Practical Manual of

Seed Technology and Nursery Management

FBT 212 3(2+1)

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Syllabus: Seed Technology & Nursery Management Practical: Identification of seeds of tree species; Seed maturity tests; Physical purity analysis; Determination of seed moisture; Seed germination test; Hydrogen peroxide test; Tetrazolium test for viability; Seed vigour and its measurements; Methods of breaking dormancy in tree seeds; Testing membrane permeability; Study of seed collection and equipments; Planning of seed collection; Seed collection; Seed extraction; Visit to seed production area and seed orchard; Visit to seed processing unit/testing laboratory; Study of seed sampling equipments. Preparation of production and planning schedule for bare root and containerized nurseries. Nursery site and bed preparation. Pre-sowing treatments. Sowing methods of small, medium, and large sized seeds. Mother beds and transplant bed preparation- Pricking and transplanting of in transplant beds. Intermediate nursery management operations. Preparation of ingredient mixture. Filling of containers. Visit to tree nurseries.

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Session .....

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This is to certify that Shri./Km. .....ID No.....has completed the practical of course.....course No. ..... as per the syllabus of B.Sc. (Hons.) Agriculture/ Horticulture/ Forestry ..... semester in the year.....in the respective lab/field of College.

Date: Course Teacher

INDEX

Practical No. 1

Objective: To identify seeds

1. Identify different types of seeds on the basis of following criteria

S. No.	Tree species (Common name)	Scientific name	Size	Shape	Texture	Colour
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

2. Collect seed samples of any 10 species for seed herbarium

Practical No. 2

Objective: To know the time of seed ripening

1. Write name of tree species and their maturity indication of seed and time of seed collection

S. N.	Tree Species name	Maturity indication	Time of seed collection

1.			
2.			
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Practical No. 3

Objective: To determine the percentage composition by weight of pure seeds

1. Write down procedure to determine the percentage composition by weight

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2. Write down details in following Table:

Working Sample	Weight (gm)	Components of Sample
A		PS= OS= IM=
B		PS= OS= IM=
C		PS= OS= IM=

PS=Pure Seed, OS= Other Species Seed, I=Inert Material

Calculation:

Components	Weight	Percentage
PS		
OS		
IM		
WS		
Total		100%

Practical No. 4

Objective: To determine moisture content of seeds

1. Write down complete procedure for measurement moisture content of given seed sample

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Sample	Replication	Fresh weight of seed	Dry weight of seed with dish
A	1		
	2		
	3		
B	1		
	2		
	3		

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Practical No. 5

Objective: To determine the germination potential and vigour of a seed lot

1. Write down complete procedure for germination potential and vigour of a seed

2. Write down details in following table

Dates	Day	Replications				Daily Total	Cumulative total	Cumulative germination%	Peak value	Germination speed
		R1	R2	R3	R4					
	1									
	2									
	3									
	4									
	5									
	6									
	7									
	8									
	9									
	10									
	11									
	12									
	13									
	14									
	15									
	16									
	17									
	18									
	19									
	20									
	21									

Practical No. 6

Objective: To determine viability of seeds through Tetrazolium test.

1. Write down procedure for viability of seed through Tetrazolium test

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2. Write details in following table

Replication	Category								
	C1	C2	C3	C4	C5	C6	C7	C8	C9
R1									
R2									
R3									
R4									

Category	Staining Pattern
C1	completely stained seeds in red
C2	partially stained seeds with colored embryos in red
C3	seeds with colored embryos only
C4	partially stained seeds with non-colored embryos
C5	completely non-colored seeds
C6	seeds colored in Brown
C7	C1 + C2
C8	C1 + C2
C9	C3 + C4

Practical No. 7

Objective: Seed Certification procedures

1. Write down procedure for seed certification

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Labels and certificates. It is generally agreed that the amount of information required on labels should be kept within reasonable bounds, and a number of distinctive yet simple labels are in use. **Most of these bear the following items of information:**

Species (Latin name): ……..

Subspecies variety or cultivar name: ……

Category (source-identified, selected, certified): ……

Provenance (reference number, place or region, elevation): ……...

Supplier (name and address): ……...

Seed (month and year of crop, quantity): ……

Plants (age or size, quantity): ……

FAO I(1950) and IUFRO (FAO, 1952) jointly prepared an international certificate of origin and quality for tree seed and plants and this carries a large amount of information. Such a certificate would bear the following items:

Certifying agency: ……

Consignee (name and address): ……..

Sender (name and address): ……

Species (latin name): ……..

Subspecies variety or cultivar name: ……

Category (source-identified, selected, certified): ……

Provenance (reference number, place or region, elevation): ……

Gross weight of packages: ……..

Contents (seed or plants, quantity): …….

Disinfection treatment (date, place, method).: …….

Practical No. 8

Objective: To know different methods to break seed dormancy

1. Write down different methods used to break down seed dormancy.

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2) Use any one method to break seed dormancy of tree species *Albezia lebback*. Write down in detail about the method used for breaking seed dormancy.

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Practical No. 9

Objective: To know seed collection timing, location and quantity of seed and method of seed collection

1. Fill the following table with different seed collection method and collect seeds using different methods:

S. N.	Species	Method of seed collection
1.		
2.		
3.		
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Practical No. 10

Objective: To know seeds extraction by using different methods

1. Write down different stages in method of seed extraction and processing

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ii) Write down seed extraction procedure for *Dalbegia sissoo* tree species.

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Practical No. 11

Objective: To know about the basic methods of sampling bulk lots and some special applications for tree seeds

1.Write down complete procedure for seed sampling

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2. Write down complete procedure for seed processing stepwise

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3. Visit to seed processing unit/testing laboratory to University /Institute

Practical No. 12

Objective: To prepare for production by planning for bare root and containerized nursery plantation

1. Select species suitable for bare root planting and plant it in field and fill up the following information of bare root planting method:

i) Name of the specie ……

ii) Type of planting technique ……...

iii) Season required ……...

2. Select species suitable for container planting and plant it in field and fill up the following information of container planting method :

i) Name of the specie ……

ii) Type of planting technique ……...

iii) Season required ……

Practical No. 13

Objective: To identify ideal site and bed preparation in nursery

1. Draw nursery lay out with proper labels.

2. Write down procedure for raised bed and sunken bed for seed sowing

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Practical No. 14

Objective: To know sowing methods for different seed size

1. Enlist different methods of seed sowing and explain any one of them in detail.

Practical No. 15

Objective: To know technique of pricking and transplanting from mother beds

1. Write down step wise procedure in pricking and transplanting of seedlings in bed

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Practical No. 16

Objective: To identify natural seed production areas and plant artificial seed production areas for abundant seed production

1. Visit Clonal seed orchard or seedling seed orchard and write down following details

i) Name of species……..

ii) Type of orchard……..

iii) Year of establishment……..

iv) Spacing…….

v) Experimental design……..

vi) Objective of orchard…….

vii) Area of the orchard……

vii) Thinning year…….

Practical No. 17

Objective: To know the propagation techniques and management practices in nursery

1. Visit nursery nearby to your locality

Observations to be recorded in nursery field visit

i) Name of the nursery: ……

ii) Address of the nursery: ……

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iii) Type of nursery: ……..

iii) Facilities available in nursery: ……

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iv) Techniques use for raising material: ……

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v) Type of fencing: ……..……

v) No. of labors available:……..……

vi) Road facilities available:……..……

APPENDICES

SEED IDENTIFICATION

Seed definition: The seed is a mature ovule consists of an embryo a protective covering and stored food as endosperm. The useful clues for the identification of seed from the following characters:

1. The size, shape and color of seeds
2. The nature, arrangement and pattern of markings that is lines, ridges, pits, projection on the seed surface
3. The shape and position of the attachment scar
4. The presence of wings, hair or scale, spines etc
5. The internal structure, position and size of the embryo, presence or absence of the endosperm

Seed identification (using seed keys): Like many botanical keys to identify plants, seed keys are called dichotomous keys. Seed keys are developed on the basis of characters pertaining to family, genus, and species. Once the seed is characterized for a particular family, identification of the seed could easily be made by studying the above-mentioned seed characters. In this key the user is given two statements and chooses the one that most pertains to the seed they are looking.

Seed identification (Using seed drawings, photographs and descriptors): Many people use Seed drawings called plates to come to identify seed they are looking at. Photographs of seed may also be used for this. Good visualization skills are needed for this comparison type of seed identification. Once the identity of a seed is found then the use written description of the seed called descriptors to confirm identification.

Seed identification (using seed herbarium): A seed herbarium is a standardized collection of seeds with a known identity. These may be arranged phylogenically from less complex plant families to more complex simply alphabetically by family, then by genus and finally by species.

Seed images virtual seed herbarium: Photos of seed with seed images database is the main content. This database contains descriptions of the seeds and seed descriptors to aid you in your seed identification. This allows identifying seeds simply by the search mechanism.

Seed maturity test: The criteria for seed maturity generally used are given below:

a) Laboratory methods

Germination test: The seed samples are put to germination test and correlations are developed between per cent germination and time of collection. Maximum seed germination is considered as the right indication of fruit and seed maturation and thereby collection.

Dry weight of seed: When seed has reached its highest dry weight it is an indication or measure of maturity.

By chemical analysis of seed: When seed get matured some bio-chemical changes takes place. In some special cases increase or decrease in some metabolites can be used to know the seed maturation.

Using X-ray radiography: By using soft X-rays the examination of development stage of endosperm and embryos can be done rapidly.

B) Field methods:

Direct examination of seed: This method is quite applicable for those species which have relatively large seeds. Cutting of the fruit or seed reveal the development of embryo and the firmness of endosperm and seed coat. The endosperm wherever present should be firm and not milky except in case of coconut. Mature seed have firm embryo/or endosperm.

Change of colour: Change of colour and size in fruits give a simple and reliable indication for assessing the maturity of seed. In several cases it is essential for the person associated with seed collection to have enough experience to judge simply by visible appearance the change in colour, size shape and softness or smell of pulp when seed and fruit are ripe and fully suitable for collection.

Seed maturity variation often occurs among trees and sometimes even on different parts or sides within a single tree or shrub. Change in colour of bark of fruit and seed from green to also shows indication for fruit or seed ripen. In several species immature seeds after ripen satisfactorily when the fruits are stores under congenial conditions.

3. Physical purity analysis

Physical purity Analysis: The objective of purity analysis is to determine the percentage composition by weight of pure seeds, seeds of other species, and inert particles that make up the sample.

A working must be drawn from the submitted sample, weighed and recorded in grams to three decimal places, and separated into three components: pure seed of the test species, seed of other species, and inert matter. Each component

must then be weighed and recorded in grams to three decimal places. Calculation of the purity analysis must be done as follows:

The sum of the weights of the three component fractions of the submitted test sample must be compared to the original weight for any gain or loss. If a discrepancy of more than 5% of the original sample weight is found, the test must be discarded and a re-test is required.

The percentage by weight of each component fraction is calculated by the following formula:

$$\text{Component (\%)} = \frac{\text{weight of each component fraction}}{\text{Total test sample weight}} \times 100$$

$$\text{e.g. Pure seed (\%)} = \frac{\text{weight of pure seed fraction}}{\text{Total sample weight}} \times 100$$

When percentages of all three components are added together, they must equal 100%. The percentage by weight of pure seed must be expressed in one decimal place (e.g. 99.9%). In case the sum does not equal to 100% (either 99.9 or 100.1%), 0.1% must be added or subtracted from the largest value (usually the pure seed fraction). Fractions of the components less than 0.05% are recorded as 'trace'.

Determination of moisture content: The importance of moisture content is affecting the longevity of seeds in storage. ISTA prescribed "Low constant temperature oven method" as applicable to forest trees.

Procedure:

- Tree seeds often have high oil content and therefore an oven temperature of between 101 and 105°C for a drying period of 17 hours ± 1 hour is recommended. For large seeded species, the seed are cut open to facilitate uniform drying in the oven.
- Tins are used to dry the samples. The diameter of the drying tin determines the sample size for the moisture test. Using a tin with a diameter of between 5 and 8cm the sample weight should be 4.5g ± 0.5g. With a drying tin diameter of greater than 8cm the sample weight should be 10.0g± 1.0g. The weights should be weighed to 3 decimal places.
- At the end of that period the seed should be placed in a desiccator to cool for 30 – 45 minutes and then reweighed. The relative humidity in the laboratory where the final weighing is done should be less than 70%, to avoid rapid re-absorption of moisture.

Calculations: The calculation of moisture content should be made on a wet weight or fresh weight basis.

$$\text{Moisture Content (\%)} = \frac{\text{Fresh weight- Oven dry weight}}{\text{Fresh weight}} \times 100$$

Study of seed germination attributes

Germination and vigour test: The potential germination of seeds is more important than other quality measurements. The main aim of a laboratory germination test is to estimate the maximum number of seeds which can germinate in optimum conditions.

Material /Equipment: Seed Germinator, Plastic wooden boxes, germination trays, filter paper.

Procedure:

- Take 400 pure seeds and divide them into 4 replicates with 100 seeds each. For the standard test, non-dormant seeds can be set to germinate immediately after the seeds have been separated during the 1000 pure seed weight determination. Four replicates are spread evenly over the surface of four germination substrates, ensuring a water supply is in place.
- Some species have very large seeds which require special treatment. If germination boxes which can accommodate 100 large seeds are not available, replicates of 50 seeds or 25 seeds can be used. Here, four pairs of boxes with 50 seeds or four quartets of boxes with 25 seeds are grouped together at random, and labelled. Each group of 100 seeds is counted as one replicate. When seeds with large wings are tested, it is perfectly acceptable to remove the wings so that the 100 seeds in a replicate can fit into one container.
- Record the germinated seeds after 3 weeks. At the end of the germination period the number of seeds which have germinated per replicate are counted and expressed per unit weight, from which the numbers germinating per kg are calculated.

Calculation:

$$\text{Germination \%} = \frac{\text{Total number of seed germinated}}{\text{Total number of seed sown in all replication}} \times 100$$

$$\text{Germination capacity (GC)} = \frac{\text{Total seed germinated+ seed found viable after cutting}}{} \times 100$$

Total number of seed sown in all replications

Germination Energy (GE): It is the percent, by number, of seed in a given sample which germinate up to the time of peak germination. Where Peak germination is the highest number of germination in a particular day.

$$G E = \frac{\text{Number of germinated seed up to time of peak germination}}{\text{Total number of seed sown in all replications}} \times 100$$

Germination Value (GV): It **is** a measure combining speed and completeness of seed germination with a single figure. Higher the germination value better is the seed stock.

G V = final MDG (Mean Daily Germination) X PV (peak value)

Peak value is the maximum mean daily germination reached at any time during the period of test.

$$MDG = \frac{\text{Cumulative (\%) of seed germinated at end of test}}{\text{Days since sowing to end of test}}$$

$$PV = \frac{\text{cumulative germination (\%)}}{\text{Days since sowing}} \times 100$$

$$\text{Cumulative germination (\%)} = \frac{\text{Cumulative total}}{\text{Total number of seed sown}} \times 100$$

Calculation:

$$\text{Germination \%} = \frac{\text{Total number of seed germinated}}{\text{Total number of seed sown in all replication}} \times 100$$

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$$PV = \frac{\text{cumulative germination (\%)}}{\text{Days since sowing}} \times 100$$

$$\text{Cumulative germination (\%)} = \frac{\text{Cumulative total}}{\text{Total number of seed sown}} \times 100$$

TETRAZOLIUM TEST FOR VIABILITY

Objective: To determine the quality of a seed lot where it is not practical to do a germination test, a viability test must be done on the submitted sample. There are four viability tests that provide different types of information viz. cut test, tetrazolium test, excised embryo test and x-ray test**.** Out of four tetrazolium test is widely used. Tetrazolium test, commonly known as the TZ test. The various tests have been briefly reviewed by Moore (1969). The tetrazolium test was introduced in 1942 by G. Lakon in Germany.

Equipments: Staining dished e.g. watch glasses for small seeds or petri dishes, Beakers of 100 to 250 ml capacity for largerseeds, Single edge razor blade, Needles, Forceps, Magnifying devices, Medicine dropper, Dispensing bottle Germinating blotters, filter paper, paper towel and Oven or incubator.

Procedure:

- Preparation of the staining solution The chemical used for this test is a cream or light yellow coloured water soluble powder called 2,3,5,- triphenyl tetrazolium chloride.
- To prepare a 1.0%solution, one gram of tetrazolium salt is dissolved in the distilled or tap water to make 100ml.The pH of the solution should be around 7.0for the proper staining to occur. Solutions of pH4 or lower will not stain even viable embryos and solution of pH more than 8 will result in too intense staining.
- At least 100 seeds should be tested in replicates of 50 or less. The seeds should be randomly selected from the pure seed component and counted in replicates. Before soaking in tetrazolium, the seeds are prepared to facilitate the penetration of tetrazolium (0.5-1%). Often the pericarps are removed and the seeds are cut transversely or longitudinally depending on species to expose the embryos. In endospermic seeds, both the embryo and the associated endosperm of each seed are placed in the solution. For conifers, it is gametophytic tissue which surrounds the embryo and is placed with the embryo in the solution. For non-endospermic seed, only the embryo is placed in the solution.
- Seeds are soaked in 2,3,5 Triphenyl tetrazolium chloride, which is a redox indicator for cellular respiration. The colourless solution is imbibed by seeds. In viable seeds, the stain interacts with dehydrogenases, which occur in metabolically active cells, to form an insoluble stable red compound formazan. In non-viable seeds, the stain remains white due to the degraded dehydrogenases. The solution should not be exposed to direct light as this brings about a reduction of the tetrazolium salt.
- The prepared seeds are incubated in tetrazolium for the optimum staining time, which is usually about 18 hours (30±2°C). Staining periods should not to be taken as absolute, because they may vary according to the condition of the seed. As experience is gained it may be possible to make evaluation at an earlier or later stage of staining. The staining period may be prolonged if the seeds are incompletely stained in order to verify if the lack of staining is due to slow uptake of tetrazolium salt rather than an indication of defects within the seed. However, over staining should be avoided as this may hide differential staining patterns which are indicative of weak seed and specific damage such as that caused by frost
- The seeds are then removed from the tetrazolium, rinsed in water, and then evaluated as viable or non-viable based on staining patterns and tissue soundness. Accurate interpretation of staining by tetrazolium requires a great deal of experience before the results will correlate well with germination test results. Different seeds have different anatomical and morphological structures, which influence the uptake and penetration of tetrazolium and therefore the interpretation of staining patterns.

Calculation: The result of all viability tests is calculated as the average of the four replicates. When reduced numbers of seeds per replicate are used in the tests, the percentage germination should be calculated. Using the average viability percentage, the number of seeds per kg and the purity percentage, the number of viable seeds per kg can be calculated.

% viable= number of viable seeds/total number of seeds x 100.

LABELING AND CERTIFICATION OF SEED

Labeling and certification of seed: The object of the certification of tree seed and plants is to maintain and make available to the practicing forester sources of seeds, plants and other propagating materials of superior provenances and cultivars so grown and distributed as to insure the genetic identity and high quality of the seed and plants.

An outline national certification: The elements of a comprehensive national certification scheme for forest seed and plants are as follows:

1. *Inspection of the seed source by a qualified professional forester before pollination of the seed* crop. At this time (which is from 6 to 21 months before seed collection) the quality of the seed trees, incidence of inferior trees and effectiveness of the isolation can be checked. Many forest trees do not produce seed every year and, after the first inspection, subsequent re-inspections are made only in years when seed is to be collected (the longest interval being about 5 years).
2. Assessment, if possible, of the cone or fruit crop by a qualified professional forester at a stated time (about 90 days) before collection begins.
3. Collection of the cones of fruits by a registered seed collector; extraction, cleaning and packaging of the seed at a registered seed extraction plant; and storage of the seed at a registered seed store. The records of collection, processing and storage are made available for inspection and the labels must conform to minimum requirements.
4. Testing, under the rules of the International Seed Testing Association, of an adequate sample of the seed at an official seed testing station.
5. Sowing of the seed in a registered nursery where labels and records satisfy minimum requirements. Inspection of the seedlings and transplants should be made by a qualified professional forester before they are lifted and dispatched.

BREAKING SEED DORMANCY IN TREES

To break dormancy of seed pretreatments before sowing needed. Pretreatment to terminate dormancy and speed up germination is thus one important type of pretreatment. Pre seed treatments required to break dormancy are as follows:

Stratification: The seeds of many woody and non-woody species are released from dormancy when they are hydrated and exposed to relatively low temperatures usually between 1-5 ^{o}C with abundant aeration and moisture for varying period between 30-120 days. This exposure to low temperature is variously described as stratification. The absolute dependence upon low temperature is displayed by seeds of many species. However more often the stratification interacts with altering temperatures, light and various chemical treatments etc. to overcome seed dormancy of many species. The seeds should be planted without delay after stratification. Desiccation and exposure of higher temperatures immediately after stratification may cause development of deep dormancy.

Scarification: It is the process of scratching, breaking or chemically altering the seed coat to make a permeable to water and gas. Cutting seed with file, rubbing it on a sand paper, cracking the seed with hammer are some of the means of mechanical scarification on small scale. The impermeable seed coat of a number of species can be rendered permeable seed coat of a number of species can be rendered permeable by mechanical scarification. As far as chemical scarification is concerned treatment with concentrated H2SO4 for varying durations of time followed by washing with water has been found quite successful. Both type of scarification i.e. mechanical and chemical have been found very effective in breaking seed dormancy of tree species.

Soaking of seed in water: Stratification at low temperature in several species is effective only if it is proceeding by soaking the seed at warm temperatures.

Breaking dormancy by chemicals: In seeds of many species' dormancy has been broken by treatment with various chemicals. Scarification normally improves the effectiveness of chemicals in breaking dormancy in seeds with hard seed coats. Gibberellins have been proven very successful in breaking coat- imposed as well as embryo-imposed seed dormancy. However, cytokinenes have rather supplementary role together with light and GA in overcoming seed dormancy.

Heating or burning: The dry heat has same effect on seed coat of dry fruits as boiling water. Effectiveness of burning and dry heat is generally enhanced by rapid temperature change i.e. by rapidly pouring the seeds into cold water after heat pre-treatment.

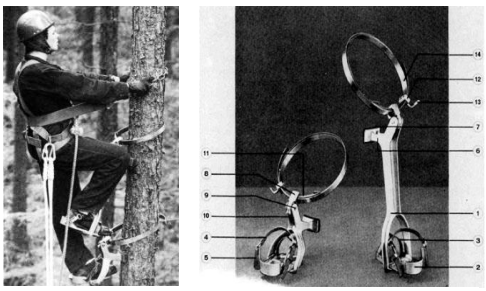
Biological methods: the biological methods such as ingestion by large animals or the effect of microbes or insects are rarely used as a managed pre-treatment method, however, incidents of such action frequently result in improved permeability.

PLANNING OF SEED COLLECTION AND SEED COLLECTION EQUIPMENT'S

Planning is very important. The careful planning should be done for seed collection and all the processes that follow. Because planning relates to future activities therefore it not only requires knowledge of the biological basis nut also of succeeding activities like collection processing, storage and germination. However, planning of seed collection relates to the given points:

- Species selection
- Quantity of seeds
- Seed source or seed trees
- Harvest time
- Collection method

First two points are determined by the plantation program which is beyond the decision of the seed supplier. In order to compensate for annual fluctuations in seed production demand it is usually good to establish a reserve stock of seed in store. Last three point relate to the immediate objective of seed collection viz; to provide the appropriate quantity of seed of particular species and provenance with high genetic and physiological quality at the lowest cost. Planning of collection involves prediction of quantity of seed collection, harvest time are based on knowledge of species biology and also current observations.



Tree Bicycle

1. Stirrup	**8.** Hinge head
2. Foot support	**9.** Hinge pin
3. Vamp strap	**10.** Coil Spring
4. Instep strap	**11.** Leaf Spring
5. Strap tightener	**12.** Holding Device
6. Support	**13.** Locking Lever
7. Rubber pad	**14.** Steel Band

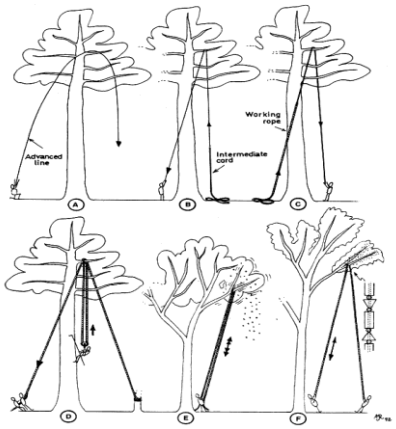
Different methods used for seed collection are as follows:-

Collection from ground: Collection from the forest floor of fruits which have fallen after natural ripening and abscission is common practice with a number of large-fruited genera. This method is normally used in

those species which have large indehiscent fruits or large seeds. Collection of seed is done after maximum number of seed fallen on round. Many seeds generally fall during strong winds or heavy rain storms. In case of recalcitrant seed which deteriorate easily several collections may be necessary.

Collection from the crown of felled trees: This method mostly used for bulk collections from large plantations species where collection can be combined with logging operation. The individual trees with good phenotypes preferably marked as seed trees before logging. The fruits are or seeds are collected from the crowns after cutting as quickly as possible. The seeds from ground must collect from within circumference of the crown of tree when the trees are standing on ground.

Collection from standing trees: Collection can be done from low trees or lower branches of larger trees before fruit dehiscence or dispersal. Lower branches can be reached from the ground or from the top of vehicles where retain allows access for vehicles. Higher branches are reached by long handled access like saws or hooks to cut or pull-down fruit or seed-bearing branches, pruners etc. For very tall trees with heavy crop of small of small seeds a large caliber rifle with telescopic sight and pointed soft point ammunition is used. Also, climbing can be used when trees are tall and the fruits or fruit bearing branches cannot be reached by long handled tools from the ground. Trees with relatively straight height and long clear bole climbing spurs and tree bicycles are used for collection of fruit and seed whereas, in case of low to medium sized trees different types of ladders are used. Nets also used to collect seeds from middle height trees.



Advanced line technique is used for intermediate to tall trees. The positioning of the line requires a relatively open crown and a reasonable distance between the trees in order to give a good sight and to avoid entangling of weight and line in the canopy. The principle of the method is that a rope is positioned over a high branch by throwing a heavy object attached to a thin line over the branch. Thin line then may be used to pull up a working/ safety/ lifeline or rope ladder.

SEED EXTRACTION METHODS

It denotes the procedure of physically releasing and separating the seeds from their enclosing fruit structure. Seed should be extracted in the shortest possible time after collection of fruits to avoid damage to the seeds as also to facilitate storage and sowing. In some cases, the seed as sown in the nursery consists of whole fruit and no extraction is needed. In other cases, it becomes necessary to split or open the fruit walls to release the seeds. The following special methods are required to extract the seeds.;

Natural drying: It takes longer time however less risk of lowering risk of seed quality is. The method not to be used on very wet or rainy days.

Drying under cover: the fruits are kept in well ventilated rooms, the seeds are spread thinly, stirred regularly and placed on trays, with wire mesh to allow all round air circulation. It is the safest method for any delicate species which cannot withstand rapid drying e.g. Hopea, Dipterocarpus, oaks, fir, deodar, Vitex, Fir etc.

Sun drying: The method is suited to drying of cones where the seeds are borne between scales of cones which open when the fruit is dried and release seeds. In addition to conifer cones the method is equally suitable in broad leaved species which have one fruits such as Casuarinal capsules Callistemon, Toona and eucalyptus etc.

Treshing: Seeds from dry fruits of any species are extracted by spreading the fruits on a platform and beating them with sticks. In case of large quantities mechanical threshers can be used.

Artificial drying of fruits: Artificial heating in kilns permits control moisture, air, and temperature with continuous process. Sometimes hot air oven can be made use for drying of seeds.

Extraction of small seeds from fleshy fruits: the method is used for species like *Morus* and *Ficus* and other species in which there are numerous small seeds embedded in a fleshy fruit. Fruit is soaked in water and then broken up manually and rubbed through a sieve in to the water kept below. Seeds are often collected from the water and dried.

Removal of pulp of large stoned fleshy fruits: Flesh left on the stones of such fruits may often cause the viability of the seeds to be considerably reduced and as such it be removed as soon as possible after the collection of fruits. Pulp can be removed from some fruits simply by rubbing the fruits between fingers. In other cases, soaking and macerating the fruits may be necessary.

SEED SAMPLING, SEED PROCESSING EQUIPMENTS

Sampling is essential that the sample taken is representative to get a true picture of the seed lot. It is however, only possible by using right methods and by taking proper care in all the processes. Hence sampling is an operation of utmost importance. If there is a uniform distribution throughout of the components it would be sufficient to take a handful from one point in the lot and use it as a test sample.

Thoroughly mix each lot either with a mechanical mixture or by hand. In order to mix with hand, spread the seeds out on a smooth surface and mix by scooping from side to side. After that pour back and forth between two containers. Determine the proper size of the submitted sample (twice the working sample). Then draw the samples using equipments/methods viz; seed trier, mechanical divider, division, extended hand. Weigh each sample to the nearest gram, place in a plastic bag and then label it. Save these bagged samples for latter purity measurements, moisture and weight.

Methods: Mix each lot thoroughly either with a mechanical mixer or by hand. To do latter, spread the seeds out on a smooth surface and mix by scooping from side to side. Then pour back and forth between two container. Determine the proper size of the submitted sample (twice the working sample)

1. Draw samples using the following equipments/methods: a) Seed trier b) Mecahnical divider c) Extended hand

2. Weigh each sample to the nearest gram, place in a plastic bag and label.

3. Save these bagged samples for later measurements of purity, weight and moisture.

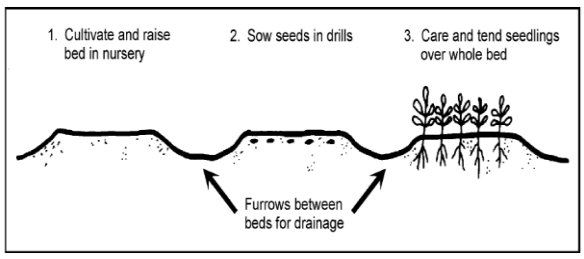
4. Materials: A mechanical divider, a seed trier, a spoon, a spatula, plastic bags, balance and marking pens

5. Seed processing:

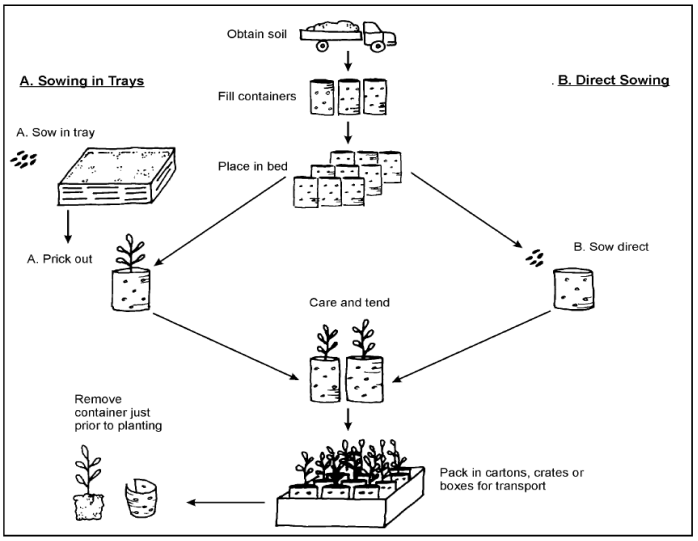
- **Pre cleaning:** For fruit or seed lots containing bigger debris, twings, leaves, empty and dead fruit parts etc.
- **Pre-curing:** For fruits that must be after –ripended or where quick deciccation hampers extraction of seeds.
- **Dewinging:** For seeds and fruits with wings. It also includes removal of dry appendices like arils, hairs and spines.
- **Extraction:** For species where the fruits are collected however, only the seeds and sometimes part of fruit are stored and sown in the field.
- **Cleaning:** For fruits or seeds with impurities like leaves, empty seeds, foreign seeds, fruit parts, twigs and chaff etc.
- **Grading:** For those seed lots which have variation in size of seed and weight.

PRODUCTION AND PLANNING SCHEDULE FOR BARE ROOT AND CONTAINERIZED NURSERIES

Production of seedling is depending upon facilities present in nursery. The demand of species for plantation drive in monsoon season and farmers demand needed to grow species in nursery. Therefore, proper planning and preparation is required before monsoon started. Before rainy season there are number of operation and preparations required for



Bare root planting: Bare-root is when a plant and its roots are removed from the soil and sold this way. This limited the harvest and planting season to a few weeks in springtime. Bare-root plant production involves growing plants in rows or beds for one to three years. These plants are then harvested by removing the plants and roots from the soil. These plants may then be sold, planted in soil again or placed in containers to be grown into larger plants. Bare-root is when a plant and its roots are removed from the soil and sold this way. This limited the harvest and planting season to a few weeks in springtime. Bare-root plant production involves growing plants in rows or beds for one to three years. These plants are then harvested by removing the plants and roots from the soil. These plants may then be sold, planted in soil again or placed in containers to be grown into larger plants.



Plantation technique: Spacing is always a concern in new fields, especially if you are uncertain about the size of plants you will need or about the market for your crops. If you anticipate that you will sell trees to professional landscapers or that they will be used as municipal street trees, space them wider to allow for more growth before they become crowded and so that you will have better access during harvesting. Wider spacing is also encouraged if the market strategy is uncertain, because it

allows more opportunity for finding a market before the trees become overgrown. In choosing planting dimensions, it is important to account for space required by fertilizing, cultivating, mowing, and spraying equipment. Each tree is considered to "own" half the space between it and the next tree or row for calculations such as the number of trees per acre. In reality, the canopies and roots may exceed half the distance by harvest time.

One method of increasing planting density is to plant some species, such as dogwoods, 3 feet apart within rows and after two years, dig and sell every other plant down the row. The following season, the remaining trees would have additional space to develop caliper and full, well-branched canopies. In theory, this method seems like a good idea. The critical issue with this plan is that you must have a sales mechanism in place for the trees that are dug after two years. If all the alternating trees are dug and sold, or possibly containerized to be sold during the current season, this plan may be feasible. However, in many cases, if the grower has no immediate market for the smaller trees or place to hold them, then the entire crop becomes over-grown and diminishes in value. Spacing between seedlings is 6"x 6" and is accomplished by eye while planting. Soil moisture is critical and the bed may require watering prior to planting.

NURSERY SITE AND BED PREPARATION

Site selection: The selection of the area for a nursery is critical and it should be sited as centrally as possible to the field(s) to be planted. In addition, the following should also be considered:

Topography (Terrain): The selected area should be flat to gently undulating with slopes between 0 and 3^0 and preferably, with a reliable/permanent source of water supply for irrigation purpose.

Water requirements (quality and quantity) must be determined prior to starting site preparation. The easiest source of water is where there is a large natural pond or lake whereby all that is required is to place an intake pipe to connect with a pump unit. A back-up system should be considered, particularly in isolated areas or areas of lower or unreliable rainfall.

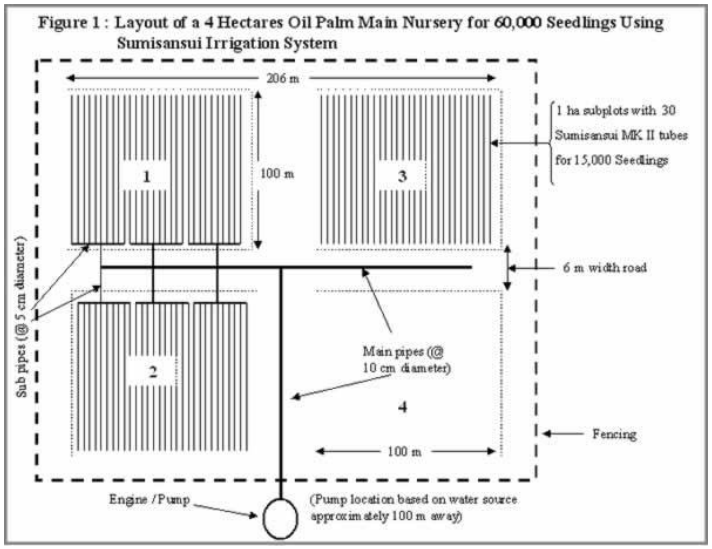


Figure 1 : Layout of a 4 Hectares Oil Palm Main Nursery for 60,000 Seedlings Using Sumisansui Irrigation System

Drainage: The site chosen should not be prone to flooding, which will damage seedlings and buildings (stores).

Area: To achieve good growing conditions with minimal risk of etiolation, a main nursery planting density of 13,800 polybags per ha with 0.91m (3ft) x 0.91m(3ft) D planting is recommended excluding allowance for accessibility. The spacing should be increased by another 0.15m (0.5ft) if the seedlings are anticipated to be kept in the nursery for longer than 12 months.

Accessibility and Nursery Roads: Roads within the nursery and their alignments will need to be carefully planned and laid out depending on the placement distance of the polybags and the type of irrigation to be utilized. Access roads to the nursery should be sufficiently wide to allow vehicles to maneuver during peak planting periods to facilitate supervision and movement of materials.

Site preparation: The preparation of the area for a nursery is important to allow optimum seedling growth, maintenance of nursery site, unimpeded access and to provide hygienic conditions for plant growth. Four main activities are involved in preparing a site for nursery, namely nursery design, clearing, fencing and lining.

Nursery Design: A well-designed nursery allows for access of many vehicles during evacuation of seedlings for field planting especially for large-scale plantings. This objective can be achieved through the drawing up of a plan to show all paths, roads and irrigation points.

SEED SOWING METHODS

Type of sowing: When the containers are beds or boxes, seeds can be sown by broadcasting or in lines. When the containers are pots, then it is pit sowing. Bare root planting beds follows broadcasting, direct sowing or line sowing.

Broadcast Sowing: This is usually done in specially constructed beds containing sand or sandy loam or pre-mixed sterile sowing medium in a wood or concrete block frame or metal tray. Clay or heavy soil must not be used as it is essential to have free drainage in the beds. Make the surface smooth, level and firm but not compact. The seed should not be broadcast too thickly over the bed surface to avoid overcrowding and to allow each seedling to have sufficient growing space. A 'roll

on' cover may be necessary to protect the seed from birds and to provide shade.

Broadcast Methods: For tiny seeds such as Eucalyptus species, the practice is to mix the seed intimately with an equal part of fine, dry sand of a similar size and spread the mixture evenly with the fingers. An alternative method is to make a 20 by 20 cm tray using strong mosquito or similar wire netting. The tray is then covered with fine sand particles just large enough that they will not penetrate the netting. On top of this the seed is added, usually sufficient to sow 1 square meter of the germinating seed bed. After shaking the tray, the small seed will find the openings and be deposited on the bed evenly and in the quantity desired. If the seed is mixed with sand of a similar size, it will be sown more evenly and uniformly. The work can be simplified if seedbeds are divided into 1-meter quadrants so that the recommended amount of seed to be sown per square meter can be premeasured.

Depth of sowing: Seeds are sown at a depth of 1-3 times their diameter. When seeds are sown at this depth adequate moisture and optimum temperature will hasten their germination. Excessively deep sowing will impair seedling emergence. Small seeds like those of Eucalyptus are mixed with fine soil before sowing to facilitate uniform distribution of seeds and to avoid seed waste by dense sowing. To economize in sowing Eucalyptus seeds, the seeds are mixed with fine sand in the ratio of 2 sand: 1 seed. This mixture is placed in a container while a small brush is first dipped in water, then dipped in the sand/seed mixture and then brushed gently onto 4-5 nursery pots containing soil. This was found to give a maximum number of 4-5 seedlings per pot.

Ideal sowing time: This is determined by the period required to raise a plantable seedling of the desired size. For example, if it takes four months in the nursery to raise plantable seedlings of *E. microtheca*, to be planted in June; then the ideal sowing date for that species and locality is the first of February. Similarly, for planting in October, the ideal sowing date is the first of June.

Care of Seedbed and Direct Sown Container: After sowing, cover the seed with a layer of fine sand or sifted nursery soil or potting mix to the desired thickness and water the bed or container lightly. Do not press the seed into the seedbed or container. Shade the seedbed from direct sunlight immediately after sowing with jute bags, newspaper, bamboo or any suitable available cover. This may be placed directly on the seedbed at first as a source of protection and to maintain humidity and an even damp moisture condition that favours germination. The cover must be lifted to about 30 cm or higher at the first sign of germination and removed completely as soon as possible afterwards to avoid weak, pale looking seedlings. Watering must be done gently with a fine spray and in large nurseries where piped water is available, mist nozzles are recommended for watering seedlings, using a filter to avoid sediment from clogging the small openings of the mist nozzle.

Direct Sowing: The advantages of direct sowing are lower cost and the avoidance of damage to seedlings through careless transplanting. Although only one seed is necessary if the germination rate is high, the aim is to sow an average of two to three seeds per container. With small seed, special methods need to be used to regulate the amount to be sown. In some overseas nurseries, a shaker is used, made from a small bottle with graduated holes in the lid set to allow a given number of seeds to drop per shake. Good results have been obtained from direct sowing *Acacia auriculiformis, A. mangium* and *Azadiracta indica* in pre-filled polythene bags. The use of cell packs that resemble egg boxes is also popular since the germinated seedling can be lifted with a plug of potting medium thus avoiding shock on transplanting.

MOTHER BEDS AND TRANSPLANT BED PREPARATION

Pricking out is the act of lifting seedlings from the seedbed into the transplant bed or pots.
Tools required: Sprinkler, bamboo stick, spud

	Steps
	• Water the seedling one day before pricking out. • Prick early in the morning and late afternoon as the solar radiation is not so intense to damage the young seedlings.
	• Remove the seedlings by inserting a small, flat stick beneath them and gently lever them out. • The volume of seedlings to be lifted at one time should be enough to be planted within 15minutes. Otherwise, seedling swill die due to desiccation
	• Using a small stick, make a hole in the potting medium. The hole in the potting medium should be enough to accommodate the root system without bending the taproot to avoid root deformation particularly J-rooting. If necessary, the taproot must be cut.

	• While holding the seedlings at its terminal leaf, insert the root system into the hole and cover the hole gently with the potting medium and carefully firm the potting mix to prevent air pockets left around the roots. • Water the plants after planting. Do not water too much, wetter conditions favor decay-causing organism. Keep them under shade for all this time
	• After 3 or 4 days replace the seedlings that have died. • When new leaves have started to grow gradually start to remove the shade. First of all, take the shades off for 1 hour in the morning and then for 1 hour in the late afternoon when the sun is not very strong. Eventually, over a week, increase the length of time in the morning and evening when the seedlings are unshaded until on the seventh day, they are left unshaded all day.

SEED PRODUCTION AREAS AND SEED ORCHARDS

Seed production areas: A seed production area is defined as "a natural or planted stand or group of stands, set aside, periodically rouged, and treated to stimulate seed production. The genetic quality of the seed is not known. It is also called seed stands, are quite widely used in young programs, especially for exotic species. The production areas are rarely progeny tested; therefore, both of the parents are selected only on their phenotypic qualities. It must be emphasized that seed production areas are generally used as interim sources of seed in forest tree improvement and that they are phased out as better genetic seeds becomes available from seed orchards.

Seed production areas have three attributes that are vitally important. These are as follows:

- Collected seed will have better genetic qualities than seed from commercial collections, especially in bole and crown characters, pest resistance and adaptability.
- The geographic origins of the parent trees are known when seed production areas are established in a natural stand thereby yielding the seed from a suitable source.
- These are the reliable sources of well adapted seed at modest cost.

Seed orchard: A seed orchard is a plantation of genetically superior trees, isolated to reduce pollination from genetically inferior outside sources and intensively managed to produce frequent, abundant easily harvested crops (Zobel *et al.* 1956).

Types of seed orchards: Based on type of plant material used for the establishment, seed orchards can be classified into two major groups

a) Clonal seed orchard (CSO): where vegetative material (cuttings, grafts or plantlets derived from tissue culture) of selected phenotypes (plus trees) are planted in areas with good isolation, under conditions favoring flowering and fertilization and managed for production of maximum amount of seed. Here the identity of each ramet (member of clone) is properly maintained by maps and tags.

b) Seedling seed orchard (SSO): where progenies from open or controlled pollination of selected phenotypes are planted at normal plantation spacing. Identity of the families is maintained in order to allow for thinning among families and individuals within families (called roughing) based on their phenotypic performance. This thinning must be done before abundant seed production starts.

c) Extensive seedling seed orchards: Stands established with special stock from balanced mixture of seeds from at least sixty good parents (superior combining ability) and gradually culled.