Standard Operating Procedures for Seed Collection and Handling





Indian Council of Forestry Research & Education

(An autonomous body under Ministry of Environment, Forest and Climate Change)

P.O. New Forest, Dehradun - 248006 (Uttarakhand)

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Submitted To:
Forest, Environment and Climate Change Department,
Govt. of Odisha

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(An ISO 9001:2008 Certified Organisation)

Message

I am pleased to present the long-awaited manual on Standard Operating Procedures (SOP's) manuals for Seed Collection and Handling of Forestry Species. These SOPs are a key advancement in our mission to uphold the best procedures for seed collecting, processing, germination and storage in our forestry operations.

A crucial step in the forestry cycle is seed gathering since it has a direct impact on the success and quality of succeeding plants. These painstakingly crafted instructions, which incorporate the most recent scientific findings and best practices, will help the field teams execute standardized and effective seed collection techniques across all of the forestry projects.

The guidelines include thorough instructions on many different areas of seed harvesting, such as adopting the best collection methods, handling procedures, seed storage and viability testing. By following these SOPs, one can make sure that our seed stock has a diverse genetic makeup with better longevity, usage of which will result in healthier, more resilient forest ecosystems. Additionally, these instructions stress the significance of ethical harvesting methods, encouraging minimal ecological effect and preserving the long-term viability of our forestry resources.

I wish to express my thanks to the ICFRE scientists and contributors who gave their time, knowledge and skill towards the creation of these guidelines. Their wisdom and dedication to quality have produced a priceless resource that will improve our seed collecting procedures and solidify our position as forestry sector pioneers in sustainable forestry management.

I sincerely hope that the use these SOP guidelines would continuously improve our seed handling and collection procedures. By working together, we can significantly impact biodiversity conservation, ecosystem recovery, and the development of a greener future.

Dated: 10 July, 2023

(Arun Singh Rawat)

सत्यमेव जयते

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Foreword

I am delighted to announce the release of Standard Operating Procedures (SOP) manuals for Seed Collection and Handling of Forestry Species. This manual represents a significant step forward in our commitment to ensuring the highest standards of seed collection, storage, and handling practices in our forestry operations.

A crucial step in the forestry cycle is seed gathering since it has a direct impact on the success and quality of succeeding plants. These painstakingly crafted instructions, which incorporate the most recent scientific findings and best practices, will help our teams execute standardized and effective seed collection techniques.

The mannual includes thorough instructions on many different areas of seed collecting, such as selecting the best collection methods, handling procedures, seed storage, and viability testing. By following these SOPs, we can make sure that our seed stock has a diverse genetic makeup and is viable, which will result in healthier, more resilient forest ecosystems.

Additionally, these instructions stress the significance of ethical harvesting methods, encouraging minimal ecological effect and preserving the long-term viability of our forestry resources. This may place a strong emphasis on local community involvement, encouraging a participatory strategy that respects traditional knowledge and promotes social inclusivity.

I would like to express my sincere gratitude to the hardworking team of ICFRE who have prepared this manual.

Dated: 10 July, 2023

(Debidutta Biswal)

FOREST ECOLOGY & CLIMATE CHANGE DIVISION
INSTITUTE OF FOREST PRODUCTIVITY
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Preface

The collecting and processing of seeds are essential to the success of forestry projects. The establishment and expansion of wholesome and resilient forests are directly impacted by the quality and viability of seeds. These SOP guides were painstakingly written to offer a thorough and systematic method to seed collecting and management, guaranteeing the finest quality seeds for our forestry activities.

These guides include the most recent scientific information, best practices and priceless insights obtained through practical experience. They draw on the combined wisdom of our team of researchers, scientists and forestry experts. By offering precise instructions and defined practices, they perform as an essential resource for all parties involved in seed collection and handling operations.

The SOP guidelines go through a lot of material, including choosing, collecting methods, handling procedures, storing strategies and viability tests. We can guarantee the genetic variety, viability and quality of our seed stock by following these codified methods, which will maximize the effectiveness of our reforestation operations. These guidelines are the value of sustainability, ethical harvesting methods and community involvement. They understand the need to strike a balance between ecological concerns and the socio-economic advantages brought about by our forestry activities.

I would like to extend my heartfelt thanks to the hardworking team of scientists and contributors of Forest Research Institute, Dehradun who contributed their knowledge and enthusiasm to the creation of this manual. A comprehensive resource that will direct us toward more responsible and sustainable forestry practices has been produced as a consequence of their combined efforts.

Dated: 10, July, 2023

(Sanjeev Kumar)

Contents

List of Figures

CHAPTER 1

SEED COLLECTION AND HANDLING

- **Seed Collection**

We want standardized expectations, uniform nomenclature, and clear procedures to create native seed supply chains that are dependable, sustainable, and transparent. To make every seed count and to guarantee that seeds are transported to the proper site at the most suitable time, such seeds must reflect acceptable origin and variety with native seed batches that have been processed, stored, and treated (dormancy release, seed enhancement technologies). These factors are often unclear or poorly defined:

1. How can native seeds be collected and produced sustainably?
2. What are the most reliable methods for testing the quality of native seed batches and how should "quality" be defined for native seeds?
3. Which seed enhancement options are available, and what is the most appropriate or effective for the needs of a particular project?

Hence to address these problems, standard operating systems for seed collection and handling will be prepared by involving the following information:

1.1 Seed Collection

In general, collecting seeds from the superior parent stock has been practiced for thousands of years and has resulted in higher yields and environmentally durable plants. There are two approaches to assess seed quality. One by the seed's physical quality, and two by the intended physical characteristics of the adult trees that will emerge from it. Utilizing higher-quality seeds from carefully chosen parent trees has advantages for improved survival and higher financial returns. The method of bringing new plant materials to solve particular resource concerns begins with the gathering of seeds. To address these resource issues, it is essential to take an effort to choose superior trees and gather the seed. Too often in large planting programs, the task of seed collection is an afterthought, typically left until the last minute and done hurriedly by unskilled or untrained labours and final nursery preparations are being made. Small-scale planters usually have access to leftovers from large programs. In either case, little consideration is given to seed the quality, form, or location of the parent stock.

Sometimes, to satisfy the requisite seed volume, nursery managers purchase bulk seeds from the villagers. However, villagers tend to collect from the nearest trees or stands, which generally include immature, diseased, distressed, and otherwise inferior trees. Such trees would not normally be chosen as prime seed source candidates. Also in some species, a single tree will produce a large amount of seed in some years. Such a harvest may satisfy the bulk requirements but would be genetically dangerous because only one phenotype is represented. Such limited collections cause problems for both large and small-scale plantations.

CHAPTER 2

SEED COLLECTION METHODS

- Collecting from Natural Seed Fall
- Shaking the Tree
- Pruning off Seed Bearing Branches
- Climbing Trees to Collect Seed
- Collecting Seed from Felled Trees

2.1 Collecting from Natural Seed Fall

This is the simplest way to collect seeds. It does not require skilled labor. Collection from natural seed fall is suitable for trees with large fruits, pods, and seeds e.g. *Aegle marmelos* and *Careya arborea* etc.

Fig. 1: Rake

Fig. 2: Seed container

Fig. 3: Sieves

The following Rake, sieve, seed container, large canvas, cloth or plastic, and sheet are very helpful for collecting the seed.

Steps for seed collection:

1. Clear the ground beneath the tree of leaves, branches, and weeds before seeds begin to fall naturally. This will make seed collection easier.

   OR

   Spread plastic sheet, cloth or tarpaulin sheet under the mother trees so that the seeds will fall onto them.

2. Use a robe to gather the seeds and collect them daily.

   OR

   Fold sheets to collect seeds daily. Chances of insect attack and fungal infection which could occur if seeds are left on the ground for too long will be minimized.

3. Extract seeds from the litter by sieving.

Collecting seeds from the ground has some disadvantages:

1. Some seeds may have fallen from the tree immaturely.
2. There is a great hazard for insect attack and fungal infection.
3. Actual date of collection is not known.
4. Seeds left on the ground for a long time often lose viability.

Fig. 4: Seed collection from natural seed fall.

Fig. 5: Gathering seeds with a rake

Fig. 6: Spreading and folding the canvas sheet after collection

2.2 Shaking the Tree

If natural seed fall is spread over a long period, manual shaking of the tree is a useful method to get seeds to fall to the ground at the same time. This makes their collection easier. In some cases, however, fruits or pods are strongly attached to the branches and will not drop off easily, even when the tree is shaken. If this is the case other methods will need to be used, and these will be discussed next.

1. Clean the ground, or lay down a plastic or canvas sheet.
2. Shake the trunks of trees or low branches by hand (Higher branches may be shaken using a stick, long pole, hook on rope) (Fig.7).
3. Separate seeds from the dry pods.

Sometimes, seed-bearing branches will be low enough to allow the collector to bend branches over the collection sheet (Fig.8). (Use thick leather gloves when branches are thorny).

Fig. 7: When pods or fruits are fully mature and near ready to fall (pods will be opening naturally) beat branches with a stick to shakedown seeds or dislodge fruits.

Fig. 8: A small tree with branches that droop low enough for the collector to easily reach them.

2.3 Pruning off Seed Bearing Branches

When the seed is out of reach for hand picking various pole implements may be used for pruning branches.

1. Select branches with a heavy load of good-looking fruits.
2. Carefully locate the ground sheets so that fruits and seeds will fall onto them from pruned branches.
3. If necessary, prune out the "window" so that the fruit-bearing branches can fall to the ground and not get entangled in the tree as they fall.
4. Cut the branches.
5. Collect the fruits.
6. Extract the seeds.

To use this method, you will need:

1. A special pole pruner with shears attached or a tall tree branch lopper.
2. A long pole with a saw or hooked knife attached.

Light, rigid bamboo aluminum or plastic poles 4-6 meters in length can also be used. A hooked branch can substitute if the other tools are unavailable (Fig. 9 and 10).

Fig. 9: Use of a hooked branch to collect seed.

Fig. 10: Use of a pole.

For fruit trees:

- Tie a basket near the pruning shears to catch the fruit as it drops. Seeds can then be collected without shattering and ruining the fruit.
- Throwing a rope with a weighted end to break off seed-bearing branch:

As the last possibility, this destructive method may be used to reach high seed-bearing branches from the ground, without having to climb the tree. Branches up to 12 meters from the ground can be reached. Skill is required to throw the rope over the selected branch and in the correct position for ease of breakage.

You will need:

- A strong 5 mm diameter rope about 25 meters in length.
- A 400-gram stone or small bag of sand or soil;

1. Attach the weight at one end of the rope.
2. Throw the weight over the seed-bearing branch.
3. Break off the branch by holding the two ends of the rope, and pulling (Fig. 11 and 12).

Fig. 11: Seed harvest by using a weighted rope.

Fig. 12: Pull ends of weighted rope to break branches.

Fig. 13: A car with strong roof provides a quick and easy means to reach crown and fruits of a small tree.

Fig. 14: Climbing into the crown of the tree.

2.4 Climbing Trees to Collect Seed

To use this method, you must have skill in climbing trees and using some specialized equipment. This is the method normally used to collect from standing dry zone trees as they are of open form and relatively small. Several methods can be used when collecting seeds from standing trees. The roof of a car may serve as a platform. Climb into the crown of the tree and use a saw, a large knife, or a similar implement to cut down seed-bearing branches (Fig. 13 and 14).

Fig. 15: Using a ladder for climbing up the tree.

Well-designed portable ladders provide a quick and safe means of reaching the live crowns of trees. Ladders may be made of light wood, metal, or bamboo 6-15 meters in length. For small trees a light wooden or aluminum ladder 6-8 meters long is appropriate (Fig. 15).

2.5 Collecting Seed from Felled Trees

If a tree is to be felled, try to wait until its seed is ripe. Never fell trees just for seed collection.

CHAPTER 3

SEED PROCESSING

- Pre-cleaning
- Seed Extraction
- Extraction of Seed from Dry Dehiscent Fruits
- Extraction of Seed from Dry Indehiscent Fruits
- Extraction of Seed from Fleshy Fruits
- Mucilaginous Seeds
- Pulpy Fruits
- Stone Fruits
- Dewinging
- Seed Cleaning
- Upgrading

A seed is a fertilized mature ovule consisting of an embryo, an endosperm with a protective seed coat. Seed is the basic input in seed collection. A good quality vigorous seed utilizes the resources and rises as a healthy seedling. Seeds also exhibit greater variation in shape, size, colour, and surface characteristics. To overcome all these problems, seeds have to be processed to achieve uniform and quality seeds. After harvesting, seeds are brought to the seed processing unit from the field, frequently at high moisture content. Seed lots also contain inert matter, damaged seeds, trash materials, deteriorated seeds, off-size seeds, etc. Seed processing is vital to bring the seeds to a safe moisture content level by drying the seeds and also to reduce undesirable materials to the maximum possible. Seed processing, objectives, materials to be removed during processing, and sequence of operations are explained as under.

Seed processing is a fundamental practice for obtaining high-quality seeds. It guarantees the end clients, seeds of high quality with the least contamination. In general, the term seed handling incorporates cleaning, drying, seed treatment, packaging, and storage. Seed processing mainly targets boosting seed viability, vigour, and health.

Purpose of Seed Processing:

1. To lower the expenses of additional processes like storage and transport.
2. This is accomplished by reducing the bulk of the seed lot by cleaning debris and by eliminating empty or fractured seeds (pre-cleaning).
3. To increase the life span of seeds; by drying seeds to safe moisture content using a desiccant.
4. To decrease the variability in vigour by strengthening the seeds and eliminating the low vigour seed.

Fig. 16: Types of material removed during seed processing.

5. To improve the uniformity in seed shape or size by grading or by pelleting.

Principles and Objectives:

The seed quality is improved in two ways during processing: By separation of inert matter, and by disposal of low-quality seeds.

The maximum pure seed percentage with maximum germination capacity is acquired by seed processing. Harvested produce is heterogeneous in nature. By seed processing, we can get a product of homogeneous nature. This will help in getting uniformity in the field. Seed processing is an important process to achieve uniform seeds by using suitable processing methods.

Inert materials, common weed seeds, noxious weed seeds, deteriorated and damaged seeds, other crop seeds, other variety seeds, and off-size seeds are those materials that are removed during seed processing.

The sequence of Operation in Seed Processing:

Each seed crop possesses a unique seed structure. Seed processing can be carried out based on seed shape, size, weight, length, surface characteristics, colour, and moisture content. Therefore, suitable operations carry out using suitable equipment. However, sequences of operation in seed processing are pre-cleaning, seed extraction, dewinging, and seed cleaning.

3.1 Pre-cleaning

1. Pre-cleaning is the removal of empty seeds, twigs, branches, leaves, soil particles, stones, and other materials present in the seed lot.
2. It is usually done after arrival at the seed processing depot.
3. Harvested fruits can be stored for short time before extraction if required.
4. Fruit can be stored in sufficient air-circulated containers such as trays, nylon net bags, etc.
5. Soft fruits should be stored at 10^0-15^0 C with adequate humidity and ventilation. Hard fruits can be stored in the shade in thin layers.

3.2 Seed Extraction

Seed extraction is defined as the separation of seeds from their enclosing structures. Seeds extraction should be done from the ripened fruit and the seed should be mature before extraction to avoid rapid desiccation during extraction.

3.3 Extraction of Seed from Dry Dehiscent Fruits

Normally dry dehiscent fruits dehisce during drying when spread out in thin layers with sufficient air circulation. Some legumes require extraction by hand or by threshing due to the strong attachment of the seed to the funicle. Threshing by hand reduces the probability of damaging seeds. The strong attachment of seeds with pods can be removed by threshing by hand, beating the pods in the sack with sticks, or rubbing on a rough surface. Examples- *Lagerstromia parviflora, Acacia catechu, Xylia xylocarpa*.

3.4 Extraction of Seed from Dry Indehiscent Fruits

Dry indehiscent fruits retain their seeds and do not crack open after ripening. Example- *Dalbergia sissoo, Pongamia pinnata, Pterocarpus marsupium*. Smaller indehiscent fruits can be broken by threshing by hand, rubbing on a rough surface, or beating with sticks. Seeds from larger fruits can be extracted by splitting mechanically or by hand.

Fig. 17: Use a mortar and pestle to thresh seeds which are strongly attached to the pods.

Fig. 18: Beat a sack full of dry pods or fruits with a stick to thresh out the.

3.5 Extraction of Seed from Fleshy Fruits

In fleshy fruits, the pericarp becomes fleshy at maturity. Fleshy fruits are classified as: Berry, Drupe, Aggregation of Drupes, Pome, Hesperidium, Sorosis, Syconium, and Coenocarpium. Examples- *Careya arborea, Artocarpus heterophyllus, Syzygium cumini,* etc.

Generally, seeds from fleshy fruits are removed by cutting the fruit in half or by cutting off the distal end and squeezing out the content into a container. Small seeds of pulpy fruits can be extracted by mashing the pulp, mixing it with water, allowing the seeds to settle, and then detaching off the pulp. Large seeds from pulp can be extracted by hands/ forceps, or washing the seeds in sieves under running water, rubbing them with wire mesh. Extracted seeds should be dried in thin layers on absorbent sheets with circulating air in the shade and avoiding direct heat.

Fig.19: Fruit extraction from fleshy fruits by mashing the pulp with water.

3.6 Mucilaginous Seeds

Some seeds or fruits are remarkable for their abundance mucilage. The Mucilage in seeds is not easy to remove by washing with water.

Some simple techniques to remove mucilage from seeds-

- Rub the wet seeds on a wire mesh repeatedly with a gloved hand.
- Rubbing with clean and coarse sand followed by proper removal of sand with water.
- Dry the seeds first and then rub off the dry mucilage from the seeds.
- Acid treatment methods can also be used for removing mucilage adhering to the seed.

3.7 Pulpy Fruits

Soak the fruits in containers until they become soft and remove them when they start to ferment. Wash the pulped seeds under running water and thoroughly clean and dry them in thin layers on an absorbent sheet with circulating air. e.g., *Gmelina arborea*.

3.8 Stone Fruits

Stone fruits are de-pulped manually with a sharp knife and washed with running water to remove the pulp. The seeds are then surface dried. e.g., *Terminalia bellirica, Terminalia chebula*.

3.9 Dewinging

Wings and hair are essential appendages for wind-dispersed species mainly present in indehiscent fruits. Dewinging is the removal of wings, hairs, and spines from the seeds.

Dewinging helps to ease handling during storage, pre-treatment, and sowing and reduces the probability to get fungal attacks due to moisture retention.

Dewinging procedures are varied based on the structure, morphology, and strength of the wing.

- Delicate seeds are dewinged by tumbling in closed drums.
- Mechanical dewingers are used to dewing seeds where wings are scraped away between the brushes.
- Papery wings, hairs, and spines are removed by tumbling in mixers together with some abrasive materials like sand or gravel.

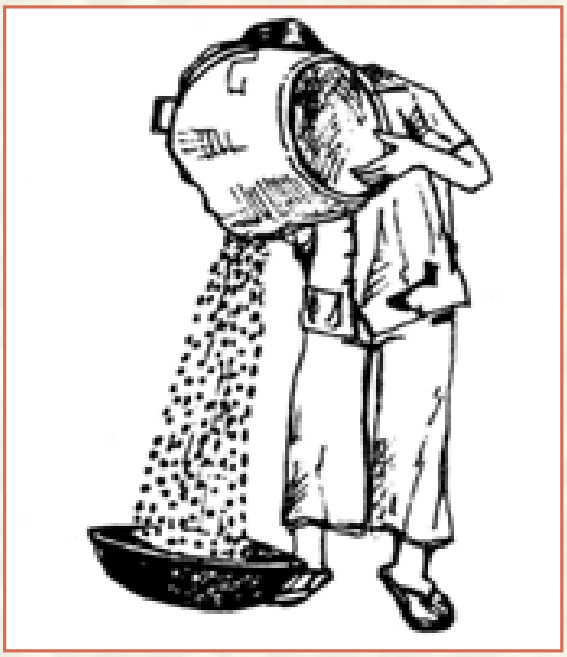

Fig. 20: Winnowing of seed.

- Abundant hair in some seeds is removed by burning.

3.10 Seed Cleaning

Cleaning seed lots is the basic step; it is the removal of impure, inert material, debris, foreign materials, and damaged and infected seeds to improve the quality of the seeds. The seed should be cleaned immediately once it reaches the seed processing site.

3.11 Upgrading

Upgrading is the process of improving the potential performance of a seed lot by removing empty, damaged, weak, immature, or odd-sized seeds. Upgrading will reduce the storage space requirements, reduce costs, and improve uniformity in container operations, reduce planting time in the nursery, etc.

Equipment used for upgrading- Air separators, Gravity Separator and Colour Separator.

CHAPTER 4

SEED DORMANCY & PRE-TREATMENTS

- **Types of Seed Dormancy**
- **Causes of Seed Dormancy**
- **Pre-treatments**

Dormancy in seeds may be advantageous or problematic during seed handling. The advantage is that it prevents seeds from germination during storage and other handling procedures and induction of dormancy is complex and seeds need a very specific pre-treatment. In the majority of forestry species, there exists a lag period between the attainment of seed maturity and seed germination. Such seeds fail to germinate even if they are exposed to favourable environmental conditions which are generally conducive to germination. This process is called seed dormancy. Seeds can overcome dormancy and germinate when "triggered" by certain internal processes that are usually induced by environmental changes. Some seeds lie in the soil for years before germinating, whereas others are delayed for only a few weeks.

4.1 Types of Seed Dormancy

a) **Innate dormancy or primary dormancy:** Seeds fail to germinate due to internal causes such as hard seedcoats which are impermeable to moisture even if environmental conditions are favourable for germination.

b) **Induced dormancy or secondary dormancy:** Dormancy develops due to unfavourable environmental conditions such as excessive moisture or desiccation, extreme light, high temperature or chilling temperature, etc.

c) **Enforced dormancy:** Germination is constrained due to external conditions.

4.2 Causes of Seed Dormancy

a) **Impermeable seed coat**: Seeds of some families like Fabaceae, Verbenaceae, etc. contain thick waxy coating, cetin, lignin, etc. in their seed coat which prevents the permeability of water into seed coat and the seed remains dormant until this layer is removed by micro-organism or other external conditions.

b) **Immature embryo**: The embryo is immature during seed shedding and remains dormant until the embryo becomes mature. e.g., *Terminalia chebula, Adina cordifolia* etc.

c) **Embryo dormancy**: It is caused by the physiological deficiency in the embryonal axis or due to the existence of metabolic blocks within the cotyledons. e.g., *Adina cordifolia, Dalbergia spp.* etc.

d) **After ripening**: A period of dry storage is required for the germination of seeds. It may vary from species to species.

e) **Double dormancy**: It is a condition due to two or more dormancy in the same seed.

f) **Germination inhibitors**: Abscisic acid, saponins, and coumarins are some of the germination inhibitors present in the seed. In this case, dormancy can be overcome by soaking the seeds in water (e.g. *Terminalia spp.*)

4.3 Pre-treatments

4.3.1 Mechanical Scarification

Treatments are designed to breach the seed coat or other covering structures and remove barriers to moisture uptake, gas exchange, swelling of the embryo and radicle emergence. In selecting a scarification treatment, the gentlest method should be tested first; then increasingly severe treatments until the desired effect is obtained. Various seed treatment techniques accomplish seed coat scarification and ensure rapid and uniform germination of the seeds planted. e.g., *Terminalia* spp.

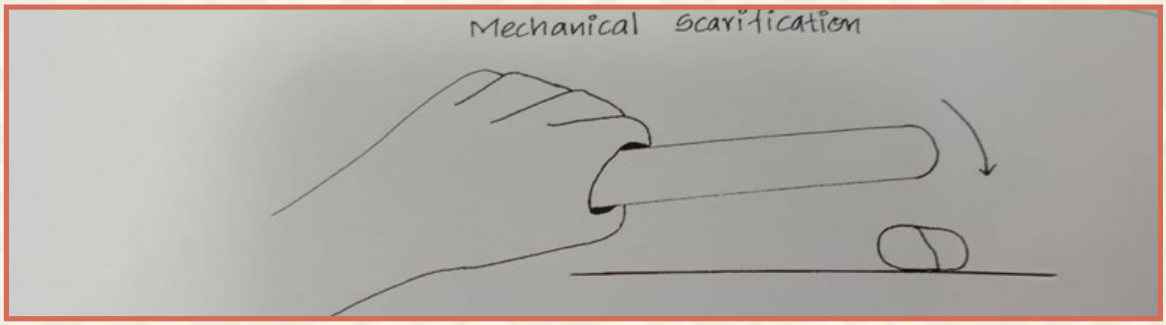

Fig. 21: Manual scarification or mechanical

This involves any process of breaking, scratching, chipping, filing, piercing or burning with the aid of a hammer, knife, needle, abrasion paper, or mechanically altering the seed coat to make it permeable to water or gases.

Manual scarification is effective at any site of the seed coat, but the micropylar region should be avoided as it is the most sensitive part of the seed where the radical is located. The main problem of manual scarification is its labour intensiveness. However, for the treatment of large quantities of seeds, mechanical scarification is more suitable. Seed may be tumbled in a concrete mixer drum lined with abrasive materials such as sandpaper, bricks, or cement mixed with sand or gravel or incorporated into an abrasive disk. e.g., *Terminalia chebula, Terminalia bellirica*.

4.3.2 Stratification

Stratification is the arrangement of seeds in layers of moist substratum like sand, peat, etc. for exposure to low temperatures.

4.3.3 Soaking in Water

This is the most widely used pre-germination treatment. It is used to tackle all the different types of dormancy. Modifying hard seeds in water from 12 to 24 hours in running or stagnant water renewed daily is effective for most species. Prolonged soaking in running water for one to several days also serves both to leach inhibitors and soften fruit or seed coat.

4.3.4 Cold Water Soaking

In some hard-seeded species, the seed coats are not completely impermeable to water. Soaking such seeds in water at room temperature for 24 to 48 hours may be sufficient for full imbibition and subsequent germination.

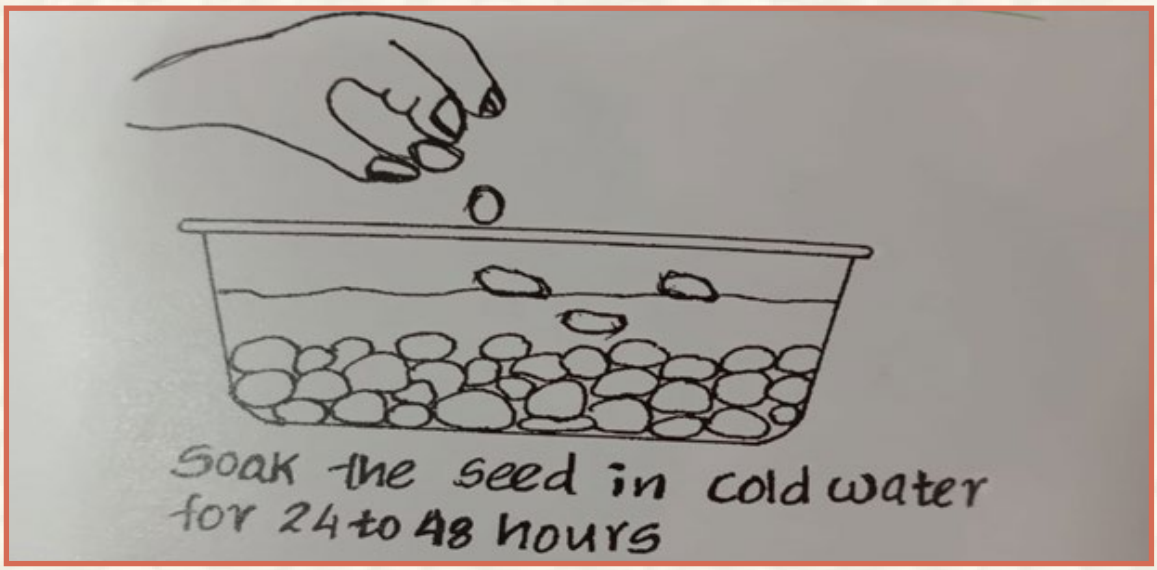

Fig. 22: Soaking the seed in cold water for 24 to 48 hours.

4.3.5 Boiling Water/Hot Water Soaking

Similar to cold water soaking, except that seeds are put into very hot or boiling and left there as the water cools. The hot water softens the seed coat or causes them to crack, and imbibition occurs as the water cools. Numerous leguminous species can be treated in this manner.

4.3.6 Dry Heat Burning

Forest or plantation fire is an important powerful natural factor in the removal of seeds at dormancy. A fierce fire will kill the seeds but a light to moderate fire such as those associated with controlled burning will reduce seed coat impermeability and stimulate germination. Dry heat has a similar effect on seed-coat of dry fruits as boiling water, tension in the outer cells causes the formation of cracks through which gas and water can penetrate. The effectiveness of dry heat and burning is normally enhanced by rapid temperature change e.g., by rapidly pouring the seeds to cold water after heat pre-treatment. This also reduces the risk of heat damage to the embryo. Kiln drying for extraction of *Acacia* spp. may serve as an incidental pre-treatment, oven drying at 100^0C for 10 minutes followed by cold water immersion was found to be effective as 83% of the seeds germinated after this treatment as compared to 3% for untreated.

4.3.7 Hot Wire

This technique requires a heated needle or an electric wood-burning tool to burn holes through seed coats.

4.3.8 Alternate Soaking and Drying

The seed of some species is difficult to scarify by soaking. Examples of alternate soaking and drying are *Terminalia chebula, Terminalia bellirica,* etc.

4.3.9 Treatment with Chemicals/Hormone

Soaking in potassium nitrate (0.2%), gibberellic acid (200 to 500 ppm), or thiourea (0.2%) solution before sowing has been found to stimulate the germination of different kinds of seeds.

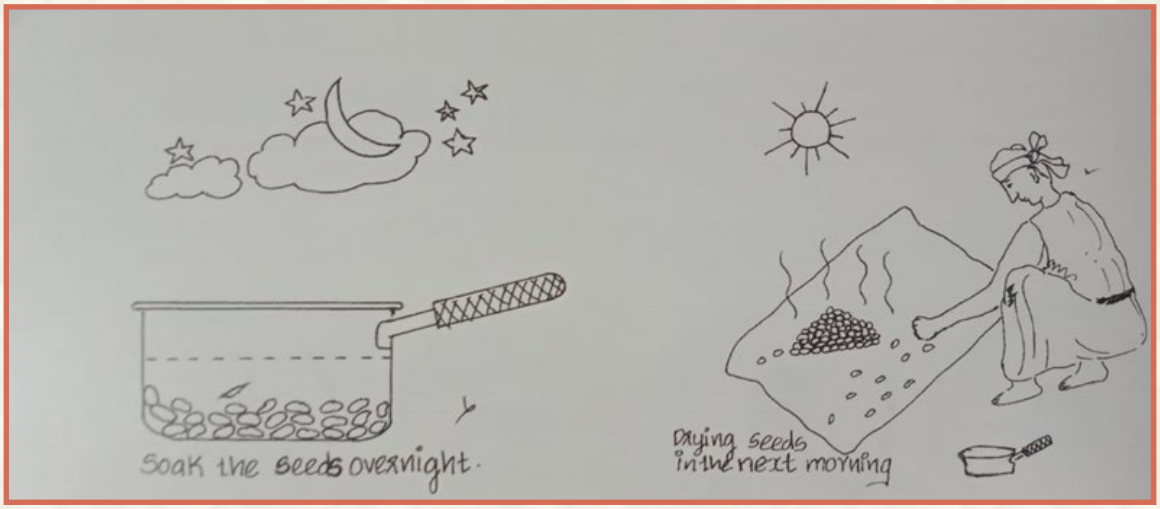

Fig. 23: Soaking the seeds overnight and drying seeds in the next morning.

4.3.10 Gibberellic Acid Treatment

Dormancy with chilling and light requirements is often overcome by treatment with gibberellic acid. Soaking the seed in 0.2% of the gibberellic acid solution has been found to stimulate germination in many species.

4.3.11 Sulphuric Acid Treatment

Soaking seeds in concentrated sulphuric acid is an effective and precise method for small lots of seeds use to break seed coat dormancy, but it requires training and laboratory facilities to be done safely. The acid causes some kind of wet combustion of the seed-coat and works equally in legumes and non-legumes.

Duration of treatment varies according to the following factors:

1. Seed coat thickness (depending on species maturity, and age)
2. Temperature (longer treatment is required at low temperatures)
3. Strength of the acid (new acid is stronger than re-used one)
4. Stirring (stirring during treatment reduces the duration of treatment)
5. The relative volume of acid (a relatively large volume of acid as related to the volume of seed is likely to reduce the time required for treatment.)

After soaking, the seed is removed from the acid and rinsed under running water for at least 10 minutes. The seeds can be sown possibly after soaking in water to enhance imbibition or re-dried and stored for a period.

Acacia catechu (L.f.) Willd.

Family: Mimosaceae **Common Name:** Khair

General:

Khair is a small to moderate sized deciduous tree, 12-15 m in height, 0.6-0.9 m in girth. Bark is dark brown and red inside. Leaves bipinnate, 10 to 18 cm long with 20-40 pairs of pin nae. *Acacia catechu* var. *Catechu* is found chiefly in Ganjam district, Koraput district, Angul District, Cuttack District of Orissa.

Fig. 24: *A. catechu* flower

Flowering:

Flowers pale yellow, sessile, in long solitary or in groups of 2-4 axillary spikes. Flowers appear in July-September.

Fruiting:

Pods ripen in December.

Morphology of fruit/seed:

Pod 10-15cm by 2-3 cm, thin, straight, flat, glabrous, dark-brown and shining when mature; seeds 3-8, about 5 mm diameter, ovate, dark-greenish, smooth, shining, moderately hard with a hard testa.

Seed Collection Time:

November-December or early January and even late February.

Fig. 25: *A. catechu* pods

Fig. 26: *A. catechu* seeds

Collection Method:

Pods are collected off the trees or by lopping twigs.

Extraction:

The pods are dried in the sun and then threshed to separate seeds (Refer to page no. 14 (Extraction of seed from dry dehiscent fruits).

Storage:

Stored in air-tight containers for 1-2 year.

Seed Biology:

No. of seeds per Kg.	Germination percentage	Time taken for germination in days
40,000	70 to 80	7 to 15

Pre-treatment:

- Soaking in cooling boiled water for six hours is more effective.
- For soaking in cold water, the time recommended is 24 hrs.
- Acid treatment is reported to be the best treatment for germinating the seeds of *Acacia catechu*.

Adina cordifolia (Roxb.) Benth *(Syn. Haldina cordifolia)*

Family: Rubiaceae **Common Name:** Kurum, Haldu

General:

It is a species of deciduous forests, found throughout Odisha. It usually grows on sandy loam and clayey loam soils. Identified by greyish bark, interpetiolar stipules and cordate (Heart shaped shell) , shortly acuminate leaves.

Fig. 27: *A. cordifolia* flowering

Flowering:

Yellow pedunculate globose heads appear from June to August.

Fruiting:

Fruits ripen from February to May. Heads turn yellowish-black when they are ripe.

Morphology of the fruit/seed:

Capsules in globose heads of 200 to 300, each splitting into 2 dehiscent cocci. Seeds about 6 in each cell, brown with numerous minute longitudinal wrinkles, one end tapering to a point and the other terminating in a pair of appendages. Seeds are extremely minute.

Collection Time:

February – March

Fig. 28: *A. cordifolia* fruit

Fig. 29: *A. cordifolia* seeds

Extraction:

Winnowing (Refer page. 16 (Dewinging).

Storage:

Seeds can be stored for the second season.

Seed Biology:

No. of seeds per Kg.	Germination percentage	No. of seedlings per kg of seeds	Time taken for germination in days
11000000 to 11800000	30 to 40	3300000 to 4720000	10 to 15

Pre-treatment:

No pre-treatment is required.

Aegle marmelos (L.) Correa.

Family: Rutaceae **Common Name:** Bel

General:

It is common in moist forests. It is characterized by a trifoliate leaf, the presence of axillary spines, and soft, grey bark exfoliating in irregular flakes. It is found typically on stiff, dry, clayey, and alluvial soils.

Fig. 30: *A. marmelos* tree bearing fruits

Flowering:

Dull white flowers appear in March-May.

Fruiting:

Fruits appear immediately but ripen in the summer of the following year.

Morphology of the fruit/seed:

Fruit is 5 to 18 cm dia., globose, grey or yellowish woody rind having a mass of orange-coloured sweet aromatic pulp. Seeds are numerous, oblong, compressed with a wooly mucous testa, embedded in clear mucilage.

Seed Collection Time:

April- May.

Fig. 31: *A. marmelos* fruit

Fig. 32: *A. marmelos* seeds

Extraction:

The ripened fruits are collected and the hard rind is broken to get the pulp which on continuous washing gives the seeds.

Storage:

The seeds lose viability after drying, and hence cannot be stored for a longer duration.

Seed Biology:

No. of seeds per Kg.	Germination percentage	No. of seedlings per Kg. of seed	Germination period in days
5300	56	2120	10 to 25

Pre-treatment:

No per-treatment is required. For better germination soaking in cold water for 12 hours is recommended.

Anogeissus acuminata (Roxb. Ex DC.) Guilum. & Perr.

Family: Combretaceae **Common Name**: Passi, Phansi

General:

It is a deciduous tree with a narrow crown and can grow up to 40m. The long, straight bole is unbuttressed and can be 100 cm in diameter. A deciduous tree with rough dark grey bark and drooping branches. Leaves gland-dotted. The tree is harvested from the wild for timber. Its habitat is tropical lowland open forests or semi-deciduous forests at elevations below 700m. It is found particularly in deep, humus-rich, and loamy soils.

Fig. 33: *A. acuminata* flowering

Flowering:

Flowers are greenish yellow-white in solitary or rarely paired heads, heads 1.2-1.9cm dia.

Fruiting:

Fruits winged, brownish red, 6-8mm in diam. 2 wings, membranous.

Morphology of fruit/seeds:

Seed collection, extraction, and storage:

Yet to be standardized

Seed Biology:

No. of seeds per Kg.	Germination percentage	Seedlings per Kg. of seed	Germination period in days
Yet to be studied			

Pretreatment:

Yet to be standardized

Anogeissus latifolia (Roxb. Ex DC.) Guilum. & Perr.

Family: Combretaceae **Common Name:** Dhaura, Axlewood

General:

It occurs widely throughout Odisha as a principal species of dry deciduous forest. Identified by greenish or greyish spotted white bark exfoliating in irregular rounded scales and copper red foliage in cold weather. The species is recommended for plantation in sandy loams, poor arid kankar soils, and alluvial soils. It avoids badly drained ground and soil with low pH and very little calcium. It is a light demander, fire resistant, and produces copious root suckers.

Fig. 34: *A. latifolia* flowers

Flowering:

Greenish-yellow flowers in small globose heads appear in December - January and June-July.

Fruiting:

Fruits ripen in January-February and July-August.

Morphology of the fruit/seed:

The fruit is a drupe, 0.85 cm across, compressed, nearly orbicular, narrowly 2 winged, imbricate arranged in a globose head, yellowish brown, crowned by persistent calyx tubes which are modified into a stiff beak.

Seed Collection Time:

January- February and July- August

Fig. 35: *A. latifolia* seeds from ripened fruits

Extraction:

Beating off the branches (Refer to page no. 14 (Extraction of seed from dry dehiscent fruits)

Storage:

Seeds should be sown immediately after drying.

Seed Biology:

No. of seeds per Kg.	Germination percentage	Seedlings per Kg. of seed	Germination period in days
30000 to 40000	5	1500	2 to 15

Pre-treatment:

Seeds soaked in cold water for 48 hours give better germination.

Artocarpus heterophyllus Lam.

Family: Moraceae **Common Name:** Panasa, Jack fruit

General:

It is grown by tribals and farmers for its fruits. It grows on a variety of soils. Identified by thickly coriaceous, dark green, shining leaves and fruits developing on the stem.

Fig. 36: *A. heterophyllus* fruit

Flowering:

November to December.

Fruiting:

Fruit ripens from July to August.

Morphology of the fruit/seed:

Fruit is a large, fleshly, oblong, more or less globose or cylindric receptacle clothed with fleshy and enlarged perianths and carpels, the tips of which are hardened, appearing as conical spines. Seeds are reniform, greyish, and oily.

Seed Collection Time:

Rainy season

Fig. 37: *A. heterophyllus* seeds

Extraction:

Ripe fruits are collected during rains and cut open for extraction of seed.

Storage:

Cannot be stored for long, as seeds lose viability very rapidly.

Seed Biology:

No. of seeds per Kg.	Germination percentage (fresh seeds)	No. of seedlings per Kg. of seed
45 to 96	75	30 to 70

Pre-treatment:

No pre-treatment is required as the seeds have a soft seed coat.

Bridelia retusa (L.) A. Juss.

Family: Phyllanthaceae **Common Name:** Kasi, Panikasi in Odiya

General:

Found in the forests throughout the state. Identified by rigid coriaceous leaves with straight parallel lateral veins and strong spines on the bark of young stems. It is a drought-hardy species, produces rootsuckers, and is a good coppicer.

Fig. 38: *B. retusa*

Flowering:

The lateral clusters of small flowers appear from May to July.

Fruiting:

Fruit ripens from December to January.

Morphology of the fruit/seed:

Fruit is a globose, fleshy sweetish drupe, about the size of a pea, purple-black, seated on a hard enlarged calyx. 1 or 2 seeds with fairly thick bony shells. The seeds have brownish papery testa.

Seed Collection time:

December

Fig. 39: *B. retusa* fruits

Fig. 40: Ripened fruits of *B. retusa*

Seed Extraction:

Depulping (Refer to page no. 16 (Pulpy fruit))

Storage:

Cannot store the seeds for a longer duration.

Seed Biology:

No. of seeds per Kg.	Germination percentage	No. of seedlings per Kg. of seed
16000 to 17000	60	9500 to 10,000

Pre-treatment:

Soaking the seeds in cold water for 24 hours.

Buchanania cochinchinensis (Lour.) M.R.

Family: Anacardiaceae **Common Name**: Chironji, Charo in Odia

General:

Common in our forests mostly in eroded ravine lands, and occurs with species like *Soyamida febrifuga*. It avoids waterlogged areas, but occurs locally in clay soils. Identified by dark grey crocodile bark with red blaze. A good species to plant on bare hill slopes. It has poor coppicing capacity and produces root suckers sparingly.

Fig. 41: Ripened fruits of *B. cochinchinensis*

Flowering:

Pyramidal panicles of greenish-white flowers appear in January - March.

Fruiting:

Fruits ripen from April to May and remain on the tree for quite a long time.

Morphology of the fruit /seed:

Drupe, globose (0.8 to 1.3 cm dia.), black when ripe. Stones hard, 2-valved; seeds biconvex, oily; the fruits and kernels are edible.

Seed Collection Time:

April- May

Fig. 42: Seeds of *B. cochinchinensis*

Extraction:

Depulping (Refer to page no. 15 (Extraction of seeds from fleshy fruits)).

Storage:

One year in sealed tins

Seed Biology:

No. of seeds per Kg.	Germination percentage	No of seedlings per Kg. of seed	Germination period in days
3000 to 5000	70	2400 to 4250	15 to 25

Pre-treatment:

Overnight soaking in cold water.

Careya arborea Roxb.

Family: Lecythidaceae **Common Name**: Kumbhi, Wild guava

General:

Found throughout the State in the moister part, and the ravines and valleys. It is abundant in the Mayurbhanj district, Sambalpur district. It is identified by leaves turning red in the cold season, dark grey thick bark, and large slow flowers. It occurs both on alluvial soils and loams. It also occurs on lateritic soils. It is a fire-resistant species. It is a good coppicer.

Fig. 43: *C. arborea* flowers

Flowering:

Yellowish or greenish-white flowers which are large and emit a fetid smell appear in March and April when trees are without leaves.

Fruiting:

The fruits ripen in June to July.

Morphology of the fruit /seed:

Berry, globose, 5 to 6.5 cm in diameter, rind thick, crowned with the limb of the calyx. Seeds numerous, embedded in fleshy pulp, scattered.

Fruits Collection Time:

June-July

Fig. 44: Fruit of *C. arborea*

Fig. 45: Seeds of *C. arborea*

Seed Extraction:

Depulping is to be done to get the clean seed (Refer to page no. 16 (Pulpy fruits).

Storage:

Cannot be stored for more than 15 days.

Seed Biology

No. of seeds per Kg.	Germination percentage	No. of seedlings per Kg. of seed
2822	30	800 (approx.)

Pre-treatment:

Soaking seeds in 500ppm IBA for 10 minutes (Sharma and Krishnamurthy, 2016).

Cleistanthus collinus (Roxb.) Benth. ex Hook. f.

Family: Phyllanthaceae **Common Name:** Karada

General:

It is a small tree with bright green foliage, reaching not more than 10 m in height. Bark dark brown, almost black, rough, exfoliating in small woody rectangular scale and red inside. It is one of the commonest trees in some of the dry types of mixed forests in the Indian peninsula up to the Ganges in the north and Chota Nagpur. It is a common tree in Singhbhum, Chanda, and Satpura ranges.

Fig. 46: *C. collinus* fruits

Flowering:

Flowers yellowish-green, in small axillary silky clusters, calyx lobes lanceolate. The new leaves and flowers appear in April-May.

Fruiting:

Fruits ripen in October-April.

Morphology of fruit/seed:

Capsule woody, sessile, globose, 3 rarely 4- lobed, 1.8 cm diameter, dark brown, shining. Seeds three.

Seed Collection Time:

November-December

Fig 47: Cleistanthus collinus **ripened fruit and seeds**

Extraction:

Yet to be standardized

Storage:

Yet to be standardized

Seed Biology:

No. of seeds per Kg.	Germination percentage	Seedlings per Kg. of seed	Germination period in days
Yet to be studied			

Pre-treatment:

Soaking in cold water for 24 hrs or seeds can be treated with 500ppm GA_3 for 14 hours.

Dalbergia sissoo Roxb. ex DC.

Family: Fabaceae **Common Name:** Shisham, Bali sissoo

General:

It is not indigenous but is frequently planted on roadsides. Recommended for plantations on sandy and gravelly alluvium soils on the beds of the river. It avoids stiff clay, preferring porous soil of sand, pebbles, and boulders. It is identified by somewhat crooked bole acuminate leaves.

Fig. 48: *D. sissoo* flower

Flowering:

White flowers in short panicles appear from March to April.

Fruiting:

Although fruits are formed early, they mature from December to January.

Morphology of the fruit/seed:

Pods 5 to 7.5 cm long, strap-shaped, pale-brown, glabrous, indehiscent, 1 to 4 seeded. Seeds 6-8 mm by 4-5 mm in size, kidney-shaped, thin, flat, light brown with a papery testa.

Seed Collection Time:

November to March

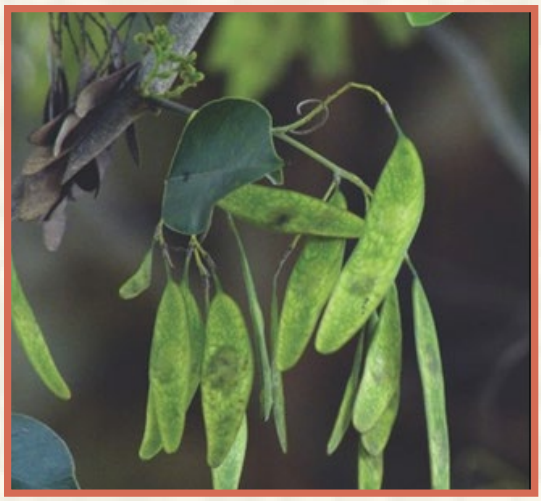

Fig. 49: *D. sissoo* fruits

Fig. 50: *D. sissoo* seeds

Extraction:

By hand (Refer page no. 14 (Extraction of seed from dry dehiscent fruits)).

Storage:

Well-dried and moisture-protected pods can be kept for 3 years without much loss in viability.

Seed Biology:

No. of pods per kg.	No. of seeds per Kg.	Germination percentage	Germination period in days
16000 to 18000	50000 to 53000	90 to 100	8 to 20

Pre-treatment:

Not required. However, for hastening germination, soak the seeds in cold water for 24 hours.

Gmelina arborea Roxb.

Family: Lamiaceae **Common Name:** Gambhari, Beechwood, White Teak

General:

It is found throughout the state mainly in deciduous forests but never occurs gregariously. Identified by light grey bark, broad-ovate acuminate leaves with cordate base, and the presence of 2 to 4 shining prominent glands on the undersurface of the leaves between the primary nerves. It shows a preference for fertile, deep, well-drained, sandy loam soils in moist valleys.

Fig. 51: *G. arborea* flowering

Flowering:

The panicle of yellow tubular flowers appears from February to March when the tree is leafless.

Fruiting:

Fruits ripen from the end of April to June.

Morphology of the fruit/seed:

The fruit is an ovoid, yellow, succulent drupe, 1.8 to 2.5 cm long, having a sweetish pulp and enclosing a hard bony stone. The stone is 1.5 to 1.8 cm long, ovoid, pointed at one end, usually 2-seeded.

Seed Collection Time:

April to June.

Fig. 52: *G. arborea* seeds

Extraction:

Depulping (Refer to page no. 16 (Pulpy fruits).

Storage:

Seeds can be stored for one year.

Seed Biology:

No. of seeds per Kg.	Germination percentage	Plant percent	Period of germination in days
4500-5000	70 to 80	60-70	10 to 15

Pre-treatment:

Pre-treatment of seeds is not necessary. Pre-germination in damp sand is sometimes practiced.

Grewia tiliifolia Vahl.

Family: Tiliaceae **Common Name:** Dhaman

General:

Dhaman is a moderate-sized to large tree, attaining a bole length of about 30 ft. and a girth of 7 ft. or more. Bark grey or dark brown. The leaves of dhaman are oblique heart-shaped.

Fig. 53: *G. tiliifolia* flowers

Flowering:

Yellow flowers appear in April-June.

Fruiting:

Fruits ripen in September-October.

Morphology of fruit/seeds:

A drupe, globose two-lobed, slightly hairy, red when ripe. Each fruit contains 2-4 Seeds.

Seed Collection Time:

March to May.

Extraction:

By rubbing and washing (Refer to page no. 16 (Mucilaginous seeds)).

Storage:

Can be stored up to one year.

Seed Biology:

No. of seeds per Kg.	Germination percentage	Time taken for germination in days
12,000 to 15,000	65 to 85	15 to 20

Pre-treatment:

No pre-sowing treatment is necessary and untreated seeds are reported to give better germination than those treated in cold, hot, or boiling water.

Lagerstroemia parviflora Roxb.

Family: Lythraceae **Common Name:** Sidha

General:

It is a very common tree both in the moist and dry deciduous forest of Odisha. It is a light demander, drought resistant, good coppicer, non-browsable and fire-resistant species. It comes up in a variety of soils including black cotton. It thrives best on deep porous loam but does not stand water logging.

Fig. 54: *Sidha* fruits

Flowering:

White flowers in panicles appear from April to June.

Fruiting:

Fruits ripen from December to February.

Morphology of the fruit/seed:

Fruit is a coriaceous capsule surrounded below by a persistent calyx; oblong, 2.0 to 3 cms long, 3 to 4 celled, 3 to 6 valved. Seeds are winged.

Seed Collection Time:

February

Fig. 55: Dried capsules of *L. parviflora*

Extraction:

By beating and cleaning (Refer page no. 14 (Extraction of seed from dry dehiscent fruits)).

Storage:

Seed viability is very low.

Seed biology:

No. of seeds per Kg.	Germination percentage	Time for germination in days
28200 to 56400	2	10 to 15

Pre-treatment:

Soaking in cold water for 24 hours.

Madhuca indica (Roxb.) A. Chev.

Family: Sapotaceae **Common Name:** Mahua, Mahula, Butter tree

General:

It is found throughout Odisha, being a characteristic tree of moist dry mixed deciduous forest. It prefers sandy soil but also grows on shallow, boulder soils. Identified by the exudation of milky latex and clustering of leaves at the ends of the branches. It is a drought-hardy species.

Fig. 56: *M. indica* flowers

Flowering:

February to April.

Fruiting:

Fruits ripen from June to July.

Morphology of the fruit/seed:

The fruit is a green egg-shaped fleshy berry, 2.5 to 5.0 cm long, containing 1 to 4 brown polished seeds 1 to 3 cm long.

Seed Collection Time:

Ripe fruits are collected by shaking the branches in July.

Fig. 57: *M. indica* tree bearing fruits

Fig. 58: *M. indica* seeds

Extraction:

Depulping (Refer to page no. 16 (Pulpy fruits).

Storage:

Seed loses its viability quickly on storage.

Seed biology:

No. of seeds per Kg.	Germination percentage	No. of seedlings per Kg. of seed	Time taken for germination in days
750	13 to 57	220	10

Pre-treatment:

No per-treatment is required. For better germination soaking in cold water for 12 hours is recommended.

Mesua ferrea L.

Family: Calophyllaceae **Common Name**: Nagkesar, Ceylon ironwood

General:

A medium-sized to large, handsome, evergreen tree, often buttressed at the base, usually attaining a height up to 24 m and a girth up to 2.4 m. Bark grey and smooth, warty in young trees, dark-brown in mature trees, exfoliating in large white flakes exposing the warty, reddish-brown inner surface. It is a common constituent of the tropical rain forests in the western ghats from S. Konkan downwards. In Bihar, Orissa, and West Bengal it is found locally.

Fig. 59: *M. ferrea* flower

Flowering:

Flowers are white, hermaphrodite or polygamous, fragrant, 2 to 10 cm across axillary, solitary, or sometimes in pairs. Flowers appear in February - April.

Fruiting:

Fruits ripen in August-October.

Morphology of the fruit/seed:

The fruit is an ovoid to globose capsule with 1-4 seeds. Seeds up to 2.5 cm x 1.8 cm in size, with a dark brown shining testa, cotyledons fleshy, oily, and pale yellow.

Seed Collection Time:

Middle of July to the beginning of September. Mature fruits are collected from the ground

Fig. 60: a. & b. Mature and dry fruits, c. Close-up of dry fruits, d. 1-seeded fruit, e. 2-seeded fruit (*Samareddy and Aluri*, 2021)

Extraction:

By threshing. (Refer to page no. 14 (Extraction of seeds from dry indehiscent fruits)

Storage:

5 months to 1 year in gunny bags.

Seed biology:

No. of seeds per Kg.	Germination percentage	Plant percentage	Time taken for germination in days
239-270	70 to 95	46 to 70	21 days (3 weeks)

Pre-treatment:

Seed soaked in cold water for 24 hours hastens germination. No treatment is given to propagules before planting (freshly collected seeds with dark brown colour give about 100% germination).

Michelia champaca L.

Family: Magnoliaceae **Common Name:** Champa

General:

A beautiful tree frequently cultivated around temples and gardens. It occurs on deep moist, well drained good quality soil. Identified by grey bark, straight bole, convolute bud, dark shining lanceolate leaves.

Fig. 61: *M. champaca* flowering

Flowering:

Yellow flowers appear from March-April and thereafter at intervals.

Fruiting:

Fruits ripen in July.

Morphology of fruit/seeds:

Fruit is borne on a spiral cluster (6-30cm long) that hangs down. Each cluster consists of 6-40 individual fruit. Each ripe fruit consists of 2-6 seeds. Seed is covered with red/pink flesh and hangs freely on a thin white thread.

Seed Collection Time:

August to September

Fig. 62: *M. champaca* seeds

Extraction:

Depulping (Refer to page no. 15 (Extraction of seed from fleshy fruits).

Storage:

Seeds lose viability rapidly.

Seed biology:

No. of seeds per Kg.	Germination percentage (fresh seeds)	Time taken for germination in days	No. of seedlings per Kg. of seed
1000	70 to 80	10 to 14	700-800

Pre-treatment:

Soaking seeds in cold water for 12 hours gives better germination.

Mitragyna parvifolia (Roxb.) Korth.

Family: Rubiaceae **Common Name**: Mundi, Kaim, Ghorkaram

General:

It is widely occurring throughout Odisha. It is identified by grey bark with shallow depressions and smaller leaves compared to *Adina cordifolia*. It attains its best development on the well-drained ground with deep soils. It often grows more or less gregariously on low-lying ground with clayey soil, around the edges of tanks and swamps. It is also recommended for plantations in black cotton soils and on the alluvial ground near rivers.

Fig. 63: *M. parviflolia* tree bearing fruits

Flowering:

Flowers in capitates heads (2 cm diameter) appear in June and July. Flowers are white or pale yellow.

Fruiting:

Fruits ripen from November to January.

Morphology of the fruit /seed:

Capsules arranged in globose heads, each with 2-follicular cocci; seeds many, winged.

Seed Collection Time:

December to January

Fig. 64: *M. parvifolia* ripened fruits

Extraction:

By winnowing. (Refer to page no. 16 (Dewinging).

Storage:

Low viability and should be sown immediately.

Seed biology:

No. of seeds per gm.	Germination percentage	No. of seedlings/kg of seeds	Germination period in days
10000	56	5600	30 to 130

Pre-treatment:

Seed germinates without any pre-treatment.

Morinda tinctoria Roxb.

Family: Rubiaceae **Common Name**: Aal

General:

It is a small evergreen shrub or tree growing to 5-10m tall throughout the tropics. The tree grows in shady forests as well as open rocky or sandy shores. The leaves are long, and oblong to lanceolate.

Fig. 65: *M. tinctoria* plant bearing fruits

Flowering:

Flowers are tubular, white, scented, and 2 cm long.

Fruiting:

The fruit, classified as a syncarp, is light green when unripe and yellowish-white when ripe; it is up to about 14 cm long, 8 cm in diameter, and is soft and fleshy, with a fetid odour.

Seed Collection Time:

Fallen fruit from the ground.

Extraction:

Depulping (Refer to page no. 15 (Extraction of seed from fleshy fruits)).

Fig. 66: *M. tinctoria* seeds

Storage:

Dried seeds can be stored for up to 6 months after which the viability of seeds declines rapidly.

Seed Biology:

No. of seeds per kg	Germination percentage	Number of seedlings per kg of seed
40000 (Approx.)	90%	36000

Pre-treatment:

Scarification is done to seeds to reduce the germination time and to increase germination percentage.

Phyllanthus emblica L.

Family: Phyllanthaceae **Common Name:** Amla

General:

It is a common species of dry deciduous forests. It is identified by greenish-grey bark exfoliating in small irregular patches and light green feathery foliage. Recommended for afforestation on dry rocky areas and refractory sites. It is a light demander and sensitive to drought. It coppices well and produces root suckers.

Fig. 67: *P. emblica* fruits

Flowering:

Greenish-yellow flowers in dense panicles develop along the leaf-bearing branchlets from March to May.

Fruiting:

Fruit ripens from October to February.

Morphology of the fruit/seed:

Fruit fleshy, globose, 1-2 cm in diameter, pale yellow, sometimes reddish when ripe, 3-celled, 6-seeded, Seeds reniform, shining, reddish brown, small.

Seed Collection Time:

January

Fig. 68: *P. emblica* seeds

Extraction:

Depulping (Refer page:16 (Pulpy fruits)).

Storage:

Cannot store the seeds, as viability decreases drastically with time.

Seed Biology:

No. of seeds per kg.	Germination percentage	Time taken for germination in days	No. of seedlings per Kg. of seed
8000-9000	40-50%	25 to 30	3200 - 4500

Pre-treatment:

No pre-treatment is necessary. But it is better to put in cowdung slurry for 48 hours.

Pongamia pinnata (L.) Pierre

Family: Fabaceae **Common Name**: Karanja, Malapari

General:

Pongamia pinnata is a legume tree that grows to about 15-25 min height with a large canopy that spreads equally wide. It may be deciduous for short periods. It has a straight 50-80 cm (20-30 in) diameter with grey-brown bark, which is smooth or vertically fissured.

Fig. 69: *P. pinnata* flowers

Flowering:

Flowering generally starts after 3-4 years with small clusters of white, purple, and pink flowers blossoming throughout the year. Flowers appear in May-June.

Fruiting:

Fruits ripen in Dec-Jan.

Morphology of fruit and seed:

The brown seed pods appear immediately after flowering and mature in 10 to 11 months. The pods contain within them one or two bean-like brownish-red seeds. The seeds are about 1.5–2.5 cm (0.6–0.9 in) long with a brittle, oily coat, and are unpalatable in natural form to herbivores.

Seed Collection Time:

April to June

Fig. 70: Unripen fruit of *P. pinnata*

Fig. 71: Ripened fruit of *P. pinnata*

Fig. 72: Seed of *P. pinnata*

Extraction:

Threshing by hand (Refer page no. 14 (Extraction of seed from dry indehiscent fruits)).

Storage:

6-12 months

Seed Biology:

No. of seeds per kg	Germination percentage	No. of seedlings per kg of seeds
1500-1700	40	600-680

Pre-treatment:

Soaking of seeds in hot water at 60^0C for 30 minutes increases the germination.

Pterocarpus marsupium Roxb.

Family: Fabaceae **Common Name:** Bijasal, Indian kino, Malabar kino

General:

It is a common tree of the moist and dry deciduous forests of Odisha. Identified by imparipinnate (5-7 leaflets), coriaceous, dark green, shining leaves, and exudation of red juice from the bark on incisions. It grows better on well-drained alluvial and sandy loam to loamy soils.

Fig. 73: Unripened fruits of *P. marsupium*

Flowering:

Golden yellow flowers with dark calyx in large panicles appear from June to October. The flowering season is short.

Fruiting:

Pods ripen from December to March and become dark reddish brown in colour and remain on the tree up to end of May.

Morphology of the fruit/seed:

Pods flat, orbicular, winged, 3 to 5 cm in diameter, 1-seeded, indehiscent.

Seed Collection Time:

February to May

Fig. 74: Ripened fruits of *P. marsupium*

Extraction:

No extraction required, directly sown after drying.

Storage:

Pods are dried and stored in gunny bags. Viability is retained for one year.

Seed Biology:

No. of pods per Kg.	Germination percentage	No. of days for germination	No. of seedlings per Kg.
2000	45 to 50	30-40	1000

Pre-treatment:

Soaking the seeds for 72 hours in cold water or in cowdung slurry for 48 hours.

Pterocarpus santalinus L.f.

Family: Fabaceae **Common Name:** Rakta chandan, Red sander

General:

It is endemic to Koraput District of Odisha. Recommended for plantation on lateritic loam, quartzite shale and limestone. It requires perfect drainage and is found mainly on stony or gravelly soils.

Fig.75: *P. santalinus* flowers

Flowering:

Flowers in yellow terminal panicles appear in February-March.

Fruiting:

Pods are formed rapidly but get ripened in next March-April.

Morphology of the fruit/seed:

Pods obliquely orbicular, 3 to 4 cm in diam. Including the wing, gradually narrowed into a short stipe. Seeds one per pod, 1 to 1.5 cm long, reddish brown with a smooth leathery testa.

Seed Collection Time:

March to May. Collection is carried out from the tree or ground.

Fig. 76: *P. santalinus* seeds

Extraction:

Extraction is not required, matured seeds are directly sown.

Storage:

Seeds are dried in the sun for 3 days, and stored in gunny bags. Seeds retain viability for a year easily.

Seed Biology:

No. of pods per Kg.	Germination percentage	Plant percent	No. of seedlings per Kg. of seed
900 to 1400	50 to 60	30 to 40	270 to 560

Pre-treatment:

Soaking in cold water for 72 hours or soaking in cowdung slurry for 72 hours.

Syzygium cumini (L.) Skeels

Family: Myrtaceae **Common Name:** Jamun

General:

It is a large evergreen tree widely distributed in Odisha. Found along streams and in damp and even in marshy localities, where it is often gregarious. Identified by the fibrous red blaze, intramarginal venation, and channeled petiole. Recommended for plantation on alluvial soil of varying texture, clayey soils, and loamy sands.

Fig. 77: *S. cumini* tree bearing fruits

Flowering:

Dirty white fragrant flowers in trichotomous panicles appear in March-May.

Fruiting:

Fruits ripen from June to August.

Morphology of the fruit/seed:

Fruit is a drupe, variable in size, oblong or sub-globose, crowned with a persistent truncated calyx limb, first pink, then black with a pink juicy mesocarp. The seed is usually 1, which is 1 to 2 cm long.

Seeds Collection Time:

June – July

Fig. 78: *S. cumini* fruits

Fig. 79: *S. cumini* seeds

Extraction:

Depulping (Refer to page no. 16 (pulpy fruits)).

Storage:

Seed lose viability within 15 days, so it should be used immediately.

Seed Biology:

No. of seeds per Kg.	Germination percentage	Plant percent	No. of seedlings per Kg. of seed
1100 to 1300	90	56	640

Pre-treatment:

Soaking of seeds in warm water for 12 hours.

Terminalia alata Heyne ex Roth.

Family: Combretaceae **Common Name:** Asana

General:

It is the most common and most widely distributed. Identified by crocodile skin bark, red blaze, and stick-like glands at the base on the backside of the leaf. Development of the tree is best on deep, rich alluvial soils but it avoids sandy soil. Silviculturally, it is regarded as suitable for afforestation on clayey soils.

Fig. 80: *T. alata* tree bearing fruits

Flowering:

The panicle spikes of small whitish flowers appear from May to June.

Fruiting:

Fruits ripen from February to April.

Morphology of the fruit/seed:

Fruit is an indehiscent drupe, 3.5 to 5.0 by 1.3 to 2.5 cm in size with 5 coriaceous wings and marked with numerous horizontal lines running from the axis to the edges which are thin and irregularly crenulate. Fruits turn brown when ripe.

Seed Collection Time:

By lopping off branches, after the tree becomes leafless.

Fig. 81: *T. alata* tree bearing fruits

Fig. 82: Ripened fruits of *T. alata*

Extraction:

Matured fruits are sown directly; seed extraction is not required.

Storage:

Dried under the sun for 3-4 days and stored in gunny bags.

Viability:

One year

Seed Biology:

No. of seeds per Kg.	Germination percentage	Time taken for germination in days	No. of seedlings per Kg. of seed
550	36 to 70	15 to 30	240 to 250

Pre-treatment:

Seeds are sometimes heaped together and watered daily; when the seeds begin to sprout, they are removed and sown. The fruits are soaked in cold water for 48 hours.

Terminalia arjuna (Roxb. ex Dc.) Wight & Arn.

Family: Combretaceae **Common Name:** Arjuna

General:

Distributed throughout Odisha, frequenting the banks of the water courses. Identified by thick grey smooth bark, exfoliating in large thin irregular sheets and buttressed trunk. It thrives best on loose moist, fertile alluvial loams and light deep sandy soils, often overlying more or less impervious rock. The soil should have ample water supplies but should normally be well-drained. The soil under this tree becomes rich in calcium as the leaves are rich in this element.

Fig. 83: *T. arjuna* tree flowering

Flowering:

The panicle spikes of white flowers appear from April to July.

Fruiting:

Fruits ripen from the following February to May.

Morphology of the fruit/seed:

The fruit is a drupe, 2.5 cm long, ovate, thick with 5 rigid, longitudinal wings, 0.6 cm broad, the fruit is often notched near the top, marked with oblique upward curving striations.

Seed Collection Time:

Collection is done by lopping twigs/ from ground in the month of March.

Fig. 84: *T. arjuna* fruits

Fig. 85: Ripened fruits of *T. arjuna*

Extraction:

Seeds are sown directly and seed extraction is not required.

Storage:

Viable for one year and stored in sealed tins.

Seed Biology:

No. of fruits per Kg.	Germination percentage (Untreated seeds)	Germination percentage (Treated seeds)	No. of seedlings per Kg. of seed
175 to 1450	50 to 60	90	60 to255

Pre-treatment:

Soak the seeds in cool water for 48 hours; or cover the seeds with boiling water, allow them to cool, and soak for 24 hours.

Terminalia bellirica (Gaertn.) Roxb.

Family: Combretaceae **Common Name:** Baheda

General :

It is found in all dry deciduous forests of Odisha. Identified by bluish-grey or ash-coloured bark and leaves clustered towards the end of the branches. It is found in different types of soils.

Fig. 86: *T. bellirica* tree bearing fruits

Flowering:

Pale greenish, white flowers with a strong honey smell appear from April to June along with the new leaves.

Fruiting:

Fruits ripen from November to February.

Morphology of the fruit/seed:

Fruit is a dry fleshy drupe, 1.3 to 1.9 cm in diameter, globose or ovoid, covered with grey-velvety wooly hairs with a hard thick-walled light-yellow putamen, 1-seeded, surrounded by a green tissue.

Seed Collection Time:

February

Fig. 87: Ripened fruits of *T. bellirica*

Collection:

By lopping off branches or from the ground.

Extraction:

Depulping manually (Refer page no. 16, (Stone fruit)).

Storage:

Dried under sunlight before storage and can be stored for one year.

Seed biology:

No. of seeds per Kg.	Germination percentage	No. of seedlings per Kg. of seed
400 to 450	65 to 70	200 to 225

Pre-treatment:

To soften the hard seed coat, the seed is soaked in mild hot water for 24 hrs.

Terminalia chebula Retz.

Family: Combretaceae **Common Name:** Harada

General:

The tree is found mostly in mixed dry deciduous forests. It is capable of growing on different types of soils but attains best development on loose well-drained soils, such as sandy loam as well as clayey loam. Identified by dark brown bark exfoliating in irregular woody scales and the presence of pair of large glands at the top of the petiole.

Fig. 88: *T. chebula* fruits

Flowering:

Spikes of greenish-white flowers appear in April-June.

Fruiting:

Fruits ripen from January-March and fall soon after ripening.

Morphology of the fruit/seed:

The ovoid, yellow to orange-brown fruits are 2.5 to 4.0 cm long. Usually 5-angled when dry. Stone very thick, bony, obscurely angled, rough, and grooved, having gum vessels on the wall.

Seed Collection Time:

January to March

Fig. 89: *T. chebula* seeds

Collection:

Seeds are collected as soon as they fall on the ground.

Extraction:

By depulping manually (Refer to page. 16 (Stone fruits)).

Storage:

Seeds can be stored in gunny bags for one year

Seed Biology:

No. of seeds per Kg.	Germination percentage	No. of seedlings per Kg. of fruit	Period of germination in days
140 to 160	60	84 to 96	15 to 30

Pre-treatment:

The seeds should be either treated by fermentation process for a period of 15 to 20 days, or the seeds may be clipped at its broad end and then soaked in water for a period of 2 days and then sown in nursery beds.

Xylia xylocarpa (Roxb.) Taub.

Family: Fabaceae **Common Name:** Kangada

General:

It is one of the chief associates of teak and is found to the east of the Tel river and in the Sabari basin. It is identified by reddish-grey bark exfoliating in large irregular flakes, leaves with one pair of pinnae at the end of the common petiole with a gland at the apex. Recommended for plantations on shallow, rocky, laterite soils. It does not grow well on black cotton soil.

Fig. 90: *X. xylocarpa* flowering

Flowering:

Pale yellow-coloured, sweet-scented flowers in long pedunculate globose heads appear from March to April.

Fruiting:

The thick, flat pods ripen during the ensuing cold season and the seeds fall from March to April.

Morphology of the fruit/seed:

Pods 10 to 15 cm by 2.5 to 6.0 cm in size, flat, woody, falcate-oblong, light brown, globose, and elastically dehiscent. Seeds 6 to 10, ovoid, compressed, 1.3 to 1.6 cm by 0.5 to 10 cm in size, brown, polished.

Seed Collection Time:

March – April

Fig. 91: *X. xylocarpa* pod with seeds

Fig. 92: Pictorial representation of *X. xylocarpa* pods

Extraction:

The pods are dried in the sun to open and seeds are collected which are dried and stored. (Refer to page. 14 (Extraction of seed from dry dehiscent fruits)).

Storage:

Seeds can be stored up to one year.

Seed Biology:

No. of seeds per Kg.	Germination percentage	Period of Germination in days	No. of seedlings per Kg. of seeds
3350	90	7 to 15	2700

Pre-treatment:

Pre soaking of seeds in cold water for 12 hours.

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