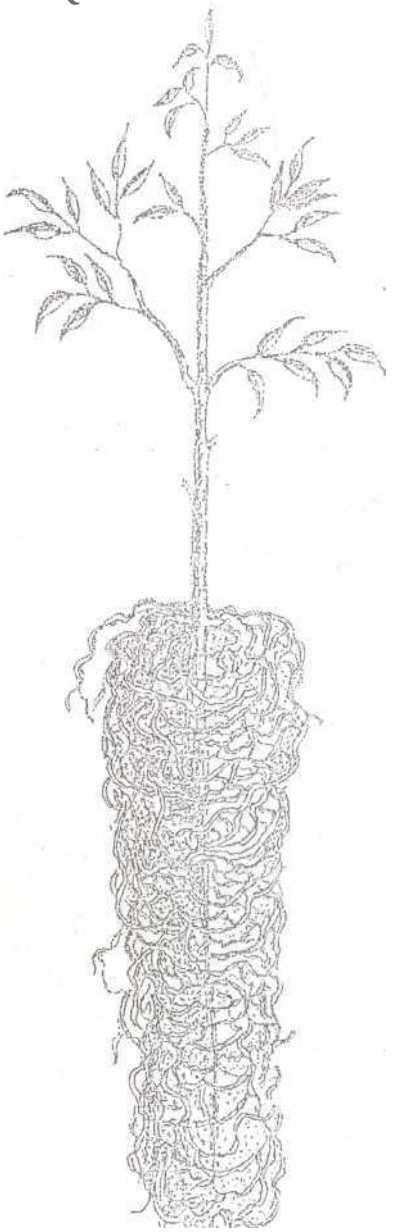
SFRI Information Bulletin No. 9

NURSERY TECHNIQUES OF LOCAL TREE SPECIES



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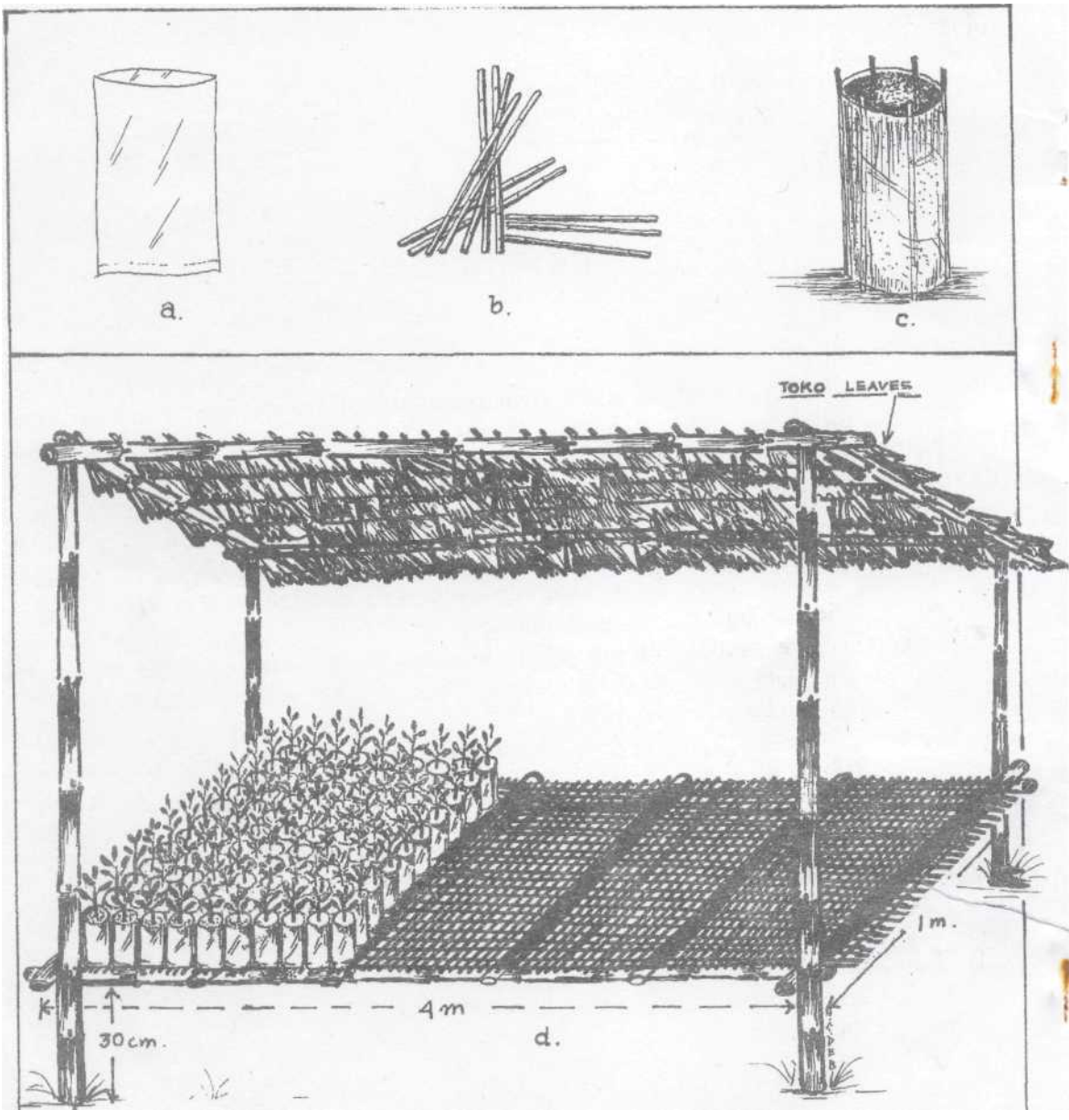

Fig. 1. Polytube nursery a. Polytube (polybag open at both the ends) b. Fine bamboo sticks which direct the roots; C; Six bamboo sticks placed in a polytube; d, Bamboo and wire-mesh stand to keep polytubes.

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PREFACE

Arunachal Pradesh, also known as the land of rising sun, is the largest state of the Northeast India. The state is bestowed with lush green forests, which harbours a great diversity of flora and fauna. From aeons people have been living in close harmony with nature. Most of the local tree species are quite fast growing in nature and have good demand in timber trade. The past experience shows that their plantations are successful and acceptable to the local people. Most of them are easy to grow, people know their nursery techniques from the knowledge gained by experience but the information has not been documented so far. A comprehensive account of nursery techniques for the plants of the region in general and state in particular is lacking. Therefore, for a new-comer it becomes difficult to handle the situation while developing and managing nursery meant for local tree species. The seeds have very short viability in most of the cases and are to be collected immediately at the time of proper maturity. Therefore, knowledge of the exact time of flowering, seed collection, seed weight, viability, seed handling and nursery techniques is of utmost importance for the success of a plantation programme. The future of each and every tree depends on the source of seed and the quality of the seedlings. Keeping this in view, an attempt has been made by the State Forest Research Institute to collect and collate the scattered information on the nursery techniques of 16 local tree species with the hope that the document may be useful for successfully raising **nursery** and in planting few-trees on the mother earth,

Sd/-

M. L. Deori
Director

Contents

Agar *(Aquilaria agallocha)*

It is a tall deciduous tree, with a close and tapering crown, having a clean bole of 14 to 15 m length. Fruits bi-valved capsules, 3.5 to 4 cm long, light greenish, seeds 2.0 to 2.5 cm long. Flowering occurs in the month of May. Fruits start maturing from June and can be collected up to mid of July. Each fruit contains two seeds and a medium sized tree produces about 1.5 kg seeds. The ripen fruits/capsules are green at maturity. They should be collected by the end of June otherwise the capsules burst open and seeds are released. After collection, seeds are dried in proper shade for a day or two, the capsules rupture and seeds come out. Seeds are recalcitrant and due to this reason they cannot be stored even for a month. It does not produce good seed crop every year.

Seed collection period	June to July
Number of seeds/Kg.	1,500
Seed viability	1 month
Germination percentage	60
Seedlings obtained/kg seeds	900
Pre-sowing treatment	Not required
Sowing method	Sowing in mother beds
Germination period	7-25 days
Nursery management	Seed starts germinating immediately after falling on the ground and it is quite likely that 50 % of the seeds might have started germination at the time of collection, therefore, sowing should be done immediately.

Sowing is done immediately due to the low viability of seeds and about 60% germination is obtained if seeds are sown immediately after collection. It reduces to 44%, 10% and 5%, respectively after one, two and three weeks of storage (Beniwal, 1987b). Seeds are sown in shaded nursery beds vertically to keep the radical upside. Sowing is done in the mother beds as most of the seeds are in pre-germinated stage and direct sowing in polythene bags may not give satisfactory result due to the damage of seeds during transportation or handling. Germination takes place after one week of sowing and continues to about twenty-five days. The seedlings become ready for transplanting after 4 to 5 weeks of sowing. It is a shade bearer in the initial stage, therefore, overhead shade is necessary in the nursery. Seedlings become ready for plantation in the next rainy season.

Amari (*Amoora wallichii)*

A tall evergreen species, which is a pronounced shade bearer, frost tender and sensitive to fire. It prefers moist areas where water does not stagnate. Fruits yellowish brown, quite large in size, 3 to 4-celled capsules with milky juice when unripe. Fruits can be collected from June to July. It is better to collect fruits from standing trees rather than collecting them from the ground. After collection fruits are spread under proper sunlight for two to three days to open out and seeds are extracted, washed and dried.. Seeds have scarlet aril and chestnut brown testa.

Seed collection period	June - July
Number of seeds/kg	150-230
Seed viability	2 months
Germination percentage	**60**
Seedlings obtained/kg seeds	100-150
Pre-sowing treatment	ML
Sowing **method**	Direct sowing in polythene bags
Germination period	15-50 days
Nursery **management**	Sowing must be done in Shaded beds to obtain good germination.

Sowing is done immediately after collection and processing the seeds in shaded nursery beds, as viability is low. Seeds are sown in polythene bags by keeping its long axis horizontal to the ground. Germination starts after 15 days of sowing and few seeds may germinate even after 189 days (Krishnaswami, 1956). (Roychowdhry, 1960) reported 85% germination within 10-20 days in shaded nursery beds while it was only 35% in un-shaded beds. Young seedlings thrive better in shade and require regular weeding to protect them from weeds. In Assam, seedlings are planted under the shade of *Tephrosia Candida* to protect it from direct sunlight (Joshi *et. al.* 1981). The species is suitable for wet areas and requires proper weeding in initial stage.

Bogipoma (*Chukrasia tabularis*)

It is a tall evergreen tree with spreading crown having a clean bole of 15 to 17m lengths. Fruits - 3-valved septicidal capsules, 3.5 to 5.0 cm long. Seeds 6 to 8 mm long, elliptic and flat with a dark brown wing (10 mm to 14 mm long). Flowering occurs from April to May and fruits start ripening by the second week of January and can be collected up to March. The experiment conducted at SFRI on different stages of pod maturity and germination revealed that pods collected at later stages of ripening gave better germination. It was observed that during 1999 in most of the species, seeds matured about one month early than their normal period of seeding possibly due to the continuous dry spell from December to April. The ripened fruits/capsules are collected from the standing trees by lopping the small branches and dried in shade for one week. Each fruit has 250 to 400 seeds. The capsules are opened with a gentle hammering or with a knife to collect the winged seeds. Seeds are orthodox and can be stored for more than a year under controlled condition (6 % moisture and 4 °C).

Seed collection period	January to March
Number of seeds/Kg.	90,000
Seed **viability**	6 months
Germination percentage	90
Seedlings obtained/kg seeds	76.500
Pre-sowing treatment	Overnight soaking in cold water
Sowing method	Mother beds
Germination period	7-35 days
Nursery management	It is better to cover mother beds with thatch and care is taken during watering so that young seedlings are not damaged.

Sowing is done in properly shaded mother beds having a mixture of sand, FYM and soil (1:1:1). Germination starts after one week of sowing and seedlings are ready for transplantation into the polythene bags after about 30 to 45 days of sowing. They can be made available for planting by the first week of July **but** it requires adequate planning for timely completion of all operations. Direct sowing as well as stump planting is also successful provided the area is protected from the mithun which causes damage to the seedlings as it gets a good passage to move along the planting lines.

Bola *(Morus laevigata)*

A valuable timber species, which occurs in tropical evergreen and mixed deciduous forests in moist localities and thrives best on well-drained alluvial soil. It is a light demander and fairly frost tender. Seeds are generally available from April to first week of May. However, care should be taken to collect the seeds from the trees which are known to be fertile as apparently all the trees are not fertile. Fruits are collected by lopping of matured catkins bearing branches. After collection they are soaked in water for 24 to 48 hours to allow the decomposition of pulp. Seeds are separated by rubbing it over a wire-mesh, washed and dried under shade.

Seed collection period	April to May
Number of seeds/kg	3,50,000
Seed **viability**	6 months
Germination percentage	40
Seedlings obtained/kg seeds	1,40,500
Pre-sowing treatment	Not required
Sowing method	Mother beds
Germination period	10-45 days
Nursery management	Care should be taken at the time of sowing of seeds and watering the beds as there are chances of damage due to very light weight of the seeds.

Seeds are sown at the depth of 0.5cm to 1.0 cm in mother beds or trays. Watering is done carefully so that seeds are not washed away. The germination starts after 10 to 15 days of sowing and continues up to about five weeks. Seedlings are transplanted after about two months of sowing or at four leaves stage when they become about four inches tall. Seedlings become ready for plantation after about 4 to 6 months of transplanting. Stump planting is also quite successful in this species. At an elevation of 5000 feet winter transplanting with ball of earth is reported to have given 100 % success. It coppices and pollards well. The growth is rapid in first few years but slows down gradually.

Bonsum *(Phoebe goalparensis)*

It is a tall evergreen tree with a compact crown having a clean bole of 14 to 17 m length. It flowers profusely during April to May. Fruits - drupe, purple, 1.0 to 1.5 cm long, mesocarp thin, aromatic. The ripen fruits are just like jamun fruits in appearance and are eaten by the birds and wild animals. They are collected by lopping the branches and dried under shade till the thin mesocarp gets dried. Care should be taken during the extraction of the seeds as over-drying may result in the breaking of seed coat thereby damaging the seeds. Seeds are recalcitrant, therefore, can not be stored for a long period.

Seed collection time	October to November
Number of seeds/Kg.	950
Seed Viability	3 months
Germination percentage	**70**
Seedlings obtained /kg seeds	650
Pre-sowing treatment	Overnight soaking in tap water
Sowing method	Mother beds
Germination Period	25-90 days
Nursery management	Removal of thin mesocarp is essential before the sowing of the seeds. Seeds are sown immediafeiy after drying in the month of November.

Sowing is done in the properly shaded mother beds at the depth of 1.5-2.0 cm in soil by keeping the pointed end of the seeds upward. Germination is hypogeal. It starts after about 25 days of sowing and continues to about 90 days possibly due to the prevailing cold weather during this part of the year. Seedlings become ready for transplantation after about four months of sowing when they are in three-leaf stage. Transplanting should be done under proper shade and once established, seedlings can be kept in open beds. They become ready for plantation after about six months of transplanting. Stump planting is also successful to some extent under aided natural regeneration in this species.

Borpat *(Ailanthus grandis)*

It is a fast growing species, which occurs naturally up to 1200m in tropical moist and deciduous forests. It is a lofty evergreen tree with a straight cylindrical bole and a very small conical crown. It prefers a deep, moist well-drained sandy loam soil. It is a light demander species which coppices fairly well and also produces root suckers. Flowering occurs in September and fruits ripe from February to March. Fruits-winged samara, seeds light brown in colour with a very thin membranous testa and oily cotyledons. Fruits can be collected by lopping the branches when they become light brown in colour. It can also be collected from the ground but care should be taken to discard the insect-damaged seeds. It is erratic in flowering and fruiting habit and fruiting output. No two consecutive seed years are good and there is differential fruiting from tree to tree even within the same plantation (Guhathakurta & Ghosh, 1972).

Seed collection period	February to March
Number of seeds/kg	1720
Seed viability	7 months
Germination percentage	**85**
Seedlings obtained/kg seeds	1300
Pre-sowing treatment	Not required
Sowing method	Direct sowing in polythene bags
Germination Period	**25 to 120 davs**

Sowing is done directly in the polythene bags. It is better to remove the wings before sowing and seeds are sown flat/horizontal in the beds. It has a long period of dormancy which breaks automatically with the onset of monsoon, therefore, seeds sown in March take as long as 41 days to start the germination (Guhathakurta & Ghosh, 1972). However, in an experiment conducted at SFRI nursery the germination started after 23 days of sowing. Shade is necessary in the initial stages of seedling development. Naked root transplanting has not given good result and attempts to raise plantation by stump planting have failed so far (Guhathakurta & Ghosh, 1972).

Dhuna *{Canarium strictum)*

A gigantic tree with a spherical crown having a clean gray bole of 30 to 35-m length. It occurs in the tropical moist evergreen and moist mixed deciduous forests. Fruits - drupe, 2.5 to 5.0 cm long, pointed at both ends, mesocarp fleshy, stone hard, aromatic, seeds trigonous, usually 3- celled with three seeds. Flowering occurs from February to April and fruits start maturing from November to January. The ripen furits/drupes are collected by lopping the small branches, the fleshy mesocarp is removed with a sharp knife, and seeds are dried under proper shade for about a week. Fruits are eaten by the wild animals and it was noticed that local people make a machan over the tree to kill the animals (deer) which come to eat the fruits.

Seed collection period	November to January
Number of seeds/Kg.	300
Seed viability	18 months
Germination percentage	90
Seedlings obtained/kg seeds	270
Pre-sowing treatment	Hot water treatment
Sowing method	Sowing in mother beds
Germination Period	26-140 days
Nursery management	Sowing in mother beds is more fruitful because in many seeds one to three seedlings \ emerge from a single stone/fruit which can be separated and transplanted into the polythene bags.

Seeds are soaked in tap water for 24 hrs after that water is drained and seeds are sown in properly shaded mother beds at a depth of 1.5 to 2.0 cm vertically to keep micropyle upward. Germination is epigeal; it starts after about three weeks of sowing and continues upto 120 days specially if sowing is done during winter months. 95% germination was observed on sand substratum at Seed Testing Laboratory, SFRI. Transplanting is done in the polythene bags when seedlings attain 3-leaves stage. Initial growth of the seedlings is very fast and they become ready for plantation after about two months of transplanting. It can be successfully raised by direct sowing in fields at the onset of monsoon rains.

Hollock *{Terminalia myriocarpa)*

A large evergreen tree with a spreading crown and long pendulous branchlets. The panicles of small, pink young fruits start appearing from October to November and fruits ripen from end of December to January. Fruits drupe, yellow, 3- cornered, and the lateral corners developing into short wings. The wings are initially pink in color, become yellow later on and are a good indication about the maturity of the seeds. The tree usually seeds welt but occasionally a poor seed year may intervene. Seeds are very small, light in weight, and collected by lopping the smaller branches. After plucking the seeds are dried under proper shade for two to three days. Seeds are gently beaten in a bag and separated from wings by winnowing. Sowing should be done immediately as seed loose viability within three months of collection.

Seed collection period	Mid December to **January**
Number of Seed/Kg.	5,00,000
Seed Viability	3 months
Germination Percentage	60
Seedling obtained/kg seed	2,50,000
Pre-sowing treatment	Not required
Sowing method	Line sowing in mother beds
Germination period	10 to 35 days
Nursery Management	Providing a cover of thatch over the beds in the initial stages enhances the germination.

Sowing is done in mother beds in lines at 10 to 15 cm intervals after that the beds are covered with straw/thatch and watering is done as and when required. Germination is epigeous and starts after about 10 days of sowing. Seedlings can be pricked out when they attain four-leaved stage. At initial stage polythene bags with newly transplanted seedlings need to be kept under shade, which can later be transferred to open beds. A heavy shade may result in etiolation and development of poor seedlings. Previous experience shows that the direct sowing in furrows made in the plantation areas after controlled burning gives good result. *

Hollong (*Dipterocarpus retusus - D. macrocarpus)*

It is the most valuable species for plywood industries, which is confined to the tropical wet evergreen forests of the north-east region. It is a lofty semi-evergreen tree with oval spreading crown which is considered to be a shade bearer at least in the early stages of its growth (Rajkhowa, 1961). However, in later stages it is a light demander. It cannot tolerate water logging and prefers sandy loam soil, therefore, its best growth is found in high table lands or in foot hill regions on well drained slopes. Flowering occurs in the month of June and the fruits start ripening by the end of January or at the beginning of March. Ripen fruits are collected from the ground because it is very difficult to collect them from the standing trees, as they are extremely **tall.** Seeds are winged and dispersed by wind. Dipterocarps are generally irregular seed bearer and period of good crop varies from three to six years. Seeds are recalcitrant, viability is very low, therefore, cannot be stored for longer period.

Seed collection period	February to first week of March
Number of seeds per kg	64
Seed viability	15 days
Germination Percentage	70
Seedlings obtained/kg seed	45
Pre sowing treatment	Not required
Sowing method	Direct sowing in polythene bags after removing the wings
Germination period	8-21 days
Nursery management	10 cm thick layer of freshly collected seeds is made over a layer of sand in a sunken bed. Seeds are then covered by sand or jute and moistened by regular sprinkling of water until radicle emerges. The germinated seeds are immediately transferred to the polythene bags.

Sowing should be done in shaded nursery beds immediately after collection of the seeds. It is better to break the wings before sowing the seeds. The micropyle end of seed is kept upward in the soil. Germination is around 70 percent and depends on the quality of seeds collected. Germination is hypogeous and starts after 8 to 10 days of sowing and continues to about 45 days. Seedling are planted in the field with the onset of monsoon. After planting, the seedlings grow best when provided with 25% overhead and 100% side shade (BeniwaL 1990).

Jutuli *(Altingia excelsa)*

It is very tall, aromatic and deciduous tree with 14 to 16 m long clean bole. Fruits rough- head-globose capsule, woody, light brown in colour, each fruit has 25 to 40 seeds. Flowering starts in the month of February and fruits are ready for collection from the end of December onwards. Fruits are similar to rudraksh seeds in appearance. It contains numerous sterile seeds along with the fertile ones. The fertile seeds are winged and small. The ripen fruits are collected by lopping the branches and dried in shade for two weeks. Then fruits are threshed and sieved to discard the husk and inert material.

Seed collection period	December end to February
Number of seeds/Kg.	8,00,000
Seed viability	4 months
Germination percentage	40
Seedlings obtained/kg seed	3,0G,00
Pre-sowing treatment	Not required
Sowing method	Sowing in mother beds
Germination Period	10 to 70 days
Nursery management	Due to very small size of seeds mulching is essential after sowing until the emergence of seedlings. This is done to keep the beds humid and care is taken at the time of watering so that seedlings are not damaged.

Seeds are sown in mother beds by making lines or by broadcasting the seeds at a depth of 0.5 cm to 0.8 cm. Germination is epigeal, starts after 10 to 20 days of sowing and continues for about 70 days. Seedlings become ready for transplanting when they attain three-leaved stage. The initial growth of seedlings is very slow. They become ready for planting after about 6 months of sowing. Stump planting is also successful in this species.

Kadam (*Anthocephalus chinensis)*

A tall deciduous tree of moist tropical regions. It exhibit self pruning and bears branches at the top only. The flower buds grow at branch tips, the inflorescence appears just like green balls. Fruit is a pseudocarp, a globose fleshy mass of closely packed capsules, each containing a large number of minute seeds. The fruits ripe twice a year, first in January to February and again from October to November. However, seeds collected during winter gives better germination. Fruits are collected by lopping the branches when the green colour of fruit changes to yellowish. Birds and rodents destroy a fair **quantity** of seed. After collection, fruits are soaked in water for 3 to 4 days and then heaped under shade for about a week until the pulp rots and becomes loose. Fruits are then rubbed to form a. paste like slum' and sieved through a fine mesh. The seeds are very minute and remain viable for about 12 months; however, by this time its germination capacity drops to around 5%. Therefore, it is better to sow the seeds within 6 months of collection to get better results. Each seed produces one to two seedlings.

Seed collection period	January to February, and October to November
Number of Seed/Kg.	1**6,00,000**
Seed viability	1**2** months
Germination Percentage	**60**
Seedlings obtained/kg seed	**9,50,000**
Pre-sowing treatment	Overnight soaking gives better result
Sowing Method	Mother beds/trays
Germination period	10-30 days
Nursery Management	Watering should be done carefully with a fine sprayer in the initial stages, because seeds are very minute and improper watering may wash away seeds as well as the seedlings. Seeds should be cleaned properly as seeds with pulp give around 4.8% germination only (Beniwal & Dhawan. 1991).

As the seeds are extremely light in weight it is better if sowing is done in small trays or wooden boxes (45 an x 45 cm). A mixture of fine soil and sand in 1:1 ratio is better. It is better to put a cover of grass till germination occurs. The beds should be prepared in such a place so that proper sunlight is available throughout the day. Germination is epigeous and starts after about a week of sowing and seedling are ready for transplantation in 60 to 75 days. According to the field experiences providing of light during night may hasten the germination. It should be done under shade and after 4 to 5 weeks seedlings are shifted to open beds. Young plants are sensitive to drought and frost. Field planting is done at onset of monsoon ram.

Khokan *(Duabanga grandiflora)*

Tall semi-evergreen trees with horizontally drooping branches and large flower at branch tips. Fruit-capsule. The tree generally produces good seed crop every year and on an average a medium sized tree produces 40 to 50 kg. fresh capsules. The capsules are green when young and become black at maturity. The capsules can be collected by lopping the small branches, dried in sun for 2-3 days and seeds are removed by gently thrashing the dried capsules. One-kilogram fresh capsules give about 70-80 gms seeds. Seeds are very small and about 48% of them are sterile (Beniwal, 1987a).

Seed collection period	March to May
Number of seeds/kg.	50 million (approximately)
Seed viability	3 months
Germination Percentage	30
Seedling obtained/ kg of seeds	15,00,000
Pre sowing treatment	Not required
Sowing method	Sowing in mother beds; mixing with sand ensures even spread and prevent washing away of seeds while watering
Germination period	10 - 40 days
Nursery management	Young seedlings are very minute, therefore, requires proper care during watering. Excessive watering is harmful and may lead to damping-off of seedling.

Raised mother beds having a mixture of sand and soil (1:1) should be prepared with proper shade to protect the seedlings from rainfall. The beds should be watered before sowing so that the seeds do not get washed away. Broadcasting about 5 gm seeds in 1 m x 1 m bed and the beds are covered by thatch or straw does sowing. Germination starts after 10-12 days and seedlings are ready for transplantation in polythene bags after 50-60 days of sowing when they attain two-leaves stage. Seed shows positive preference of light for germination and gave fast and maximum germination of 80% in continuous light but failed to germinate in dark (Shukla & Ramakrishnan, 1981). After transplanting the seedlings, the polythene bags are kept in shade for about a month. The initial growth of the seedlings is very slow but it picks up from September onwards and seedlings become 60 cm to 70 cm high by the end of April and the roots start penetrating the ground. The seedling height can be manipulated managed by extending the date of sowing as per the requirement.

Mandhani (*Acrocarpus fraxinifolius)*

A tall deciduous tree with spreading crown attaining a clean bole of 20 to 24 m length, stem often buttressed at the base. It is sensitive to frost. Fruits pod, 10 to 15 cm long, thin, dark brown in colour. Flowering generally occurs during February and the pods mature from April to May. They are collected by lopping the small branches and dried in proper shade for one week. Seeds are removed by gently threshing the dried pods. One kilogram dried pods give about 250 to 300 gm seeds.

Seed collection period	April to May
Number of seeds/Kg.	29,300
Seed viability .	27 months •
Germination percentage	40
Seedling obtained/ kg seeds	12,000
Pre-sowing treatment	Overnight soaking in hot water
Sowing method	Mother beds
Germination Period	10-45 days
Nursery management	Overnight soaking in hot water (80 °C) or 2 to 3 minutes soaking in concentrated sulphuric acid gives better germination.

The mother beds are prepared by mixing sand, soil and FYM in 1:1:1 ratio. Sowing is done by putting the seeds in 5 cm apart lines at a depth of 8 to 10 mm. Seed sown immediately after collection gave 30% to 40 % germination; others may remain dontiant for as long as a year. Germination is epigeal and highly erratic probably due to the hard seed coat. It starts alter 10 to 14 days of sowing and continues for about 45 days. Seedlings become ready for transplantation in polythene bags after about 70 days of sowing. They are kept under proper shade for about a month. Initial growth of seedling is slow, but it picks up after six months. One advantage with mandhani is that the seedlings are not browsed by the cattle.

Mekai (*Shorea assamica)*

It is a lofty evergreen tree that grows on damp rich soil in tropical wet evergreen forest. Flowering occurs from August to October and fruit begins to ripe from February to March. Fruit 1,5 - 2.0 X 1.5 cm. clasped by the bases of the enlarged calyx segments, wings linear to spathulate, 6 X 10 - 12 cm, glabrous and shining. Weevil's attack the fruits on the tree itself, which are further damaged by the insects and worms after falling on the ground. It never seeds profusely and regularly; therefore, it is difficult to collect sufficient quantity of seeds. Seeds are generally collected from the ground; however, it is better to clean the area below the selected trees before collection of seeds.

Seed collection **period**	March - April
Number of seed/Kg.	600-**1**000
Seed viability	**25** days
Germination percentage	35
Seedlings obtained/kg seed	350
Pre-sowing treatment	Not required
Sowing method	Direct sowing in polythene bags
Germination period	10-25 days
Nursery management	10 cm thick layer of freshly collected seeds is made over a layer of sand in a sunken bed. Seeds are then covered by sand or jute and moistened by regular sprinkling of water until radicle emerges. The germinated seeds are immediately transferred to the polythene bags.

Sowing should be done immediately after the collection as viability is very low (15 days app): Sowing is done in shaded nursery beds and germination starts after about 7 days of sowing and continues up to two months. Krishnaswamy (1952) has reported 83.2 % germination of the fresh seeds. Seedlings are transplanted into polythene bags at four-leaved stage or after about one and half months of sowing. According to Roychowdhary (1960) it is better to sow seeds in bamboo pots (both ends open) and planting should be done along with the bamboo pots in wet sal areas.

Most of the seedlings and saplings in the natural forests are seen to remain stunted and in bushy form and may die back due to adverse climatic conditions. The seedling beaxs a coral like outgrowth in the leaf axis, which results from "dwarfed bud". This stunted growth and dwarfing of bud is noticed in drier areas where soil is very shallow with shales and sand stone underneath and also with lack of adequate soil cover. (Chowdhury, 1967). The saplings are heavily attacked by a species of mistletoe. The natural regeneration is poor and the species is getting depleted in its natural habitat.

Nahar/Nagkesar *(Mesua ferrea)*

Large evergreen tree with compact and conical crown in the early years. Fruits 2.5 to 6.4 cm in diameter, ovoid, pointed, 1-celled, 1-4 seeded, supported by persistent sepal. Seeds up to 2.5 cm in diameter, variously facetted according to their number in each capsule, with a dark brown shining horny testa , cotyledons fleshy, oily, pale yellow. The seeds are attacked and eaten by weevils, pigs, porcupines and other animals. Local people also collect them for burning. The fruits are collected either from the ground or directly from the trees itself. It should be collected when they are fully mature otherwise germination percentage is less. After collection, fruits are spread out in the sun until they dehisce and seeds are dried in shade. Seeds kept in open cracks and loose its viability rapidly. Seeds being recalcitrant can not be dried to lower moisture content. According to Bahuguha & Rawat (1989) 27 % viability can be obtained even after 4 months of storage if seeds are kept at 5 °C in perforated polythene bags Sowing should be done immediately otherwise its viability is lost. During storage seeds should be spread out occasionally under shade to examine insect attack.

Seed collection period	August - September
Number of seed/Kg.	230
Seed viability	4 months
Germination percentage	70
Seedling obtained/kg seed	160
Pre-sowing treatment	Not required
Sowing method	Direct sowing in polybags
Germination period	15-90 days
Nursery management	Shade is necessary in the initial stage, as the species is extremely sensitive to drought.

Sowing is generally done in polythene bags, however, it is better if seeds are germinated in mother beds and the sprouted seeds are then transplanted to polythene bags. Seeds are placed on their edges at a depth of 1-2 cm. Germination is hypogeous and starts after 10-12 days of sowing. Soaking of seeds in cold water for 24 hours hasten the germination. The seeds seem to be slightly dormant as they took around 15 days for initiation of germination. It is probably due to the seed coat as the excised embryos exhibit full potential of the germination (Behuguna & Rawat, 1989). Seedlings are transplanted to poly bags at four-leaved stage or after about one month of sowing. They become ready for planting in the field by the next rainy season. It has also been observed that seedlings from the open nurseries i.e. one not under natural shade survive better than the seedlings from evergreen forest nurseries.

Titasopa or Champ (*Michelia champaca)*

It is a tall evergreen tree with a close, tapering crown - having clean long cylindrical bole of 18-21 m suppressing all its associates. The mature trees have branches at the top only as it cleans up lower branches (self-pruning) well even in its early stages.. It does not stand waterlogging and prefers well-drained soil. Flowering occurs in April or May and fruits can be collected from August to September next year by plucking the fruits. Proper care should be taken while collecting the seeds as fruit ripening takes more than one year, therefore, branches bearing the mature fruits also bear the flowers of the current year. Fruits aggregate of follicles, consists of long clusters of dark brown follicles on a thalius (7.5 to 15 cm long), opening at the back by two valves. Seeds brown, angular, covered with a pink fleshy arillus. Seeds are oily and loose viability within few weeks. Seed year records from West Bengal show that a good seeding may be expected almost even-year but in Assam, a good seed year is reported to occur once in three years (Troup, 1921).

Seed collection period	August to September
Number of seed/kg	12.000
Seed viability	One month
Germination percentage	70
Seedlings obtained/kg seed	8,400
Pre-sowing treatment	Not required
Sowing **treatment**	Sowing in mother beds
Germination period	10 to 45 days
Nursery management	The red pulp (aril) around the seeds should be removed before sowing because de-pulped seeds give significantly higher percentage of germination compared to seeds sown with pulp.

Seeds are mixed with red-oxide before sowing to prevent its damage by the rodents. Birds and wild boar also eat seeds. Sowing is done immediately after the collection and cleaning (de-pulping) of seeds. Germination starts after 15 to 20 days of sowing and continues up to 45 days. Germination percentage is around 70. which decreases with delay in sowing of seeds. Seedlings are transplanted when they attain three- leaf stage and kept in shaded beds under initial stage. Seedlings become ready for planting in the field by the next rainy season. The tree coppices well and stump planting has also been successful at some places.

Polytubes: A Low Cost Alternative to Root-Trainers

In India, containerized seedling production (Root-trainers nursery) is gaining momentum day by day and in many states such as Andhra Pradesh, Maharashtra, M.P., U.P. and West Bengal more and more forest nurseries are being converted to root-trainer system specially under some externally funded forestry projects. However, due to its very high initial cost majority of nurseries are still continuing with the traditional system of raising seedlings in polythene bags. The main advantages of using root trainers are as follows:

They require lesser nursery space.
They require less amount, of porting mixture and are easy to fill.
They are well aerated.
Aerial pruning of roots takes place.
They do not cause root coiling.
Easy to check soil moisture and root growth during the growth of seedlings.
Seedlings have a good root/shoot ratio.
Lateral/ adventitious root development is considerably good.
Cost of weeding, watering and transportation is less.
The containers are reusable and lasts for 5 to 6 years.
Culling and sorting of seedlings is very easy. It helps in better utilization of nursery space as well as in maintaining the uniform size of seedlings.
Virtually eliminates transplanting losses.

Disadvantages:

Initial cost to switch over to root trainer nursery is very high

The disadvantages associated with the use of polythene bags are:

Requires large quantity of nursery space and potting media.
Root growth specially lateral root growth is poor.
Root coiling occurs which results in slow growth, poor drought tolerance and lack of wind firmness after out planting (Wilson. 1986).
Poorly aerated.
Comparatively higher cost of weeding, watering and transportation.
Seedlings rarely develop sufficiently extensive fibrous roots to bind the core plug of the potting mixture (Josiah and Jones, 1992).
Roots come out of the bags and break off while taking out seedlings which gives a severe shock to plants postponing its recovery and growth.
In case polythene bags are used without a hole at its bottom, a perched water table may form, which further limits aeration and root growth.

Gera *et al.* (1998) suggested the use of mounted angle iron beds to keep the polythene bags so as to avoid the coiling of the roots. Nanhorya ***et al.*** (1999) further

modified it by using polytubes *(polythene* bags open at both the ends) and kept them on the raised platform just like root-trainers. The same technique was tried at SFRI Nursery, Itanagar with some local modifications such as bamboo culms were used to prepare the raised platform as well as vertical ridges for inserting into the polytubes. The changes required to switch over from a normal nursery to a polytube nursery are very simple and do not require much technical skill and expenditure. The cost of preparing 5m long raised platform with wire-mesh and bamboo comes to about six hundred rupees at Itanagar and this bed is sufficient for keeping 1000 seedlings. The only precaution, which is required to be taken, is at the time of filling of polytubes because initially the staff/labour feels awkward in filling the potting mixture in a polytube, which is open at both the ends. The vertical ridges are prepared by splitting the locally available bamboo culms (2mm wide, 3mm deep and length equal to the length of the polytube). Six sticks are inserted slowly at equal distance into the polytubes after filling the potting mixture. Care should be taken that polytubes are not ruptured while inserting the bamboo sticks. The main requirements to change a normal nursery to a polytube nursery are: .

1. Use of polytubes in place of polythene bags
2. Preparation of fine bamboo sticks for inserting into the polytubes which acts as root trainers
3. Construction of a platform from bamboo culms (30cm from ground level) and fixing a wire-mesh (3mm thick) by binding wire to keep the seedlings over it.

The main advantages of using polytubes are:

It does not require high capital investment.
The staff can easily switch over and adopt this technique.
It prevents root coiling and ensures better lateral root development similar to root-trainers.

A comparative analysis of capital investment in establishing a root trainer nursery and a polytube nursery has been given in Annexure-1 (Nanhoyra *et al.,* 1999). However, the cost is even much higher in northeastern areas for root trainer nursery because one root trainer tray may not be available in less than Rs. 150,00 and the cost of each stand comes to about Rs. 200.00 per stand Therefore, polytubes nursery seems to be a better option. Our experience with polytubes nursery is very encouraging and suggests its adoption for raising large-scale seedling production. Decreasing the size of polythene bags can further reduce the cost. It would simultaneously help in decreasing the quantity of potting media, nursery space as well as cost of weeding and watering.

NURSERY MANAGEMENT TIPS

1. Potting Mixture (Nursery-Soil)

There is a tendency to collect the topsoil from forest area to fill the polythene bags. This practice is not good as it contributes to soil erosion.
The whole success of nursery depends on good soil mixture. It should be light in weight, well decomposed and well drained and free from insects as well as weed seeds.
Always use compost in the nursery. It can easily be prepared by decomposing organic materials (green leaves). It increases the nutrient contents of the potting mixture and enhances the air spaces and water holding capacity of the mixture.

2. Seed Collection and Sowing

Always collect seeds from plus trees or phcnotypically superior trees.
A chart should be prepared in each nursery indicating the seed collection period of local tree species along with the location of plus trees.
Seedlings developed from poor or abnormal trees will never produce good trees.
After collection seeds should be processed carefully otherwise they may get damaged and loose viability.
Each species requires different processing after seed collection i.e. seeds with pulp (kadam) are to be processed in a different way than the pods (mandhani), drupes (bonsum and dhuna) and capsules (bogipoma and khokan).
In tropical area most of the seeds have short viability, therefore, sowing is to be done immediately after collection and processing the seeds.
Sow large seeds 2cm to 3cm deep in the soil.
Sow small seeds (Kadam, Khokan) about 0.5 to 1cm deep or broadcast and cover them with a small amount of fine soil. The beds can also be covered with thatch or plastic sheet till the germination of seeds.

3. Watering

Keep seedbeds moist not wet.
Do not water at a fixed time each day. Water when the plants need it.
Small seedlings require less amount of water.

Large seedlings require more water more often.
Seedlings require more water more often on windy days and sunny days.
Water less often when seedlings are kept in shade.
The moss and algae growth is an indication of excess watering.
Always use clean water; dirty water may cause disease problem.
Over-watering results into weak plants and causes diseases such as root-rot and damping-off of seedlings.

4. Transplanting

Water mother beds thoroughly before transplanting the seedlings.
Always use some tools (bamboo-sticks, etc.) to loosen the soil before pulling out seedling from the beds.
Make a deep and wide hole in the polythene bag or container for transplanting the seedling.
Hold seedlings at the base of the stem and pull it out gently from the mother beds.
Never bend the roots and do not force the seedlings to fit into the hole.
Keep transplanted seedlings under proper shade until they have recovered.

5. Hardening of Seedlings

In a nursery seedlings are kept under ideal condition, therefore, hardening is essential to make them strong enougli to tolerate the harsh conditions of field/ planting site. It is generally done by reducing the amount of watering about one month before the date of planting.

6. **Nursery** Hygiene and Disease **Control**

Most of the micro-organisms, insects and pests that cause diseases in the nursery live in weeds, trash and puddles. Therefore, keeping nursery in neat and clean condition to reduces the chances of attack of common diseases. All trash, waste, **polythene** bags and diseased plants should immediately be removed and burnt at a place far from the nursery.

Pesticides Recommended : Diazinon. Melathion, Sevin
Fungicides Recommended : Bavisteen. Benlate, Captan. Dithane M-45

Dangerous Pesticides	:	Aldicarb. Aldrin, DDT, Lindane, Nuvacron, Heptachlor, etc. These are very dangerous. Never use them.
Natural insecticides	:	Neem Seeds: Make powder of 500g dried neem seeds and soak overnight in 15 litres tap water. Sieve it twice and spray. Besides this, chilli powder and tobacco leaves powder can also be used. They generally take little longer to repel or kill the insects, therefore, apply them immediately as soon as insect problem is noticed. The main advantage is that they are natural, hence safe and biodegradable. Remember the following things while using them:

Proper doses should be prepared by carefully reading the label or guidelines.
Always provide protective clothing, mask, gloves and goggle to the person spraying the pesticide.
Never mix insecticides and fungicides together in the same sprayer.
Never eat, drink or smoke while spraying.
Never use pesticides containers to store other things.
Extra pesticides should be disposed by digging a hole away from rivers and wells.

Comparative Analysis of Capital Investment involved in establishing a Root Trainer and a Polytube Nursery having a capacity of One lakh Plants (Nanhorya *et al.* 1999)

Root-Trainer Nursery

1) Cost of Root Trainer Blocks -
   a) One block having 20 cells of 150 cm^3
   b) Total requirement 5,000 blocks
      i)Cost of one block = Rs. 75/- (Rs.150 at Itanagar)
      ii)Cost of 5,000 block = Rs. 5,000 X 75 - Rs. 3.75 lakhs.
2) Cost of Iron stand for keeping Root Trainer Blocks
   a) Iron Stand (size 110 cm X 20 cm) = Rs. 115/- per stand (Rs.200 at Itanagar)
   b) One stand holds 5 blocks
   Therefore for keeping 5,000 blocks we need (5,000/5) = 1000 stands.
   c) Cost of 1,000 stands = 1000 X 115 = Rs. 1.15 lakhs
   d) Total Capital Investment = 3.75+ 1.15 = Rs. 4.90 lakhs.

Polytube Nursery:

1. Cost of Polytubes (10,00,000 polytubes)
   a) 1 Kilogram = 750 Nos. Polytubes
   b) Requirement (10,00.000/750) = 134 kg. Polytube
   c) Cost per Kilogram = Rs.115/-
   d) Total cost = 134 X 115 = Rs. 15,500/-
2. Cost of Root Training vertical Ridges
   a) One Polytube consumes 6 vertical ridges
   b) Therefore 10,00,000 Polytubes will consume (10,00,000 X 6) = 60,00,000 Ridges
   c) Ridges count per kg. =2,700
   d) Total requirement = 60,00,000/2,700 = 222 kg.
   e) Cost per kg. =Rs. 75/-
   f) Total cost = 222 X 75 = Rs. **16,650/-**
   g) Total cost of Polytube and Ridges = 15,500 + 16,650 = Rs. 32,150/-
3. Cost of Stands made up of GI Wire Mesh and wooden Rafts for keeping Polytubes
   a) Cost of one stand made up GI- Wire and wooden raft - Size 182 cm X 94 cm = Rs. 300/-
   b) One stands holds 650 Polytube
   c) Therefore total requirement of Stands(10,00,000/650) = 154
   d) Cost of Stands =154X300
   e) Total capital cost of establishing a Polytube Nursery = 32,150 + 46,200 = Rs. 78,350/-

Cost Ratio : Root Trainer : Polvtube = 4.90.000 : 78.350 = **6.25** :1

The establishment of a Root - Trainer Nursery is 6.25 times more costly than a Polytube Nursery

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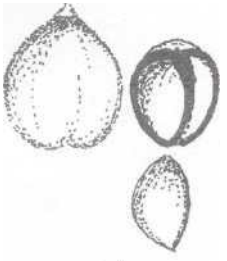
Fig. 2.

1. Amari fruit & seeds x 1/10; 2. Jutuli furit & seeds x 1; 3. Agar fruit & seeds x 1; 4. Mandani pod & seeds x $^1/_2$; 5. Bola seeds x 2; 6. Bogipoma seeds x 1; 7. Bonsurn fruit & seeds x 1; 8. Dhuna fruit/seeds x $^1/_2$; 9. Hollong seed x $^1/_4$; 10. Hollock fruits & seed x 1; 11. Khokan fruit x 1/10, seeds x 1; 12. Kadam fruit x 1/5. seeds x 1; 13. Nahar fruit, seeds x 1/5; 14. Mekai seed x 1/3; 15. Titasopa fruit, seeds x 1; 16.Borpat seed x 1/5.



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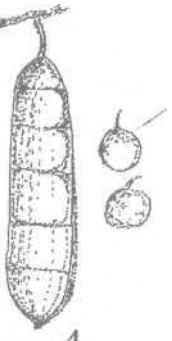

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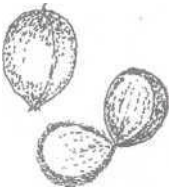

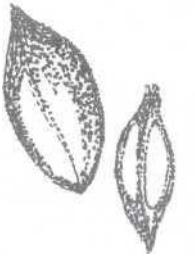

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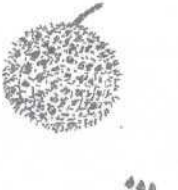

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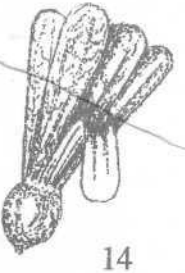

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