps. The first step is to identify the species. When seed collection, consideration of seed collection seasons, when the required species have fruit at optimal condition is very important.

For any reforestation project, producing seedling is the primary activity. To produce seedlings, we commonly use various types of planting materials. These are:

- **Seeds**
- **vegetative materials**

A **seed** is a matured ovule which is the result of fertilization of the egg in the ovary with pollen grains. In short, seed is a part of a plant from which a new plant of the same species can grow.

Advantages of seeds are:

- It is easy to store and transport.
- It is cheap and convenient method of raising large number of plants.

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- Seedlings are often more robust than their parents.

Disadvantages:

- difficulty of germination
- slow to reach maturity

Vegetative material: means untreated or unprocessed wood, including, but not limited to, trees, tree stumps, tree limbs, bark, chips, duff, grass, grass clippings, leaves, conifer needles, bushes, shrubs, weeds, clippings from bushes and shrubs, and agricultural plant residue.

Advantages of vegetative material:

- Quicker and more certain.
- Produces identical quality as the parent.
- Plants that do not have viable seed, can be reproduced.
- Flowers produced are of superior quality.
- Desirable character of fruit can be maintained.

Disadvantages:

- Vegetative propagated plants are short lived, small compared to seed propagated plants.
- **No new varieties can be produced.**
- Skilled persons are required and often expensive compared to seed propagation.
- More susceptible to diseases as the entire plant may get affected as there is no genetic variation.

2.3.1. Selecting method of seed collection

May be selected based on consideration of the geography of the local area, size and type of tree(s), available resources, and organizational guidelines

Seed collection method/ techniques include:

- Collecting from fallen seeds (after natural dispersal or shaking)
- Collecting from the crown (high-powered rifles, cherry-pickers, bending by rope, climbing using ladders and access from the ground).

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Collection techniques to use depends on factors like the way a species disperses, size of the fruit/seed, tree characteristics like diameter, height, bark thickness, crown size, tree frequency and underground vegetation.

A. Collection from the Crown

This technique is advantageous when:

- fruits release too tiny seeds (and it is difficult to pick from the ground)
- it is necessary to ascertain identity of mother trees
- it is needed to avoid competitors
- when seeds germinate soon after dropping
- when seeds rot easily once they have fallen

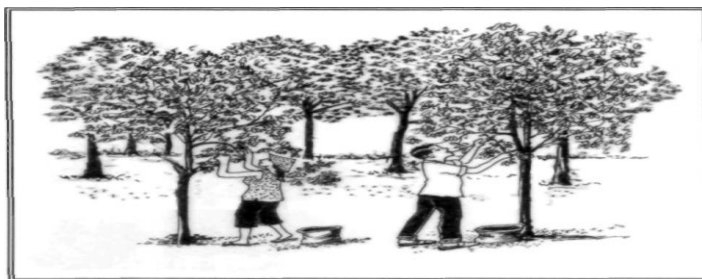


Figure 2.1. Seed collection from the crown

I. Collection in the crown (climbing)

There is a limit of the height to which long handled tools can be used for collecting seeds and then the climbing in to the crown of the mother tree is only the practical method. This is necessary in the following cases:

Disadvantages: dangerous, exhausting, time consuming, expensive, requires experience

Climbing trees to collect seeds is dangerous and must be done carefully, so as to avoid accidents. Falling from trees is a common accident and your collectors should be especially cautious while collecting seeds. Local methods can be safe if properly supervised.

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- Follow these guidelines for safety:
 - ✓ only employ seed collectors if they like climbing;
 - ✓ only use strong and healthy collectors;
 - ✓ collectors should work in twos; then if one needs help, the other can go and get it;
 - ✓ only healthy trees with strong branches should be climbed;
 - ✓ while picking fruits, the climber should be tied to the tree whenever possible;
 - ✓ Proper fruit cutting tools with long handles (see below) should be used, so that there is no need to cut off large branches.

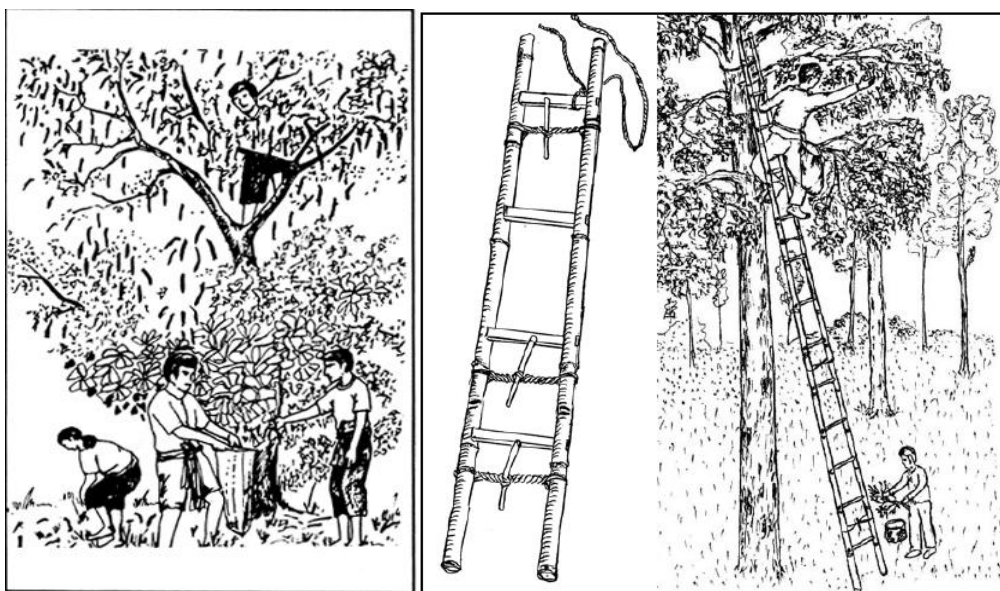


Figure 2.2. Climbing into the crown of the tree

II. Collection in the crown (Using pole implements):

Collection from the ground but using pruning shears, hooked poles (sometimes used to bend and shake). Poles should be made of light but rigid material; bamboo, aluminum).

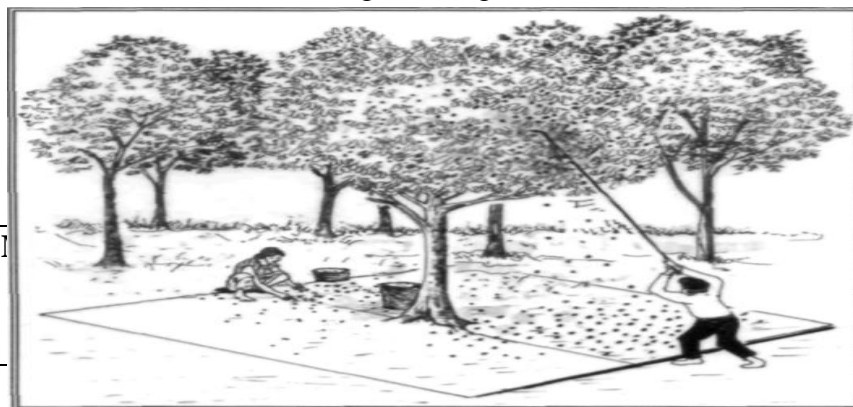


Figure 2.3. Seed collection using pole implements

IV. Collection in the crown (Using ropes):

With a weight on one end and throwing it over a chosen brunch; twisting and pulling the brunch. However, skill is required in throwing rope over the aimed brunch. Skill required in throwing rope over the aimed brunch, But once the collector is experienced,... ropes are cheaper!

B. Collection of fallen seeds/ access from the ground:

- I. After natural dispersal:** for species with big seeds or fruits that drop when matured. The method involves large plastic sheets or canvas, nets under the tree or clearing the site under.

Advantage: Easy, cheap, requiring less skill

Disadvantage:-

- loss of viability of many tropical species' seeds after dispersal; attack by insects and fungi, competitors
- inefficient for tiny seeds

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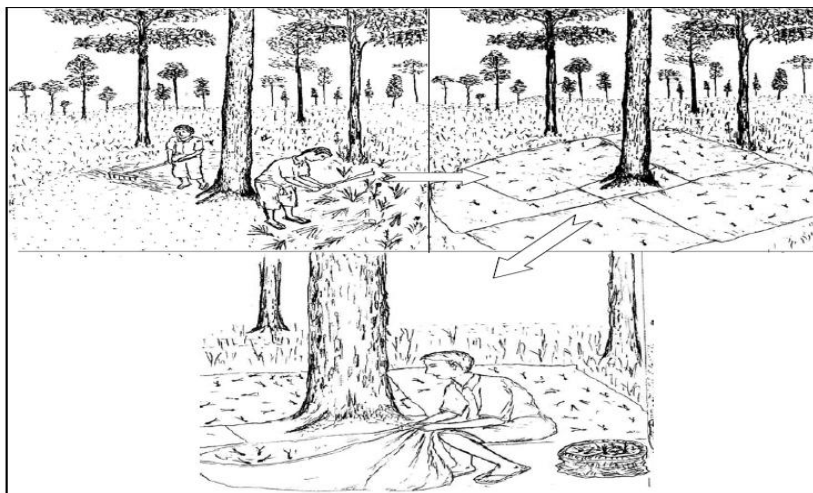


Figure2.4. Seed collection from natural seed fall

II. After manual or mechanical shaking

Fruits or seeds of some trees do not naturally fall simultaneously, so we should shake the trunk or branches so that the ripe fruits or seeds fall together. It is an easy collection method. For seeds/ fruits which detach easily after shaking; manually it is limited to small trees, mechanical shakers (high cost/hr, skill). In the case of shrubs or tree with low brunches, the collector would stand on the ground and pick seeds, brunches are bent over and seeds released to bags or canvas.

Advantage: Easy and cheap

Disadvantage: fruits of lower brunches of some species contain few seeds, possibly of insufficient pollination. Moreover, lower brunches often bear less viable seeds due to old age and low photosynthesis.

NB. If possible, never fell a tree for collecting seeds and use a tree felled for another purpose.

Also take care of the quality of the seed.

Steps:

- Clear the ground under the tree, then lay down the mat or plastic sheet;
- Shake the trunk or branches by using a long picking stick; and
- Collect by sorting out fresh from dried seeds.

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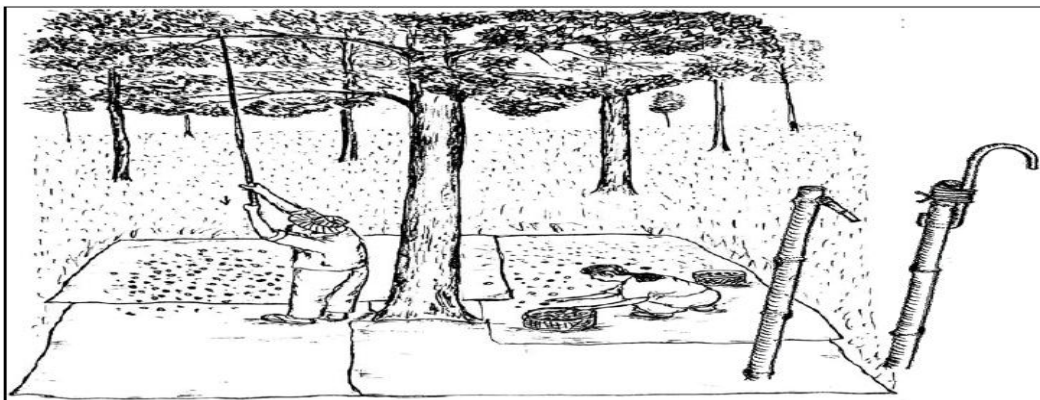


Figure2.5. Shacking the tree or its branches

III. Cutting fruit bearing branches

When fruits or seeds are high on the tree, beyond your reach, and its stem is tough on the branch, and will not fall when shaken, then you have to cut the fruit-bearing branches to collect the fruits on the ground.

Steps:

- Select branches with good fruits;
- Use a stick attached to a sickle or adze to cut the selected branches; and
- Collect the fruits or seeds from the cut branches.

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Figure2.6. Cutting fruit bearing branches

2.3.2. Determining and documenting quantity, cost and impacts on provenances and species

A. Determining seed quantity

For some seed sources, collection may be subject to special restrictions in relation to ownership, administration or conservational aspects. This may put limitations on both amount of seed to be collected and collection methods.

Prediction of quantity and quality of an expected seed crop and prediction of the correct harvest time is especially essential for species with variable seed crops from year to year, and with a short harvest season. Some years, fruit production may be so low that collection does not pay at all; other years a sudden mast production may justify a very large collection, where stores are filled up to serve as seed supply during interim low production years. In some cases an exceptionally large seed production may even influence the current nursery program.

The best seeds are produced in mast years, or in stands with prolific flowering, efficient pollination and few predators. The best time to collect seeds is when they are mature but before they are lost to predators or dispersal. Forecasting quantity, quality and timing of a seed crop is

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subject to the following inevitable problem: the earlier the assessment, the better it can be incorporated into the work plan, but the more unreliable the prediction. In some cases where the potential seed sources are located far away, it may be impossible to make preliminary assessments on the actual stand, and one must rely on geographic correlations or other measures.

Calculation of quantity of seeds required

From:

- ✓ Size of area to be planted for each species (in hectares)
- ✓ intended number of seedlings for planting depending on spacing (N)
- ✓ Estimate of survival after planting & the need to fill gaps(S)
- ✓ Estimated number of palatable seedlings per kg (Ps)

$$\text{Quantity (kg)} = \frac{N}{S \times Ps} \quad \frac{G\% \times P\%}{100} = \text{U.V. (Utilization value)}$$

Number of seeds/kg x U.V. = Effective germination per Kg.

$$Ps = \frac{n/\text{kg} \times G\% \times P\%}{100} \times (1-C.F)$$

Where C.F. = Casualty factor

There is always a loss in the nursery between time of germination & the harvesting of seedlings for dispatch to the planting site. The annual losses due to disease and the proportion culled should be recorded in the nursery records so that over a period of time the nursery manager knows the average proportion of seedlings he expects to lose each year.

- ✓ If records for C.F are unavailable, factors of **0.5 - 0.6** can be assumed.

An additional **5-10 %** should also be dispatched to compensate for losses from packing or unpacking during handling.

B. Cost estimation and analysis

Larger seed collecting expeditions, taking several days and going to remote areas, should be budgeted and later accounted for individually. This assists the economic planning of collection

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i.e. determining appropriate amount of seed to be harvested and duration of collection tours. The procurement costs ultimately influence pricing of the seeds.

A seed-collection tour has typically certain basic expenditures which are independent of the duration of the trip and the amount of seeds collected (e.g. transport to collection site and equipment), and some variable expenditures according to duration and amount of seed collected (e.g. local transport, salary and daily subsistence allowance (DSA)). Collection in remote areas typically has large basic costs both because of the direct transport cost and because people must be paid while unproductively sitting in the vehicle to and from the collection site. In some cases hiring of local casual labourers near the seed source may be an economical alternative to bringing many people from the central seed unit. Hiring local staff may also have other positive effects, e.g. facilitating access to seed sources. On the other hand, much time may be used looking for labourers, and operations that require technical skills, such as climbing, can only be done by trained personnel.

There are three types of documents are recommended and summarized below. The objective of these documents is to record and evaluate the seed sources and seed (both collected and procured elsewhere) used in local tree planting programs. This information will enable farmers to focus seed collection activities on the best quality seed sources accessible to them.

1. Seed Source Document

- Botanical and local name of the species
- Location and site information of seed source (elevation, temperatures, rainfall, soil types, etc)
- Type of seed source (seed trees, seed stand, seed production area, seed orchard, other)
- Number of seed trees in the seed source
- Age of seed source

2. Seed Collection and Handling Document

- Botanical and local name of the species
- Date of seed collection

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- Seed source from where the seed was collected
- Number of seed trees from which the seed was collected
- Average distance between seed trees
- Weight of fruit/seed collected
- Number of seed containers filled with the seed collected
- Name of collectors
- Seed lot number (a unique number to identify the seed collected on a specific date from a specific seed source)

3. Seed Quality Document

- Botanical and local name of the species
- Seed lot number
- Date of seed testing
- Seed purity
- 1000 seed weight test
- Moisture content
- Percentage of germination or viable seed

2.4 Identifying sought/required approvals

If the seed collection unit and the owner or administrator of the seed source are under the same administrations, for example: forestry department, permission for seed collection may be irrelevant or a minor formality. This is often the case in collections from seed orchards, seed-production areas or plantations. In the cases where several governmental offices are involved, or the responsibilities and authorities is not clearly defined, seed collection can be seriously delayed due to bureaucratic procedures? On private land, permits and restrictions are often up to the individual owner and often more easily negotiated. In either case payment for the collection may be involved, either as a fixed fee or dependent on quantity collected. Collection in natural stands may imply specific problems since they may be conservation areas and subject to various restrictions. Seed collection in national parks, game parks, sanctuaries or forest reserves is normally limited by protective legislation, which differs from one country to another. Special restrictions on seed collections are often put on the following activities:

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Permits including specification of limitations or restrictions plus possible fee should generally be negotiated well in advance of the actual collections. On public or governmental administrated land (parks or reserves) the permit is often obtained from the head office of the administrative department, and confirmation obtained from the local administrative unit (forest office, park office etc.) just before the collection takes place. In most cases the particular permit is based on a general agreement between the unit in charge of seed collecting and the administration of the seed sources. In some countries there are restrictions on the transfer of plant material between regions; local legislation should be consulted.

Approval may be required where heritage and other issues may apply to seed collection operation and licenses and permits required for commercial or non-commercial seed collection and government permits and landholder permits very important.

2.5 Determining and documenting measurable performance indicators, specifications & targets

The determinants measurable performance indicators, specifications and targets of seeds are:-

Seed Lot

- Purity Test
- Seed Weight
- Seed Moisture Content
- Germination Test
- Laboratory germination counts (LGC)
- Germination energy
- TetraZolium Chloride (TTZ)Test

2.6 Documenting and communicating seed collection plan and appropriate personnel

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Communication may include verbal and non-verbal language, constructive feedback, active listening, questioning to clarify and confirm understanding, use of positive, confident and cooperative language, use of language and concepts appropriate to individual social and cultural differences, control of tone of voice and body language.

It is important that careful planning precedes seed collection and all the processes that follow. Since planning relates to future activities, it not only requires knowledge of the biological basis, but also of succeeding activities like collection, processing, storage and germination. Planning of seed collection relates directly to the following questions:

- Which species to collect (species selection)
- How much seed to collect (quantity)
- Where to collect (seed sources, seed trees)
- When to collect (harvest time)
- How to collect (collection method)

Generally planning seed collection includes may detail organizational terminology, guidelines, plans, budgets, policies and timelines, internal memos, resources (people, materials, equipment). The **purpose** of collecting seed should be well defined. How much seed is needed? What type of planting will be established with the seed? How long will the seed be stored before use? Will the seed be used for internal needs or will it be sold or exchanged? This information will affect the intensity of tree seed collection activities and the amount of seed to be collected.

Where should the tree seed be collected? Identify the best available seed source for the species in question. Local forestry officials and farmers may be very knowledgeable concerning the locations of various seed sources. (An alternative to collecting seed directly is to purchase seed from a dealer or government office of proven reliability.

When should seed be collected? A few tree species produce seed all year. Most species produces seed only during a certain period of the year. Some species produce seed only on cycles of multiple years. For many species information on flowering periods, seeding periods and the

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characteristics of mature fruits is available from books, forestry professionals and farmers. This information should be validated through field visits to proposed seed sources when planning collection activities.

Warning!

Prepare the required seed collection tools and supplies before leaving for the field. These items might include: pole pruners, hooks or saws; hand pruners or saws; ladders; ropes; seed baskets, sacks, bags or other containers; mats, tarps

Seek permission to collect seed from the landowner or land manager of the seed source. This is particularly important when collecting seed from private land, industrial forests, and government plantations or seed sources.

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Self-Check – 2	Written test
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Name..... ID..... Date.....

Directions: Answer all the questions listed below.

Test I: Choose the best answer

- Which one of the following are the seed collection opportunities?(5pts)
 - Characteristics of the fruit
 - Characteristics of the tree
 - characteristics of the site
 - All
- Which one of the following are the laboratory Methods maturity is judgments?(4)
 - Cutting test
 - Specific gravity
 - Color test
 - All

Test II: Short Answer Questions

- What are the four characteristics of seeds (4pts)?
- Seed maturity is judged by different means explain some of them? (3pts)
- What are the main points you focus on in planning the seed collection? (4pts)
- Briefly specify seed collection techniques with the appropriate materials needed? (5pts)

Note: Satisfactory - 20 Unsatisfactory - below 20points

You can ask you teacher for the copy of the correct answers

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Operation Sheet -2

2.1. Plan for Seed Collection

A. Tools and equipments

- | | |
|-----------------------|---------------|
| I. Note books | IV. Pencil |
| II. Binocular Camera | V. Pen |
| III. Collecting sheet | VI. Computers |

B. Procedures/Steps/Techniques

- Organize the teams
- See seed collection opportunities
- Determine and document suitable area
- Estimate cost and benefit analysis
- Identify for what purpose to collect seed
- Identify the best available seed source(when)
- Define when should seed be collected
- Determine who collect the seed
- Set quantity/amount of seed be collected
- Take licenses and permission from concerned body of the seed source and approve.
- Select method of seed collection.
- Carry out seed collection

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LAP TEST-2

Performance Test

Name.....ID.....Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 45 min. The project is expected from each student to do it.

Task-1. Perform planning of Seed Collection

LG #9

LO #3- Implement Seed Collection Plan

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Selecting and checking equipment and resources
- Liaising relevant individuals, bodies and groups
- Assessing and checking plant species and condition
- Selecting and applying method of seed collection without causing damage to health of parent plant
- Collecting seeds from different plant species and area
- Placing and labelling seed as organizational requirements
- Carrying out seed collection
- Identifying and assisting limitations

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Select and check equipment and resources
- Liaise relevant individuals, bodies and groups
- Assess and check plant species and condition
- Select and apply method of seed collection without causing damage to health of parent plant
- Collect seeds from different plant species and area
- Place and label seed as organizational requirements
- Carry out seed collection
- Identify and assist limitations

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Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets 3
4. Accomplish the Self-checks 3
5. Perform Operation Sheets 3
6. Do the “LAP test” 3

Information Sheet-3

3.1. Selecting and checking equipment and resources

Equipment and resources appropriate to work requirements should be selected and checked for operational effectiveness in accordance with manufacturer's recommendation. Equipment and resources may include; personnel, vehicles, pruning and shaking equipment, sheets, tarpaulins, clean containers for holding seeds, vacuum seed collecting machines, ladders or elevating work platforms, personal protective equipment. Good seed-collection tools include A hook for bending branches towards the collector. Fix a metal hook to a wooden handle 2 m long. Provide a 2 m length of rope so that the climber can tie the hook and the branch to himself, so that he has both hands free to pick the fruits and put them in the collecting bag, A strongly made hook can also help in climbing the tree.

Collection tools: rakes, knives, and baskets, palm-leaved mats or plastic sheets

Ladders, Spurs (pairs), Rope of different types , Safety harness / belt, Extended pruners, Hand pruners (secateurs), Saw pruners, Shaking devices, Tarpaulins, Flexible saw, Tree bicycle, Shooting equipment (gun, bolt, ammunition, cleaning equipment, rifle case, ear muff), Repair kit (special spares, plus rivets, straps, strings, screws etc. and tools)

3.2. Liaise relevant individuals, bodies and groups

The relevant individuals, bodies and groups that are professional for implement Seed Collection plan are communicate to each other's and it will be fully participate in implementation of seed collection, according to the organizational regulations and requirements .

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3.3. Assessing and checking plant species and condition

The major aim in seed collection is to get good quality seeds in sufficient quantities and quality. Specifically, quality in seeds implies:

- Viability
- Germ ability
- Healthiness
- purity
- true-to-type
- resistance(disease, draught etc)
- collected from trees with desirable attributes
- Collected from a diverse gene pool

Therefore, we have identified our parent trees (right species/ provenance, with the desired quality), have trained crew (if necessary reference collection), determined the optimum age, the next step is flower and seed survey.

a) Flower Survey

Sometimes a preliminary flowering assessment can be conducted in the bud stage (e.g. eucalypts). Flowering often gives an indication of the future fruit crop but the correlation varies from species to species and from year to year.

The time of flower survey is necessary atleast 1-2 months prior to actual collection.

Flower Survey can provide information on:

- Whether flowering is distributed regularly throughout the area,
- If flowering Plus trees are distributed throughout the area,
- How many male trees are contributing to pollination,
- Whether male trees are distributed uniformly.

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Due to the relatively unreliable connection between flowering and fruiting, floral assessment is usually rated rather than quantified. Rating can, for instance, be done according to the following scale:

4. **Very-good**- Most of the trees in the stand have abundant flowers
3. **Good-Most** of the trees have flowers, some abundant
2. **Intermediate** -Less than 40% of the trees bear flowers, few have many flowers
1. **Poor**- Most trees in the stand have few flowers, edge and exposed trees may flower prolifically

0. **Very poor** -Flowering poor and only on edge trees or isolated exposed trees

Floral assessment and rating require a high degree of knowledge of the species and experience in order to establish an arbitrary reference frame. The relative rating of flowering may be helpful in identifying potential seed sources. Stands with ratings 0 or 1 are excluded; those with score 2-4 are potential sources for further evaluation.

b) Seed Survey

Flower survey is not enough, as many of the flowers might not develop in to seeds because of abortion, failure of fertilization or other factors. Then, seed survey is a reliable tool towards crop estimation. The information gathered includes:

- Checking existing stock
- Whether the crop is sound (not attacked by insects, disease etc.)
- Whether seeds are mature: Seeds should be harvested when or just before they are matured. It is also important to make sure that a high proportion of it is viable when harvested.

Seed maturity is judged by different means:

i. Field Methods:

Color: Seeds/ fruits turn from green to grey, shades of yellow, brown or reddish when matured.

Fleshy and pulpy fruits commonly lose their hardness and become soft when matured.

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Cutting test: One of the best ways to see if a fruit/ seed is ripe; simple and practical. It also helps to see the soundness (viability and insect attack).

The cutting test gives more information than simply the color. It enables us to discern the stage of maturity of the embryo and endosperm. Most embryo and endosperm have ‘milky’ appearance when immature followed by a ‘dough’ stage. Mature seeds have a fully developed and firm embryo and endosperm.

ii. Laboratory Methods:

1. Determining the maximum dry weight of seeds when they reach maturity (i.e., physiological maturity)
2. Chemical analysis (based on the contents of fat, protein, carbohydrate; increase during maturity)
3. Seed radiography: shows different shades of colors showing the degree of maturity; quick but needs skilled personnel and resources)
4. Specific gravity: lower when seeds mature

3.4. Selecting and applying method of seed collection without causing damage to health of parent plant

There are a great variety of methods available for collection of fruits and the choice depends on a number of factors. These are:

Characteristics of the fruit: size, number, position and distribution of fruits; resistance of peduncles to shaking, pulling, breaking or cutting; interval between ripening and opening.

Characteristics of the tree: diameter, shape and length of bole, bark thickness; shape of crown; size, angle, density and resistance to breakage of branches; density of foliage and depth of crown.

Characteristics of the stand: distribution and stocking of trees (e.g. isolated trees, open or dense stand; density of understory and ground vegetation).

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Characteristics of the site: slope, accessibility and etc.

Availability and transport of equipment

3.5. Collecting seeds from different plant species and area

3.5.1 Potential locations for seed collection

Before starting to collect seeds; potential locations for the required seed should identified to collect healthy and enough quantity of seed. Identification of potential locations related to questions of:-

1. Which species to collect (species selection)
2. Where to collect (seed sources, seed trees)
3. From which stand (stand selection)

Thus, potential locations for the collection of required seed needs approvals and sought and obtained from relevant authorities. Relevant authorities may also include:-

- Local governments, parks/reserves managers, and forestry managers
- To collect seed from where the required potential site, liaise or negotiate with bodies or groups internal and external to the organization is necessary.

Prediction of the quantity, quality and harvest time of an expected seed crop is especially essential for species with variable seed crop from year to year, and with short harvest season. The best seeds are produced in mast year, or in stands with prolific flowering and efficient pollination and few predations. There is usually a cyclic periodicity of seeds production in which a year of excellent production (seed year) is followed by a varying period in which production is low (off year). Variability occurs as a function of genetic makeup and the environment (site, climate).

So, we find:-

- Tree to tree variation, and stand to stand variation.
- Good sites are likely to induce good quality and quantity seeds than on poor sites (low moisture/low nutrient).

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The major aim in seed collection & handling is to get good quality seeds in sufficient quantity & quality. Quality entails: the right species & provenance; genetic & physiological quality and reliable seed source.

To determine the potential location of seed, flower & fruit assessment is necessary.

Seed survey should apply due to flower & fruit assessment is not enough for successful by itself.

The information gathered from seed survey includes:

- Checking existing stock
- Whether the crop is sound
- Whether the seeds are mature

Checking for seed maturity a useful guide to whether the seeds are sufficiently mature is how easily they can be detached from the parent plant. Fruit color changes may also signal maturity. For instance, many bird dispersed fruits change to a color (such as red) that stands out well against green foliage. Do not collect very immature fruits and seeds. However, it may occasionally be possible (or necessary) to collect slightly immature fruits (still fairly green) and to mature these in the laboratory. Maintain fruits under fairly humid, light conditions until mature, when the seeds should be extracted and dried. This approach has been found to be particularly useful for species with explosive seed capsules. If in doubt about maturity, examine a few seeds (internally and externally) using a hand lens; soft seed contents might indicate immaturity. It is also important to make sure that a high proportion of it is viable when harvested.

3.6. Placing and labelling seed as organizational requirements

Typically, the label information includes the seed lot number, which enables tracking of the seed through the distribution chain and back to the seed producer; the kind/species, cultivar name, and origin of production; percentages of germination, pure seed, inert matter, other crop seed, and weed seed; percentage of seeds.

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Labelling is compulsory but certification is voluntary. The seeds should label as follows:

- | | |
|-------------------------------|----------------------------|
| ☞ kind | ☞ Other crop seed % |
| ☞ Variety | ☞ Weed seed % |
| ☞ Lot no. | ☞ Germination % |
| ☞ Date of test inert matter % | ☞ Net content |
| ☞ Pure seed % | ☞ Sellers name and address |

<https://www.youtube.com/watch?v=8Rtn6Z8dG0Q> (access date August 29/2022).

3.7. Carry out seed collection

After selecting and marking good mother trees, several seed collection methods can be used.

Those methods are:-

1. Collecting from natural seed fall
2. Shaking the tree
3. Pruning off seed bearing branches
4. Throwing a rope with weighted end to break off a seed bearing branch and
5. Climbing trees to collect seed.

3.8. Identifying and assisting limitations

Identify all activities that answer the question what, for what purpose, when and how Seed collection plan is implement is important. Improve the supplementary limitations according to the organizational regulations.

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Self-Check – 3	Written test
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Name.....ID.....Date.....

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. What method of collection you use if the seed tree is short? (5 pts)
2. What are essential materials for seed collection?(3 pts)
3. How hook uses as seed collection tool? (5 pts)
4. What is the importance of identifying seed collection sites? (5 pts)
5. What are questions related to Identification of potential locations for seed collection? (2 pts)
6. If most seeds are flower prolifically during that year, what be year is called? (2 pts)
7. Why fruit and seed assessment be necessary? (3 pts)
8. What type of sites is side to be poor site? (2 pts)

Test II: Multiple choices

1. Which one is the indicator of seed quality? (1pts)
 - A. Viability
 - B. Germ ability
 - C. Healthiness
 - D. All
2. Which one are the potential locations Identification related to questions for seed collection? (1pts)
 - A. Which species to collect (species selection)
 - B. Where to collect (seed sources, seed trees)
 - C. From which stand (stand selection)
 - D. All

Note: Satisfactory rating -20 points Unsatisfactory - below 20 points

You can ask you teacher for the copy of the correct answers.

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Operation Sheet -3

3.1. Collecting seeds from natural seed fall.

A. Tools and equipments:

- | | |
|--------------------|---|
| I. Binoculars | V. Sieve |
| II. Binoculars | VI. Seed container |
| III. Tree markers: | VII. Insecticidal and fungicidal powder |
| IV. Rake | VIII. cloth or plastic sheet |

B. Steps:

1. Follow the methods for selecting the mother tree that discussed above
2. Clear the ground beneath the tree of leaves, branches, and weeds before seeds begin to fall.
3. Use a rake to gather the seeds and collect them
4. Extract seeds from the litter by sieving.

3.2. Collect seeds by shaking the tree

1. Tools and equipments:

- | | |
|--------------------------|---------------------------------------|
| I. Binoculars | VII. Shaking devices |
| II. Tree markers: | VIII. Sieve |
| III. A stick | IX. Seed container |
| IV. Long pole | X. Insecticidal and fungicidal powder |
| V. Safety harness / belt | XI. Cloth or plastic sheet |
| VI. Hook on rope | |

2. Steps:

1. Follow the methods for selecting the mother tree
2. Clean the ground,
3. Lay down a plastic or canvas sheet under the mother trees
4. Shake the trunks of trees or low branches by hand.
5. fold sheets to collect seeds
6. Separate seed from the dry pods / extract seeds from the litter by sieving.

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LAP TEST-3	Performance Test
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Name.....ID.....Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary tools and materials you are required to perform the following tasks within 24hour. The project is expected from each student to do it.

Task-1 Perform seed collection.

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LG #10

LO #4- Process and Store Seed

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Separating, weighing and storing seeds
- Applying seed treatment
- Packaging seeds as legislative requirements
- Recording seed information
- Recording and reporting seed collection information and results

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Separate, weigh and store seeds
- Apply seed treatment
- Package seeds as legislative requirements
- Record seed information
- Record and report seed collection information and results

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
2. Read the information written in the information Sheets
3. Accomplish the Self-checks
4. Perform Operation Sheets
5. Do the “LAP test”

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Information Sheet 4

4.1. Separating, weighing and storing seeds

4.1.1. Separating and weighing seeds

Seed processing /extraction: In Agriculture, the term seed processing includes cleaning/, drying, seed treatment, packaging and storage. Seed processing may be understood to 'comprise all the operations after harvest that aim at maximizing seed viability, vigor and health.

The methods of separating seeds from fruits are determined mainly by the characteristics of the fruits.

De-pulping: Separated/ treated by a de-pulping process which usually involves a combination of soaking in water with pressure or gentle abrasion. Example for fleshy fruits such as: Podocarpus, Olea, Azadirachta, Melea, Prunus and Juniperus. For such species the pulp must be removed soon to avoid fermentation and heating. Cones and other woody or leathery fruits are first dried until cone scales open or seeds become detached from the placenta of the fruit, and then treated manually or mechanically by tumbling or threshing in order to separate the dry seeds from the dry fruits.

The technique involves: Soaking the fruit, then the flesh hand squeezed or mashed by wooden blocks, rolling pin or fruit press; or macerating flesh by rubbing it against or through a screen. In maceration, the fruits are placed in water in a warm place to soften the pulp, which is then broken down by vigorous stirring or rubbing against wire screening. HCl can soften pulp, and NaOH can cut resin when Juniper berries are being treated.

The de-pulping process entails the following steps:

1. Immerse fruits in water for 1-2 days until the fleshy tissue becomes soft.
2. Scrape, crush or nub lightly with hands to separate seeds thoroughly from pulpy flesh, but avoid injuring the seeds.
3. Discard all floating seeds and pulp (most seed species are sinkers).

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4. Drain seeds, rewash and air-dry for 1-2 days before sun-drying.

5. Winnow /separating grain from chaff/to dean.

For some species which have seeds covered only by thin layer of flesh (Example: *Vitex parviflora*), the fruit itself may be kept intact, dried and directly sown. However, germination may be further improved by removal of the pulp.

Extraction by Drying: It uses natural or artificial heat source. Drying can be: under cover, sun drying or kiln drying.

1. Kiln drying: Problems encountered when trying to control humidity and temperature may complicate drying by natural methods. Then we resort to artificial methods:

- i. when large amount of seeds have to be processed,
- ii. When regulation of temperature and moisture is required (often, natural drying may not be sufficient to achieve the desired moisture content)
- iii. When we want to save time.

2. Drying under cover: used as an extraction method for species that cannot withstand direct sun light, and must be stored at relatively high moisture content.

Good ventilation required. The time required depends on the relative humidity. This method can offer uniform drying to prevent case hardening.

The harvested pods should be shelled and the seed dried under shade to a moisture content of 10 to 15%. This process should take 3 to 5 days. The seeds should be weighed, winnowed, screened and sorted to remove foreign objects and poor quality seeds.

3. Sun drying: the extracted, cleaned seeds for 1-3 days (depending on the weather and on how wet the seeds are) if seeds will be stored for future use. Air dry washed or wet seeds for 1-2 days before sun drying. For species that can withstand high temperature (e.g. many dry land species); covering may become necessary when fruits/ cones are still fresh, and under very intense sunshine.

The procedures include:-

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- Lay a mat, canvas, light-colored plastic sheet, winnowing basket or screen on the ground where the sun shines all day.
- Spread the seeds thinly and evenly.
- Stir and turn the seeds 4-5 times a day for uniform drying. If possible, keep seeds (especially moist ones) shaded during intense heat (noon to 2:00 p.m.).
- Before it rains or gets dark, take the seeds indoors.

The same drying procedure may be used for seeds of most fruit trees.

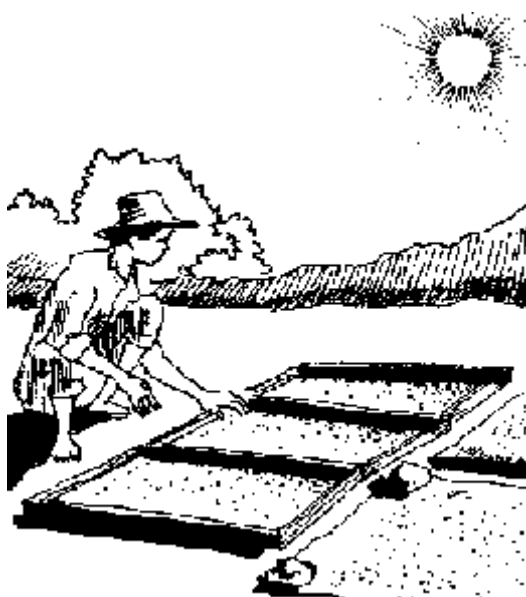


Figure 4.1 Sun drying

Some pods do not crack even if we dry them in the sun. In this case, we should crush them by stepping on them with our feet, or by putting them into a sack and beating them a pestle. These species include *Peltophorumdasyrrhachis*, *Albizialebbeck*, and *Dalbergiabariensis*.

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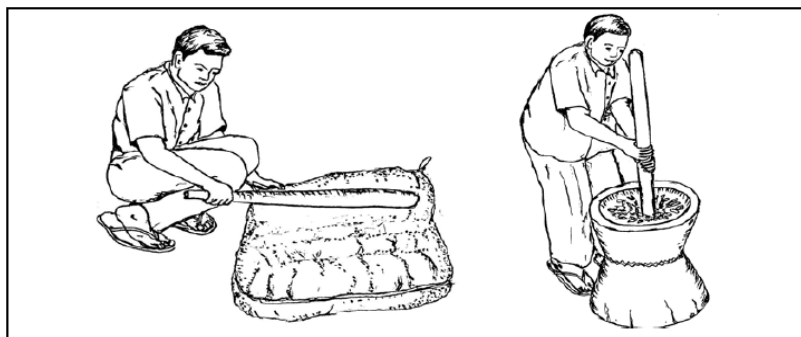


Figure 4.2 Crush them by stepping

The following are the most important operations between extraction and storage.

- Cleaning and separation
- Species related moisture content for storage
- Grading

The following are some of the methods of cleaning and separation.

A. De-winging: especially when the wing is greater than the seed. It is done manually or by machine (cement mixer, mechanical de-winger), by tumbling, or threshing. The characteristics by which sound seeds may be distinguished from inert matter including sterile and empty seeds are: size, shape, color, texture and specific gravity. The first three are the major criteria for visual separation, while seed-cleaning machines employ size and specific gravity.

B. Screening or sieving

- **Blowing:** This includes falling, floatation, rising, winnowing

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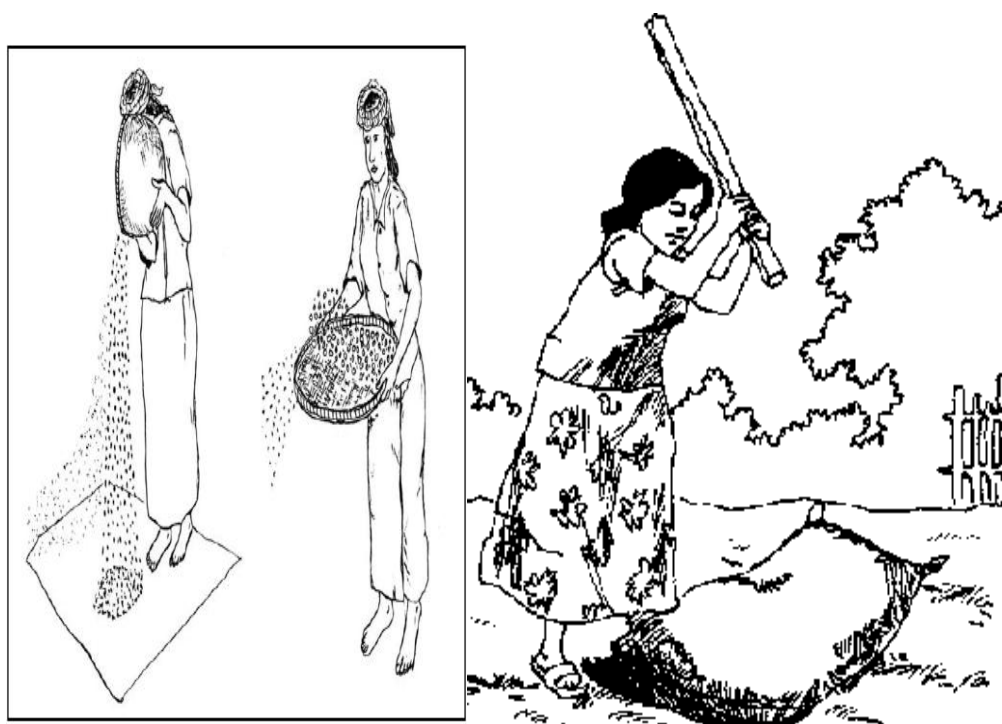


Figure 4.3 Clean seeds by blowing or winnowing.

- Liquid floatation:** to get cleaner and better quality seeds, immerse seeds in a container of water for one to several hours. Discard those that float. Drain and re dry the remaining seeds well. Avoid soaking seeds for too long as this may cause fermentation. Soaking should also be avoided for seeds which rapidly expand to avoid damage. When seeds are to be planted immediately, re drying may be omitted. The cleaning by flotation relies on the principle that the density of the seed of a given species is specific both for filled and unfilled seed.

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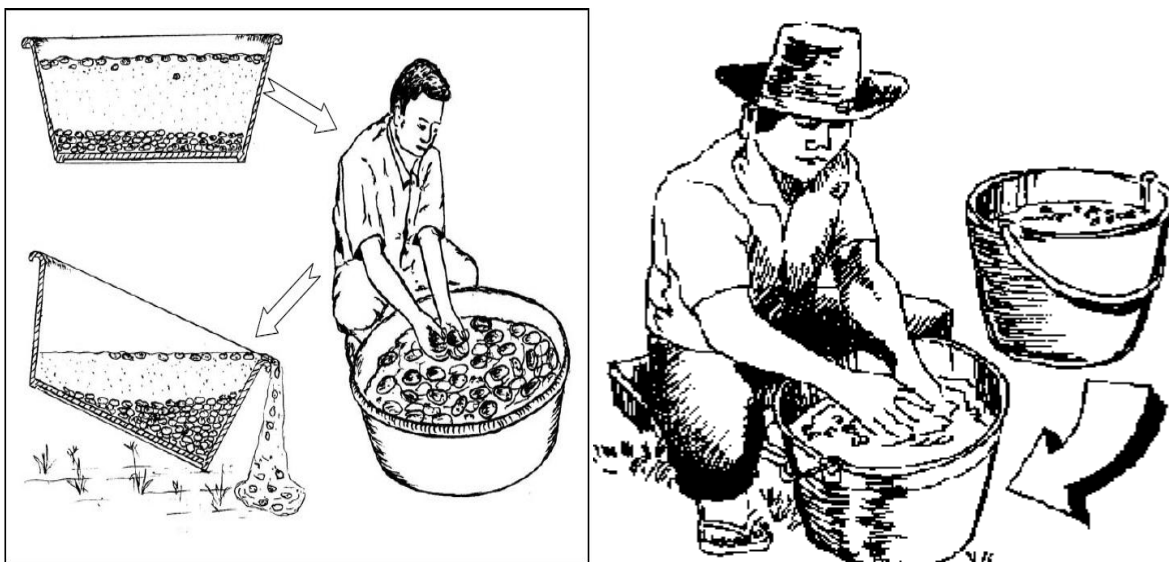


Figure 4.4 Clean seeds by immersing seeds in a container of water

Seed extraction/processing of fruits from seeds is necessary to:

- reduce weight and volume
- enable more rapid drying
- for storage under low risk of fungal attack
- Eliminate the negative impact of fruit chemistry on germination.

4.1.2. Storing seeds

Storage may be defined as the preservation of viable seeds from the time of collection until they are required for sowing. When seed for afforestation can be sown immediately after collection, no storage is needed.

If you are sowing the seeds immediately after processing (within a few days), put them in a cloth bag and keep them cool. Never use a sealed container such as a polythene bag, glass jar or tin, as the seed will be too moist and will quickly get warm and moldy.

If you are keeping the seeds for more than a week (often several months or even a year may be required), store them properly to avoid loss of viability. When the seeds have dried sufficiently,

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leave them in the sun until the afternoon, and then put them immediately into a container that can be properly sealed, thus keeping them dry. Do not leave packing until the morning, as the seeds will absorb moisture overnight.

The simplest container is a thick polythene bag, or two thin ones, one inside the other. Squeeze out the excess air, and then tie the neck tightly with string or wire. It is often a good idea to put the bag in a tin box to protect it from being punctured and from rodents that may try to eat the seed. Label and number the containers of seed. Keep the containers in a cool, dry room. The best place is a well-ventilated ground-floor room on the north side of a two-storey building. Keep the containers off the ground, preferably on shelves half way up the wall. Do not put them in the eaves of a roof, as this will become warm during the day; or directly on a ground floor as this may be damp. Only fully developed, healthy, undamaged seed should be stored.

Seed are prepared for storage by: extraction and drying seed. Long-term storage for purposes of conserving genetic resources. The period of storage will vary according to the seed longevity of the species and the storage conditions, but will be measured in decades in species which are easy to store.

4.2. Applying seed treatment

After carrying out the test, we may come up with a significant % of sound but dormant seeds, i.e., many seeds will not germinate even when supplied with optimum conditions: they remain dormant. There are different methods of seed pre-treatment depending on the type of dormancy. Very often, a method for a certain type can also do for another type so as to hit ‘two birds with one stone’.

i) Physical/ Mechanical Methods

For seeds with exogenous dormancy (impermeable, hard seed coat), common techniques include Scarification which involves rubbing the seed against a rough surface (file, sand paper, concrete mixers, seed scarifiers or any other abrasive material), or nipping/ nicking so as to make a very

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small ‘hole’ sufficient to allow water. This method is more applicable to seeds with seeds coat dormancy, but not for resinous or pulpy fruits. However, nutcrackers can be used for such fruits with hard coats/ nuts.

ii) Hot/Cold water treatment

Such treatments combine the effects of softening hard seed coats and leaching out chemical inhibitors. Some seeds that have little resistance to germination may respond well to soaking for 12-48 hours (depending on how hard the seed coat is) in water at ambient temperature. A more effective treatment, especially in hot climates, is alternate wetting and drying of seeds. (e.g. one day’s soaking , 3-4 day’s drying).

- In hot water treatment seeds are usually placed in to boiling water which is immediately removed from the heat source and left to cool gradually (boiled, and then cooled for about 5–10 minutes to 80 °C), the seeds remaining in the water for about 12 hrs.
- The ratio of water to seeds can be determined by experiment, and may vary considerably according to species; **2-3 time, 4-5 time, 5-10 times**. By and large, the volume of water should be much higher.

NB: Care should be taken not to damage the embryo by excessive heat; especially if the seed coat is permeable.

iii) Chemical treatment/Acid treatment

Concentrated H₂SO₄ (95%) is commonly used to treat dormancy especially for seeds that have been kept in store for a long time.

Materials: Acid (SG= 1.84, 95% pure), acid resistant containers, screens for handling draining & washing seeds, abundant supply of water for rinsing.

- Steps:
1. Allow seeds to come to air temperature
 2. Thoroughly mix seeds
 3. Immersed seeds in the acid (duration based on experiment)
 4. Remove seeds from acid, rinse seeds with abundant water (5 to 10 min)
 5. Spread the seed in a mat for drying.

Care is required in handling acid (safety); excessive application of acid may damage the seed. It requires skill.

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iv) Cold stratification

Usually applied to treat physiological dormancy mainly for temperate species, but also effective for some tropical highland species. Stratification (strictly) refers to the method of placing seeds in layers alternating with layers of a moisture retaining medium such as sand/peat and keeping them at a cool temperature for a certain period, which is commonly between 20-60 days but varies considerably from species to species. It might involve soaking in cold water/moisture medium at temperature of 3-5 °C.

v) Biological methods

Natural mechanisms can be copied by man to overcome dormancy. Sheep & goats in particular may be fed with pods & fruits, and using the natural acidity of the digestive tract the seed coat may be softened or ‘chemically’ treated inside.

vi) Heat & Fire

In nature, fire plays an important role in breaking dormancy while reducing seed coat impermeability & stimulating germination.

It involves spreading seeds in thin layers (bed) over which a grass layer is spread, and the grass set in fire. After burning, the seedbed is sprinkled with water and the nuts are pushed 2cm deep in to the soil and watered thoroughly. However, fire needs exercise.

vii) Seed Dressing

Dressing seeds with a mixture of: repellents, chemicals such as Fungicides to protect infection, to stimulate germination). By and large a combination of one or more treatments is more effective than any single.

4.3. Packaging seeds as legislative requirements

Packaging: is keeping the seed in to the container for storing. Seeds are packaged for storage in accordance with industry, legislative and organizational requirements. Packaging may include:

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Vacuum sealing, use of inert atmospheres such as nitrogen and carbon dioxide, control of packing, environment (temperature, light and moisture).

4.4. Recording seed information

Information about seed must be recorded. Seed dealers, shippers, and handlers are required to maintain and make accessible for inspection, a complete record of each lot of seed.

- **Some information recorded for documentations are:-**

- ✓ the species
- ✓ location seed was collected including latitude and longitude
- ✓ environmental factors such as rainfall, temperature range, and elevation
- ✓ number of trees collected from
- ✓ date
- ✓ collector's name
- ✓ seed lot number
- ✓ recommended scarification technique
- ✓ germination percentage if available
- ✓ the weight of seed in each container

4.5. Recording and reporting seed collection information and results

After recording seed information, they are reported to the concerning body. This information helps for the next process of the collected seed. Recording information also uses for identification of the seed species. It can be done by; Maintained by electronic data base, card index, data sheets, and filing systems manual, using a computer-based system or another appropriate organizational communication system. It may include difficulties or issues faced, any recommendations for future work, results, costs, collation (of information or documentation), interpret information in a way relevant to workplace requirements, organize and maintain records

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accurately, utilize a full range of information media (written, printed, oral, electronic, hand goals, visual display units, personal computers).

● **Information or data that should be record and report in seed collection include:**

- ✓ Name of collector:_____
- ✓ Date of collection:_____
- ✓ Name of species:_____
- ✓ Location (distance, Altitude):_____
- ✓ Site characteristics:_____
- ✓ Tree and stand characteristics:_____
- ✓ Collection methods:_____
- ✓ Amount or weight of seed (kg):_____
- ✓ Signature of collector:_____

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Self-Check – 4

Written test

Name..... ID.....Date.....

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. What is orthodox seed?(3 pts)
2. Define the recalcitrant seed? (2 pts)
3. List down seed separation methods.(5 pts)
4. If insects are the main seed deteriorating agent. How we prevent it? (3 pts)

Test II: Multiple choices

1. What are seed treatment methods to prevent seed from deterioration?(5 pts)
A. Cold stratification B. Chemical treatment C. Mechanical treatment D. All
2. Sealed container such as a polythene bag, glass jar or tin are good storage materials for seed (2 points)
A. TRUE B. FALSE
3. Which is the seed information recorded for documentations?
A. The species B. Seed lot number C. Collector's name D. All

Note: Satisfactory rating - 15 points Unsatisfactory - below 15 points

You can ask you teacher for the copy of the correct answers.

Operation Sheet -4

4.1. Methods of physical seed treatment

A. Tools and equipments

- Hard coat seed
- File(tamp let)
- Screener
- Sand paper
- Concrete mixers
- Seed scarifiers or nicking material

B. Procedures:

1. Select hard coat seeds
2. Sieve the seeds
3. Rubbing the seed against a rough surface
4. Make a very small 'hole' sufficient to allow water

4.2. Methods of hot water seed treatment

A. Tools and equipments

- Boiling water
- Impermeable seed (hard coat seed)
- Screener

B. Procedures/Steps/Techniques

- a. Select hard coat seeds/ Impermeable seed
- b. Sieve the seeds
- c. Boil, and then cool for about 5–10 minutes to 80 °C
- d. Use 10 parts of water to 1 part of seed
- e. Soaking for 12hrs in boiling water
- f. Let stand for 3–10 minutes or until water cools off
- g. If seeds have not swelled, leave to soak overnight
- h. Drying the seed for 3-4 day's
- i. Take care to damage the embryo by excessive heat

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4.3. Methods of chemical/acid seed treatment

A. Tools and equipments

- Concentrated H₂SO₄ (95%)
- Acid resistant containers
- Screener
- Washed dormancy seeds
- Abundant water

B. Procedures/Steps/Techniques

- a. Select hard coat seeds
- b. Screens for handling draining
- c. Allow seeds to come to air temperature
- d. Thoroughly mix seeds
- e. Immerse seeds in the acid (duration based on experiment)
- f. Remove seeds from acid
- g. Rinse(clean) the seeds with abundant water (5 to 10 min)
- h. Spread the seed in a mat for drying
- i. Taker from the excessive application of acid may damage the seed

4.4. Separate the seed from fruits by using de-pulping process

A. Tools and equipments

- Hard coat seeds
- Seed scarifiers or nicking material
- Screener
- Water

B. Procedures/Steps/Techniques

1. Immerse fruits in water for 1-2 days until the fleshy tissue becomes soft
2. Scrape the seeds
3. Crush or nub lightly with hands to separate seeds thoroughly from pulpy flesh
4. Avoid injuring the seeds.
5. Discard all floating seeds and pulp (most seed species are sinkers)
6. Drain seeds
7. Rewash and air-dry for 1-2 days before sun-drying
8. Winnow /separating grain from chaff

LAP TEST-4	Performance Test
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Name.....ID.....Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 3-4 days. The project is expected from each student to do it.

Task-1 Perform seed treatment.

Task 2 Perform seed separation from fruits

LG #11	LO#5-Prepare Seed Sample for Viability Testing
---------------	---

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Identifying and checked seed sample with work order requirements
- Taking seed sample and prepared for testing
- Labelling and packaging representative seed sample
- Recording seed sample information

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify and check seed sample with work order requirements
- Take seed sample and prepare for testing
- Label and pack representative seed sample
- Record seed sample information

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets 5
4. Accomplish the Self-checks 5
5. Perform Operation Sheets 5
6. Do the “LAP test” 5

Information Sheet 5

5.1. Identifying and checked seed sample with work order requirements

The quality of a seed lot determines how well seeds store or perform in the field. To assess the quality of a seed lot, draw a sample from a properly stirred or mixed seed lot.

To get a representative sample, we first mix the seed lot thoroughly (if it is a small lot) or take a certain portion of the seed lot, mix it thoroughly and make a composite sample. The required seed must be taken for sample and prepared for testing. The work order for seed quality testing is:

- Mix the seed thoroughly
- Take representative sample from the mixed seed
- Identify the testing method
- Access the required equipment

5.2. Taking seed sample and prepared for testing

5.2.1. Seed sampling

Seed sampling is the cornerstone for seed testing and tests are based on samples, and the sample should be representative. To get a representative sample, we first mix the seed lot thoroughly (if it's a small lot) or take a certain portion of the seed lot, mix it thoroughly and make a 'composite' sample. Example: Seed Lot: A seed lot is defined as a specified quantity of seeds of reasonably uniform quality from a particular geographic source. After the seed sample identified, representative sample should be taken.

Sampling can be done by:-

1. Halving/Bisecting
2. Random cup method
3. Using mechanical seed dividers (sampling and mixing)

However, sample size depends on seed size :- if there are <5seeds per gram ,a minimum sample of 500g is needed; on the other hand ,where there are more than 750seeds/g, a minimum sample will be 3g.

<https://www.youtube.com/watch?v=lwK3ET59mbo> (Access date September 2, 2022).

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5.2.2. Seed testing

Seed testing is essential to assess the physical and biological aspects of seed. Seed tests are commonly done immediately after extraction and shortly before actual sowing. It is also done periodically on seed lots kept in long storage. For small nurseries, common sense, clean hands, a clean working table and one good knife are sufficient for most seed testing tasks. Some of the common terms and methods have been described below:

- **Purity Test**

It determines what proportion of the seed sample by weight has pure seed and what proportion is other material. The four recognized components of a seed lot are pure seeds, other seeds, damaged seeds and inert matter such as seed wings, twigs, stone soil or other non-seed materials. The separation is done manually by placing seeds on a working table.

The immature, shriveled, cracked, and damaged seeds larger than one-half of the original seed-size, including those with internal insect damage and those starting to germinate, are designated as "pure" seeds.

- **Seed Weight**

Primary seeds weigh from 3-6 mg, secondary seeds weigh from 1.5-4 mg, and tertiary seeds weigh from 1-2.5 mg. It is normally expressed for 1000 pure and full seeds. Factors affecting seed weight are size, moisture content and proportion of full seeds in the lot. It is generally calculated by taking 10 random samples of 100 seeds from a pure lot. If the difference between any two replicates exceeds 10% of the mean weight, additional replicates should be drawn. To convert number of seeds per kilogram following formula is applied:-

$$\text{No. of seeds per kg.} = \frac{1000,000}{1000 \text{ seed weight in gm.}}$$

- **Seed Moisture Content**

Knowledge of seed moisture content is essential to determine the viability and storage conditions. Seeds of high moisture content cannot be stored and overdrying can make them non-viable. It can be determined by drying of 5-10g sample in oven at 103°C for 17 hrs (or at 130°C for 1 to 4 hrs), weighing and calculating through the following formula:

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$$\text{MC\%} = \frac{\text{Original wt. of seed} - \text{oven dry wt. of seed}}{\text{Original wt. of seed}} \times 100$$

- **Germination Test**

The most reliable test of seed viability is to germinate a representative sample (eight replicates of 100 seeds each) under laboratory conditions. Under field conditions cutting the seeds into two equal parts can test viability. Seeds having fully grown, firm and undamaged embryo can be presumed to be good. However, this is not a reliable test for stored seeds because loss of viability in storage may not produce immediate visible changes.

- **Laboratory germination counts (LGC)**

Seeds (100 no.s.) are placed on moist blotting paper or cotton-wool in a Petri dish after giving the necessary pre-treatment. In case of very small seeds, e.g. khokan and kadam, one-gram seed is taken. The Petri dish is placed in a warm (**not hot**) place and kept moist regularly. The number of seeds, which germinate, is counted every day and after 4 weeks or more LGC is calculated as:

$$\text{LGC\%} = \frac{\text{No. of seed germinated} \times 100}{\text{No. of seeds sown in Petri dish}}$$

It is expressed as a number of seeds germinate per kilogram.



Figure5.1. Seed testing by Laboratory germination counts (LGC)

- **TTZ Test**

Another simple test is **tetrazolium (TTZ) staining test**, which indicates the presence of live tissue. 1% solution of TTZ (2,3,5 – triphenyl tetrazolium chloride) is applied to fully imbibed seeds, which have been cut opened length-wise without damaging the embryo. The seeds are left overnight (18 to 24 hrs in the dark at 30° C). The live embryo, cotyledons and other tissue stain pink to red indicating that the seeds are viable. Comparatively larger seeds like Albizia, Bauhinia, Phoebealpensis, etc. can be conveniently tested in this way.

- **Germination energy**

It is a measure of the speed of germination and hence it is assumed value of seed vigour and seedlings it produces.

It is the percentage of seeds that germinate up to the time that the rate of germination reaches a peak. It is expressed in percentage terms as per the following formula:

$$GE\% = \frac{\text{No. of seeds germinate in time 'A' x 100}}{\text{No. of seeds sown in the Petridis}}$$

The seed quality testing body should record the information that get from the seed sample testing. The recorded information may include the seed quality, in terms of germination percentage, seed viability, and so on

5.3. Labelling and packaging representative seed sample

All seeds need to be properly labeled and identified when stored or transported. Labels should include:

- the species
- location seed was collected including latitude and longitude
- environmental factors such as rainfall, temperature range, and elevation
- number of trees collected from
- date
- collector's name
- seed lot number
- recommended scarification technique
- germination percentage if available

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- the weight of seed in each container

The seed that selects for testing are packaged with appropriate container. Packaging can be performed by using; Vacuum sealing, use of inert atmospheres such as nitrogen and carbon dioxide, control of packing environment (temperature, light and moisture)

Labeling is used for the testing body to know the testing method, and testing environment. While sampling seeds are packaged and labeled, it is dispatched to the appropriate body to test the seed.

Labels should be placed both on the inside and the outside of the containers.

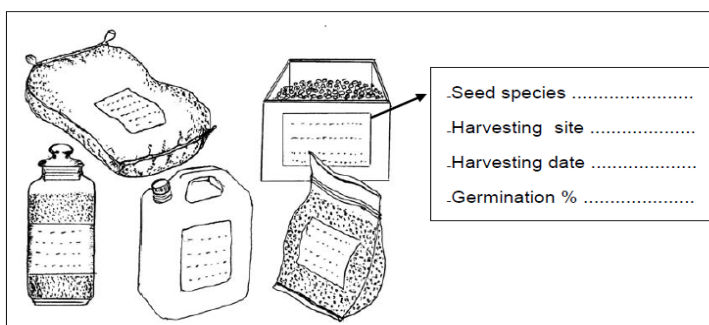


Figure 5.1. Labelling and packaging representative seed sample

5.4. Recording seed sample information

The seed quality testing body should record the information that get from the seed sample testing. The recorded information may include the seed quality, in terms of germination percentage, seed viability, and so on. Therefore testing body should know the information to test the seed quality. A detail about the sample includes; date of sampling, sampling size, seed species, location (locality, distance, latitude and longitude).

Self-Check – 5

Written test

Name..... ID..... Date.....

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. Define purity test and germination energy? (5pts)
2. What do you consider during seed packing? (6pts)
3. What is the factor that determines sample size of seeds for testing? (5pts)
4. What are the methods used to take sample? (4pts)
5. Explain about random cup method of taking sample? (5pts)
6. For large sized seeds we take higher quantity of seed in terms of weight. Why? (5pts)

Test II: Multiple choices

1. Which is the methods to identify representative seed sampling?(6pts)
A. Halving B. Random cup method C. Sampling and mixing D. All
2. Which one is seed testing for assessing the physical and biological aspects of seed?(5pts)
A. Seed Lot B. Purity test C. Seed weight D. All

Note: Satisfactory rating - 25 points Unsatisfactory - below 25 points

You can ask you teacher for the copy of the correct answers.

Operation Sheet -5

5.1. Techniques of germination test by Laboratory Germination Counts (LGC)

A. Tools and equipments

- I. Petri dish
- II. Seeds
- III. Moist blotting paper or cotton-wool and glove

B. Procedures/Steps/Techniques

1. Grouping the seeds in eight replicates of 100 seeds.
2. Place 100 seeds on moist blotting paper or cotton-wool
3. Place moist blotting paper or cotton-wool in a petri dish after giving the necessary pre-treatment
4. Place Petri dishes in a warm (not hot) place
5. Kept moist regularly
6. Counted every day which germinate

LAP TEST-5	Performance Test
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Name.....ID.....Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 1 weeks. The project is expected from each student to do it.

Task-1 Perform germination test

Task-2 Calculate laboratory germination counts and expressed as a number of seeds germinate per kilogram.

Task 3- Prepare representative seed sample

Task 4- Replicate the seeds

LG #12

LO #6-Dispatch Seed and Record Data

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Interpreting and checking seed request specifications
- Retrieving seed from storage and calculating quantity and species of seed
- Weigh, document and place each seed species
- Mixing multiple seed lots thoroughly
- Labelling seed and seed mixtures
- Organizing and undertake dispatch of seed

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Interpret and check seed request specifications
- Retrieve seed from storage and calculating quantity and species of seed
- Weigh, document and place each seed species
- Mix multiple seed lots thoroughly
- Label seed and seed mixtures
- Organize and undertake dispatch of seed

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets 6
4. Accomplish the Self-checks 6
5. Perform Operation Sheets 6
6. Do the “LAP test” 6

Information Sheet 6

6.1. Interpreting and checking seed request specifications

Specification of the requested seed is necessary for dispatching. It indicates that specification of seed; origin, (stand, locality), certificate of quality like; date of test, result of quality parameters, moisture content, treatment applied, certificate of health (phytosanitary certificate), consignment notes (designates the sender and the consignees, net weight of the seed lot. It is used by carriers, and needed in the customs, quarantine. This information must be checked and interpreted by appropriate personnel.

6.2. Retrieving seed from storage and calculating quantity and species of seed

6.2.1. Calculating seed quantity

To determine quantity of seed /kg, it is important to know the purity of seed. Though seeds are said to be cleaned, samples may (unavoidable) contain impurities. Such impurities include undersized, shriveled/dried-up, immature, diseased germinated/broken, inert matter, wings, twigs, stones, soil, leaves, and so on.

$$\text{So, purity\%} = \frac{\text{Wt. of pure seeds}}{\text{Total wt. of original sample}} * 100$$

Based on this purity analysis, the requested seed can distributed to meet the required specifications.

6.3. Weigh, document and place each seed species

Each seed species is weighed, documented and placed in appropriate container accordance with request requirements and site procedures to dispatch for the customer.

Seed should be stored at insect-proof containers at temperatures below 4°C. If possible, it should be dusted with an appropriate insecticide to minimize damage by brunched.

Store seed in airtight containers (jars, etc.) partially filled with a desiccant like calcium chloride, quicklime (burned lime, calcium oxide), or silica gel. Be sure to separate the seed (placed in

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envelopes) from the desiccant with a layer of cardboard or cotton, etc. Oven dry rice kernels are an excellent desiccant.

6.4. Mixing multiple seed lots thoroughly

Concept of seed lots

The quality of a seed lot determines how well seeds store or perform in the field. To assess the quality of a seed lot, draw a sample from a properly stirred or mixed seed lot. Multiple seed lots are thoroughly mixed as required in accordance with request specifications. The proportion of the seed lot is determined by the body that required the seed lot. To mix these seed lot, each seed lot quantify. The appropriate mixing technique is mixing by lying on the mat.

6.5. Labelle seed and seed mixtures

During storage, seed lots should be labeled with the species name, date of collection, collection site, number of mother trees from which the seed was collected and seed weigh. This information will maintain the identity of the seed source and make subsequent evaluation possible.

For this reason, Seed and seed mixtures are accurately and clearly labeled in accorded with industry requirements and site procedures. Label containers with the harvest and storage dates and place of harvest (or acquisition). If possible, also indicate the initial percentage viability or germination of seeds.

The quality of a seed lot determines how well seeds store or perform in the field. To assess the quality of a seed lot, draw a sample from a properly stirred or mixed seed lot

Multiple seed lots are thoroughly mixed as required in accordance with request specifications. The proportion of the seed lot is determined by the body that required the seed lot. To mix these seed lot, each seed lot quantify. The appropriate mixing technique is mixing by lying on the mat.

6.6. Organize and undertake dispatch of seed

Dispatching refers to movement of seed lots from the supplier, seed center to users (nurseries in the same country/nurseries or other users) in another country. In dispatching, seeds are packaged to protect them from changing temperature and moisture content.

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Dispatch of seed is organized and undertaken in accordance with request specifications and site procedures. Seeds are organized and dispatched to who request and specify the site condition. When seeds are dispatched care should be taken about whether the transport distance is long or short. When distance is long addition of a desiccant is recommended for orthodox seeds to absorb moisture. Recalcitrant seeds are dispatched together with their storage media.

For slightly longer store abilities, keep these seeds well cleaned and moist (1 to 2 days of air-drying is generally sufficient to keep the seed coat slightly dry but still moist inside). Store them in small batches in a cool room in inflated plastic bags (half-filled with seed sand opened once a day to prevent fermentation) or in perforated plastic bags. Moist charcoal, peat moss, sawdust, sand or coir dust may also be placed inside the bags. Moist storage for more than a week requires that seeds be protected from molds and bacteria. This may mean soaking seeds in a sterilant like the commercial bleach, chlorox (1 part chemical to 5 parts water) or applying anti-mold substances like fungicides or some plant extracts (try extracts of garlic cloves, acapulco leaves, malunggay leaves or achueteseeds). A temperature of 15 C is often used to further prolong storability's and, to some extent, reduce infection. Recalcitrant seeds also need special attention during transport. The life time of seeds can be extended if extraction is deferred until seeds arrive at the collection site at which time care must be taken to avoid heating and/or fermentation of fruits by aeration or cooling.

Specification of the requested seed is necessary for dispatching. It indicates that specification of seed; origin, (stand, locality), certificate of quality like; date of test, result of quality parameters, moisture content, treatment applied, certificate of health (phytosanitary certificate), consignment notes (designates the sender and the consignees, net weight of the seed lot. It is used by carriers, and needed in the customs, quarantine. This information must be checked and interpreted by appropriate personnel.

Self-Check – 6	Written test
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Name..... ID..... Date.....

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. What do you mean by dispatching of forest seeds?(5pts)
2. Write the possible information that should be includes during labeling of forest seeds.
(5pts)
3. Write the steps of Packing of forest seeds in a bag during dispatching. (5pts)
4. What is the appropriate temperature for seed storage? (3 pts)
5. Why airtight containers are advisable for seed storage? (2 pts)
6. What is the importance of labeling seed lots? (3 pts)

Test II: Multiple Choices

1. How many the purity percentage of the seed if; the weight of pure seed is 3gm and total weight of that sample is 4.5gm? (2pts)

A. 60.3%	65.6%
B. 66.7%	D. 56.6%

Note: Satisfactory rating - 25 points Unsatisfactory - below 25 points

You can ask you teacher for the copy of the correct answers.

Operation Sheet -6

2.1 Techniques of seed dispatching:

A. Tools and equipments

- All tools and personal protective equipments
- Appropriate container
- Seed that labeled properly

B. Procedures/Steps/Techniques

1. Retrieve seed from storage
2. Weigh, document and place in an appropriate container
3. Thoroughly mix Multiple seed lots
4. Labelle seed and seed mixtures accurately and clearly
5. Organize and undertake dispatch of seed
6. Record and report processed seed
7. Dispatch for the required body

LAP TEST-6	Performance Test
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Name..... ID..... Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 24 hour. The project is expected from each student to do it.

Task-1 Perform seed dispatching and show for your teacher how you dispatch your seed.

LG #13

LO#7-Prepare Cuttings for Planting

Activity

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Preparing parent plant and applying suitable method
- Clearing and cleaning work area
- Assessing and selecting cuttings for propagation
- Identifying and providing correct conditioning and storage procedures
- Determining and applying method of cutting preparation
- Arranging and undertaking dispatch of cuttings
- Disposing of discarded cutting material

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Prepare parent plant and apply suitable method
- Clear and clean work area
- Assess and select cuttings for propagation
- Identify and provide correct conditioning and storage procedures
- Determine and apply method of cutting preparation
- Arrange and undertake dispatch of cuttings
- Dispose of discard cutting material

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet 7

7.1. Preparing parent plant and applying suitable method

A cutting:-is a vegetative plant part which is severed from the parent plant in order to regenerate itself, thereby forming a whole new plant.

The success of a cutting is largely determined by proper selection of a mother plant. Every cutting, if successful, will produce a clone of the source plant. So for Preparing parent plant and applying suitable method:-

- Choose a mother plant that reflects what you want to reproduce.
- Only take cuttings from clean, healthy specimens (parent plants), free from insect pests and disease.
- Remove flowers and flower buds from cuttings to allow the cutting to use its energy and stored carbohydrates for root and shoot formation rather than fruit and seed production.
- To hasten rooting, increase the number of roots, or to obtain uniform rooting (except on soft, fleshy stems), use a rooting hormone, preferably one containing a fungicide.
- Prevent possible contamination of the entire supply of rooting hormone by putting some in a separate container for dipping cuttings.

Successfully growing plant cuttings starts with choosing the mother plant carefully and having clean equipments.

7.2. Clearing and cleaning work area

The cutting preparation area should be cleaned before and after cuttings are prepared and stuck. So should the tools used in the process. Remove all plant material, growing media, etc. from the work area. The surfaces and tools being used in propagation should be cleaned with appropriate disinfectant solutions. Be careful not to damage leaves and cuttings. Damaged cuttings are more likely to have problems in rooting both from disease and insects as well as from pre-mature aging of damaged tissue.

Take cuttings with a sharp blade to reduce injury to the parent plant- dip the cutting tools in rubbing alcohol or a mixture of one part bleach: nine parts water to prevent transmitting disease

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from infected plant parts to healthy ones. Only take cuttings from clean, healthy specimens, free from insect pests and disease. Clean and sterilize all equipments that you will use in the cutting process. Introducing foreign substances or bacteria can doom your efforts to grow plant cuttings.

7.3. Assessing and selecting cuttings for propagation

The concept of vegetative propagation is that an **exact copy of the genome** of a mother plant is made and continued in new individuals. This is possible because plants, - unlike animals or humans, - have meristematic, undifferentiated cells that can differentiate to the various organs necessary to form a whole new plant. A piece of plant shoot, root, or leaf, can therefore, grow to form a new plant that contains the exact genetic information of its source plant.

There are two methods of propagation planting stocks in the nursery. These are:

- **Seed (or sexual) propagation**
- **Clonal (or asexual/vegetative) propagation**

<https://www.youtube.com/watch?v=m4Rb8qyjD2E>(Access date September, 2/2022)

I. Seed (or sexual) propagation

Sexual propagation is propagation by seed or spores. The plants will become fertilized and produce the seed that will grow into a new with both of the characteristics of the parent plants.

Because of the traits given by the parent plants, sexual propagation offers these advantages:

1. The only method when creating new varieties or cultivars.
2. It is the easiest and cheapest way of growing plants.
3. A way of getting rid of diseases
4. Some plants are only able to be produced via seed.

Propagation by seed also carries some risks. In order for seeds to grow, they must break dormancy and germinate. Sometimes, the seeds may be dead or have difficulty breaking dormancy. In order to overcome dormancy, horticulturalists may use scarification or stratification techniques.

Sexual propagation also includes growth from spores. Spores are tiny dust-like seeds that grow on sporophytes, plants that produce spores as means of reproduction. A common sporophyte is the fern. Spores grow on the underside of the leaves then disperse when ready. Spores are propagated by taking a leaf from the fern, gently scraping of the spores, allowing them to dry, and then plant. It is recommended that fern spores are planted in sterile conditions because fungus and bacteria are very competitive with spores for space, usually the spores are unable to germinate because of this.

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II. Clonal (or asexual/vegetative) propagation

Asexual propagation involves taking a part of one parent plant and causing it to regenerate itself into a new plant. The resulting new plant is genetically identical its parent. Asexual propagation involves the vegetative parts of a plant: stems, roots, or leaves.

The most important vegetative propagation techniques for tree species are the propagation by cuttings, layering, budding, grafting and micro propagation. The most important reasons for vegetative propagation are:

- Maintaining superior genotypes
- Problematic seed germination and storage
- Shortening time to flower and fruit
- Combining desirable characteristics of more than one genotype into single plant
- Controlling phases of development
- Uniformity of plantations.

The methods to propagate **asexually** plants are classified in two main and six sub categories:

a) Plant Union

- Propagation by Graft age
 - ✓ Bud Grafting (Budding)
 - ✓ Grafting

b) Rooting

- Stock Division
- Propagation by Suckers
- Propagation by Runners
- Layering
- Propagation by Cuttings

There are three types of cuttings: leaf, stem and root. Different parts of the plant leaf, stem and root may be cut for rooting.

A. Rooted Cuttings

Root Cuttings Propagation technique for root cuttings: the following is an explanation of this technique: It is best to collect roots after the fruiting season is over and when the tree is in an active vegetative stage, producing new leaves. Listed below are the procedures: Select healthy roots growing slightly below the soil that are 1.5 to 6 cm in diameter (3-4 cm is best). Cut roots

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into 12 to 30 cm long sections. Roots should be scrubbed clean and kept moist. 9 Root cuttings are then planted directly into the ground in loose, organic soil or in a pot with well-drained soil. Roots can be oriented horizontally below the surface of the soil or diagonally with the upper few centimeters exposed to air. Make sure that the end that is cut from closest to tree is the one that goes into the ground. To avoid confusion, the tip end should be cut diagonally.

This method is one the most popular vegetative propagation techniques, due to its use on both fruit and vegetable plants (such as cassava). The stems, which are used for cloning, have to be harvested during the dormant stage from the mother plant. The cuttings, which originate from a piece of the mother plant, are then placed into the soil. Similar to layering, different techniques can be used for this propagation method. This always uses cuttings from the previous season's growth (more than one year old). There are three types of root cutting.

I. Simple Cuttings

This simple cutting is done on a stem, which usually contains 4-6 buds. The top part of the stem is cut off at an angle. If the cutting originated from an evergreen plant, the bottom two leaves should be removed and planted immediately after being cut. The shoots will then grow from the buds above the soil and the roots will grow from the nodes in the soil. Typical examples for the use of this method are the Gooseberry, Currant, Quince, Fig and Olive.

II. Torn Cuttings

This cutting is performed at the bottom portion of the stem where there is a union with the mother plant. This is a very old technique and it is rarely used nowadays.

III. Hammer Cuttings

In this case, a piece of twig is cut together with the stem. Some plant cuttings, like gooseberry cuttings, are difficult to root and the additional piece of twig helps to develop root system.

Technique: Take root cuttings about 1 meter away from the tree trunk. These cuttings should be 20- 25 cm long and 1-2 cm thick. Place these cuttings horizontally into the soil about 10 cm deep until they shoot. This technique is useful for propagation of guava, breadfruit, apple, blackberry and raspberry.

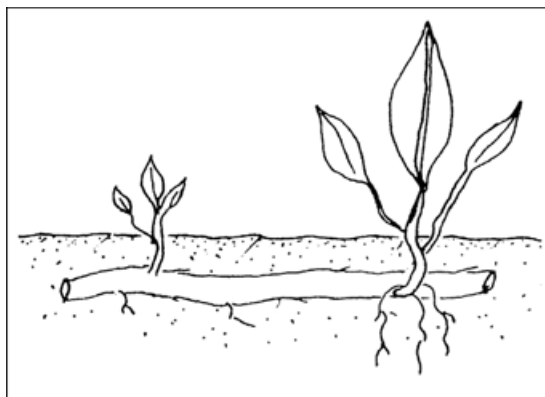


Figure7.1. Root cuttings

B. Stem cuttings

Taking stem cuttings is perhaps the most common way to vegetatively propagate shrubs or trees. The process is relatively simple requiring only a limited area for reproduction, whilst a single mother- or stock plant can yield many cuttings. A large number of ornamental plants are propagated this way, but little is known about the use of this method for most agro forestry trees. Let us briefly describe some of the underlying principles of the cutting and rooting process, highlight the different factors influencing this and look at the different steps leading to the successful propagation of trees and shrubs through this technique.

Technique: Usually a few leaves sometimes halved are left at the tip of the cutting, the number depending on growing conditions (shade, humidity, etc.). Leaves generally stimulate root growth, but cuttings are likely to dry out if the leaf area is large.

The tip of the shoot or twig is usually discarded, but a vigorous shoot can still yield several cuttings of 15 - 50 cm, the recommended length. Commonly, the diameter of cuttings ranges from pencil-thick to about 3 cm. The upper cut is oblique so rainwater runs. The lower cut is usually made just below a node, because rooting generally occurs mainly at the node.

Always use clean tools: disinfect your cutting tool in boiling water before use. Never use a blunt knife or machete for taking cuttings. If a cut is not smooth and clean, rot may lead to failure of the cutting; it can also infect the wound on the mother tree. Upright branches and twigs are preferred for cuttings, because they grow upright after rooting, forming a tree with a proper trunk. Cuttings taken from horizontal or drooping branches often do not grow upright.

If cuttings cannot be planted straight away they may be stored in a cool shaded place under damp jute bags, grass or leaves. Leafy cuttings should be planted without delay.

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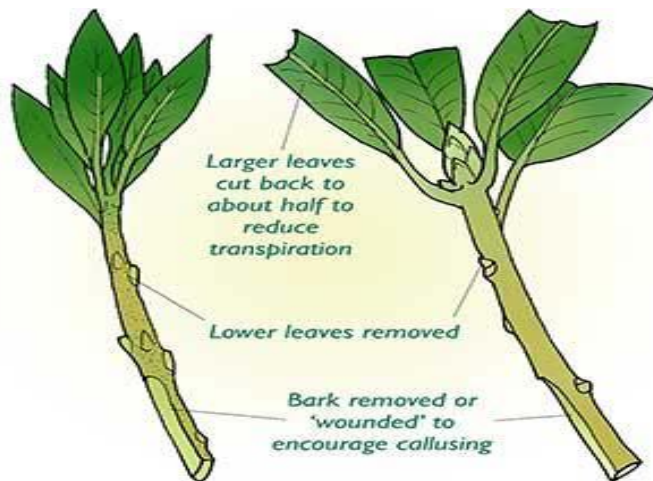


Figure 7.2. Stem cuttings

C. Leaf cuttings

In most of these cuttings, adventitious shoots form along wound surfaces near vascular tissues. Propagation by leaf cuttings is virtually limited to some ornamental plants.

Technique:

- Remove leaf with 1-2 " of petiole
- Place leaf on media surface with petiole inserted into the medium.

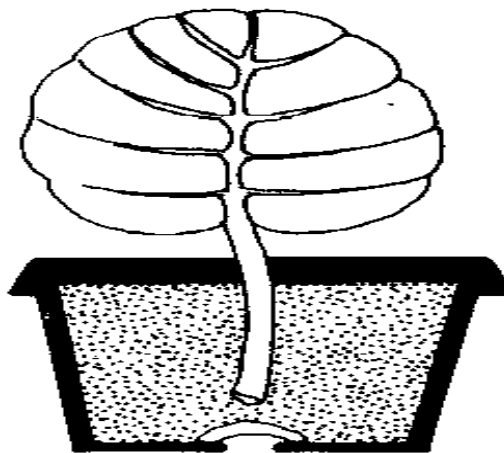


Figure7.3. Leaf cuttings

7.4. Identifying and providing correct conditioning and storage procedures

Many propagators prefer to collect prop gules from stock plants early in the day when cuttings are still turgid. If the cuttings cannot be stuck immediately, they are misted to reduce transpiration and held overnight in refrigeration facilities at 4 to 8 °c and generally stuck the next day.

Successful storage of un rooted cuttings depends on storage conditions, state of the cuttings, and species. It is important that dry matter losses and pathogens be minimized. Within the storage unit, it is best to maintain nearly 100 percent humidity, and temperature should be as low as the hardiness of the given species can tolerate.

- **Storage procedures in cuttings is include:-**

- ✓ Insert cuttings into a rooting medium such as coarse sand, vermiculite and soil.
- ✓ It is important to choose the correct rooting medium to get optimum rooting in the shortest time.
- ✓ In general, the rooting medium should be sterile, low in fertility, drain well enough to provide oxygen, and retain enough moisture to prevent water stress. Moisten the medium before inserting cuttings, and keep it evenly moist while cutting are rooting and forming new shoots.
- ✓ Place stem and leaf cuttings in bright, indirect light.
- ✓ Root cuttings can be kept in the dark until new shoot appear.

If possible, cuttings should be planted immediately after being cut from the parent tree. If this is not possible, due to distance for example, the cuttings must be protected from drying out by wrapping them in a wet sack and keeping them in a cool place.

All these methods are simple and highly recommended since farmers can grow more trees without having to establish nurseries or buy seedlings. If a new species is to be introduced to an area it may be a good idea initially to grow cuttings in pots. These cuttings grown in nurseries are better able to withstand transportation and delays in planting than fresh cuttings. For species that can be propagated both from seeds and from cuttings, cuttings normally grow faster.

- Different steps leading to the successful propagation of trees and shrubs through these techniques are:-
 - ✓ Cuttings should be taken early in the morning before the sun is hot, as this will keep transpiration and thus drying out to a minimum.

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- ✓ Trim leaves before the shoots are detached from the stock plants as this reduces water loss. Leaf areas for optimum rooting vary with species, however, 50 cm² seems to be the recommended leaf area prior to full investigation on this factor for different agro-forestry species. The leaf area should allow for a balance between photosynthesis and transpiration when cuttings are under the non-mist propagator.
- ✓ Use a polyethylene bag that is moistened inside to carry the shoots.
- ✓ Keep the collected shoots under shade, without throwing or squeezing the bags.
- ✓ If you are carrying the shoots over a longer distance, keep them in a cool box – but ensure that the shoots do not directly touch the cooling elements.

In the nursery, have all equipment and tools ready and well arranged in advance in order to keep cuttings moist and transfer to propagators without delay. Delay can cause the cuttings to dry out and is often responsible for rooting failure of cuttings in arid and semi-arid zones.



Figure7.4. Use of a polyethylene bag to carry the shoots for propagation of trees

7.5. Determining and applying method of cutting preparation

A cutting is a piece of vegetative tissue (stem, root or leaf) that, when placed under suitable environmental conditions, will regenerate the missing parts and produce a self-sustaining plant. Used mainly in the clonal propagation of herbaceous and some woody ornamental species.

For Preparing Cuttings, Sanitation is one of the activities. The cutting propagation process not only requires conditions that favor the development of disease and insect problems, we also cut the plants. Open wounds are avenues through which pest problems can enter plants. Therefore, it is important that not only the cuttings be disease and insect free but the instruments used to prepare the cuttings, the area in which the cuttings are prepared and the area where they are rooting should also be kept as clean as possible.

The basic tools for cutting is: Cutting tape, Cutting/grafting knife, Pruning shares and etc.

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Figure7.1. Basic cutting tools

7.6. Arranging and undertaking dispatch of cuttings

Delivering cutting materials to a customer is done through a process called dispatching. In addition to cutting delivery, dispatching also allows the dealer to stage the of the cutting in their warehouse first, & then deliver later. All dispatched cutting can be tracked by arranging all necessary information. on the warehouse report. At the end of the year, the dispatched seed will be used to generate a year end summary as well as process.

7.7. Disposing of discarded cutting material

7.7.1. Environmental effects of discarded cutting material

Since discarded cutting materials have negative impact on the work area as well as on the environment whole, environmental protection measures, such as hygiene of the area, relevant national, state and local legislation and regulations should be taken in order to minimize the effect and to install work and create safe work conditions.

Good attention and care should also given to contingencies for modifying operations during wet or other adverse weather conditions to make balance the disturbed environment.

7.7.2. Disposing way of discarded cutting material

If you sprayed any left over from cuttings you may mess up the proper cleaning program of the work place. So properly collect scraps (left over) from cuttings and dispose it in pit dug for this

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purpose or clean it from the area by burning. Material is disposed of in accordance with workplace waste disposal and recycling regulations.

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Self-Check – 7

Written test

Name..... ID..... Date.....

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. Write at least four reasons of vegetative propagation. (4 pts)
2. List the procedures in sorting and selecting cuttings? (4 pts)
3. Why we need to dispose discarded material during plant cutting? (3 pts)
4. What are environmental protection measures to take correction of discarded cutting materials effect? (3 pts)

Test II: Multiple choices

1. Which one are not the methods of propagation? (4pts)
 - A. Seed (or sexual) propagation
 - B. Clonal (or asexual/vegetative) propagation
 - C. A and B
 - D. None
2. Which one is the most important reasons for vegetative propagation?(3pts)
 - A. Maintaining superior genotypes
 - B. Problematic seed germination and storage
 - C. Shortening time to flower and fruit
 - D. All
3. Which one is the basic tool for cutting?(3pts)
 - A. Cutting tape
 - B. grafting knife
 - C. Pruning shares
 - D. All

Note: Satisfactory rating - 25 points Unsatisfactory - below 25points

You can ask you teacher for the copy of the correct answers.

Operation Sheet -7

7.1. Procedures of preparing stem cuttings

A. Tools and equipments

- Cutting knife
- Sharpening stone
- Hand pruners
- Dibble
- Grafting chisel and small mallet
- Grafting wrap or tape
- Grafting wax
- Plastic Bag

B. Procedures

1. Select the proper mother plant that is free from insect pests and disease.
2. Organize and prepare tools and equipments for cutting operation.
3. Clean the cutting preparation area before cuttings are stuck.
4. Remove all plant material and growing media from the work area.
5. Clean the surfaces and tools being used in cutting propagation with appropriate disinfectant solutions.
6. Remove the leaves from the stem and wounding.
7. Remove flowers and flower buds from cuttings.
8. Cut off top part of the stem at an angle and.
9. Prepare plant hormones.
10. Place in plastic bag.

LAP TEST- 7	Performance Test
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Name..... ID..... Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1:30** hour. The project is expected from each student to do it.

Task-1 Perform stem cuttings.

LG #14	LO #8- Record and Document Information
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Instruction sheet
<p>This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:</p> <ul style="list-style-type: none"> Recording and documenting seed collection, processing, sampling and dispatching Recording and reported cutting preparation information and results Reporting problems or difficulties recording and reporting materials, equipment and machinery wastage /damage Communicating work completion and hazards information Reporting work outcomes <p>This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:</p> <ul style="list-style-type: none"> Record and document seed collection, processing, sampling and dispatching Record and report cutting preparation information and results Report problems or difficulties Record and report materials, equipment and machinery wastage /damage Communicate work completion and hazards information Report work outcomes
Learning Instructions:
<ol style="list-style-type: none"> 1. Read the specific objectives of this Learning Guide. 2. Follow the instructions described below. 3. Read the information written in the information Sheets 8 4. Accomplish the Self-checks 8 3. Perform Operation Sheets 8 4. Do the “LAP test” 8

Information Sheet 8

8.1. Recording and documenting seed collection, processing, sampling and dispatching

Data documenting are maintained in an archive so as to be retrievable as needed.

- Records are preserved and archived for retrieval as needed based on the following:
 - ✓ Include documenting of all data and information required such as seed collection, processing, sampling, dispatching and all information that discussed in the above under all learning outcome.
 - ✓ Ensure that documenting is legible, identifiable and traceable to the operation/activity.
 - ✓ Ensure that documenting are stored and maintained so they are readily retrievable and protected against damage, deterioration or loss.
 - ✓ Ensure that the retention times of documenting have been established, recorded and communicated to staff.
 - ✓ The data documented should be legible, if possible written in computer, accurate (carefully documented) and complete (consisting of all the required information). Finally all the above process should be recorded and documented.

8.2. Recording and reported cutting preparation information and results

Cutting preparation information: is made for propagation and record each activities and reported for the concerned body for future performance of the activities. Each results should be recoded and reported according to the regulations of the organizations.

It produces seedlings for a forestation and tree planting. Seedlings are usually needed in large numbers and young trees of most species do not survive well if directly grown on the plantation site. It is therefore easier and cheaper to grow seedlings in one place - the nursery - and plant them only when they need less care and protection.

8.2.1. The purpose of recording and reporting of information and results

Reporting and recording are legal requirements. The report tells the enforcing authorities for occupational health and safety (HSE and local authorities) about serious incidents and cases of

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disease. This means they can identify where and how risks arise and whether they need to be investigated.

An accurate written record detailing all aspects of patient monitoring is important because it contributes to the circulation of information amongst the different teams involved in the patient's treatment or care.

8.3. Reporting problems or difficulties

Reporting problems in completing work enables to identify the cause of the problems and to take corrective measure as much as possible and to prevent those recorded problems in the next phase which may reduce cost through three mechanisms:

- Reduce labor-intensive diagnostic evaluation
- Eliminate diagnostic testing down-time
- Provide notification to management for degraded operation

Maintenance requires three actions:

- problem identification
- isolation of cause of the problem
- Coming out with corrective solution

Problem discovery requires diagnostic maintenance, which requires system down time and labor costs. Down time and cost requirements associated with diagnostics are eliminated for every item that satisfies the following criteria.

- Automated diagnostic
- Instrumented for remote viewing
- Displayed in the vicinity of supervisory personnel

Problem reporting is an optional feature that can be forwarded to remote displays using simple configuration setting in all modern computing equipment. The system level of reporting that is appropriate for Condition Based Maintenance are critical, alert, and emergency, which indicate software termination due to failure. Specific failure reporting, like interface failure, can be integrated into applications linked with these reporting systems. There is no development cost if these are incorporated into designs.

Other kinds of problem reporting involves painting green, yellow, and red zones onto temperature gages(A measuring instrument for measuring and indicating a quantity such as the thickness of

wire or the amount of rain etc.), pressure gages, flow gages, vibration sensors, strain gages, and similar sensors. Remote viewing can be implemented using a video camera.

8.4. Recording and reporting materials, equipment and machinery wastage /damage

All material and tools including PPE and those appropriate for seed collection and processing should be well-handled and in case of any damages and defects it should be immediately recorded and reported to the concern body. This increases work efficiency and even it protects the workers from damage as well as the materials and it also increase the productivity of the enterprise as a whole. Here it is essential to apply the philosophy of kaizen namely what we call it 5s.

8.5. Communicating work completion and hazards information

Hazard: is a situation at the workplace capable of causing harm (i.e. capable of causing personal injury, occupationally related disease or death).

Hazard identification: is a process used to identify all possible situations where people may be exposed to injury, illness or disease, the type of injury or illness that may result from these and the way in which work is organized and managed. It is the first part of a risk management strategy described in Occupational Health & Safety Management System (OHSMS).

Workplace Health and Safety Regulations require employers to ensure that appropriate measures are undertaken to identify all hazards and to manage risk in the workplace.

8.5.1. Reporting Hazards and Accidents

Employees are required to report any situation or occurrence in the workplace that may present a risk or have the potential to affect the health and safety of employees or others in the workplace.

It is required that all injuries, incidents and hazards are properly reported, investigated and recorded in accordance with the procedures detailed below.

An accident is commonly used to describe an incident which has resulted in an injury.

An incident is any unplanned event resulting in or having the potential for injury, ill health, damage or loss.

A hazard is a source or a situation with the potential for harm in terms of human injury or ill health.

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- **Injury Reporting**

- ✓ In the event of an injury the person involved should;
 - ✓ seek first aid or medical attention as required;
 - ✓ inform their supervisor as soon as possible;
 - ✓ complete the Confidential Incident / Injury Report Form
 - ✓ Assist their supervisor in the investigation and reporting on the incident or accident.
- The Supervisor of the person(s) involved in the incident is required to:
 - ✓ ensure that any injured person is promptly attended to;
 - ✓ conduct an initial investigation into the cause of the incident;
 - ✓ complete the Confidential Incident / Injury Report Form and ensure that it reaches the Safety and Health; and
 - ✓ Notify and liaise with the local Safety & Health Representative and line management in relation to the incident.
 - ✓ Ensure that all serious injuries are reported to the Safety and Health immediately after hours of assistance.

On identifying a hazard, staff must act as quickly as possible to eliminate it. This may mean a simple alteration, substitution or removal of the hazard.

8.6. Reporting work outcomes

During reporting, think about who is going to read the report, what you say and how you say it will depend on this.

- **In Writing a report: -**

- ✓ What need were you trying to address? (Your original aim?)
- ✓ What did you actually do? (Out puts)
- ✓ What went wrong and why?
- ✓ What difference did you make? What were the key headline achievements?
(outcomes)
- ✓ What could be learned from your experience? Will you do anything differently next time?

- For starting to write any report:

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1. analyzed your information
2. Decided what you want to say

If you don't do this, your report is likely to be muddled, and the reader will not know what you're trying to tell them. It will be a waste of time and effort.

- **The main content of your report should include:**

- ✓ **Your outputs:** The main facts and figures about your activities
- ✓ **Your outcomes:** what did we achieve? (The outcomes you have achieved specifically).

What goes here?

So, based on this principle we have to report our work outcomes to appropriate persons (concerned body).

Self-Check – 8

Written test

Name..... ID..... Date.....

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. List information or data that should be recorded and reported in seed collection (5pts)
2. What is the importance of recording and reporting damages of materials? (3pts)
3. _____ is a process used to identify all possible situations where people may be exposed to injury, illness or disease? (4pts)
4. What is the importance of recording and reporting damages of materials? (5pts)

Test II: Multiple choices

1. Which one of the mechanisms to reduce cost those recorded problems in the next phase?(5pts)
 - A. Reduce labor-intensive diagnostic evaluation
 - B. Eliminate diagnostic testing down-time
 - C. Provide notification to management for degraded operation
 - D. All
2. Which one is the following are the criteria for eliminating diagnostics Problem?(5pts)
 - A. Automated diagnostic
 - B. Instrumented for remote viewing
 - C. Displayed in the viscosity of supervisory personnel
 - D. All
3. Which one is the included in the writing a report of work outcomes? (5pts)
 - A. Your original aim
 - B. Out puts
 - C. What went wrong and why
 - D. What could be learned from your experience
 - E. All

Note: Satisfactory rating - 25 points Unsatisfactory - below 25points

You can ask you teacher for the copy of the correct answers.

Operation Sheet -8

8.1. Procedures of recording and reporting work outcomes

A. Tools and equipments

- Note book
- Pencil
- Paper
- Pen
- Computer

B. Procedures/Steps/Techniques of recording and reporting work outcomes

1. Identify applicable occupational health and safety
2. Review and clarify appropriate personnel for seed collection
3. Ensure environmental protection measures
4. Identify potential locations for the collection
5. Select and check appropriate equipment and resources
6. Plan Seed collecting operations and check safe working conditions
7. Establish and maintain communication with others (owners of the stand, organizations).

LAP TEST-8	Performance Test
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Name..... ID.....Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **30 min**. The project is expected from each student to do it.

Task-1 Comply with legislation, regulations, standards and, codes of practice and established safe practices and procedures for collecting seed

Task 2: Review and accurately identify work requirements.

Task3: Use and maintain relevant equipment and resources.

Task4: Identify problems and equipment faults and demonstrate appropriate response procedures.

Task5: use appropriate communication and interpersonal techniques with colleagues and others.

Task6: accurately record and maintain information including details of seed species, weight and place of origin.

Reference Materials

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Trends in Tree Seed Systems in Ethiopia

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[http://www.tx.nrcs.usda.gov/technical/pmc/docs/ecs580\(August29/2022\).](http://www.tx.nrcs.usda.gov/technical/pmc/docs/ecs580(August29/2022).)

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