Government of Sikkim

THE STATUS OF FOREST NURSERIES AND FUTURE ACTION PLAN 2009-2010

Prepared & Designed by

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Forests, Environment
& Wildlife
Management Department

ACTION PLAN FOR RAISING QUALITY PLANTING MATERIALS (QPM) WITH BASIC COMMON NURSERY MANAGEMENT PRACTICES 2009-2010

FORESTS, ENVIRONMENT & WILDLIFE MANAGEMENT DEPARTMENT, GOVERNMENT OF SIKKIM

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Introduction

The Government has taken further exemplary initiative to glorify the State into 100% green forest with introduction of technological extension from the year 2009-10. This mandate requires concerted efforts from various sectors of the department i.e. right from the forest guard to the PCCF-cum-Secretary. The seedling raising is one of the main activities of the Forest Department for producing planting materials with the help of local labours as a part of the management. Although, practices of the raising seedling in different nurseries of different sectors for re-generation of degraded forest has indicated better success, the process of raising seedling is more or less social service oriented to provide employment opportunities to the local poor people side by side looking after the welfare of their family. On the other hand, no adequate specific technological interventions for raising Quality Planting Material (QPM) have been implemented in the past. Also, the selection of the species and its requirements varied and was not seriously considered for re-generation programme. The capacity building and skill up-gradation of the frontline staff and M.R. hands were also not adequately addressed. The inputs for support of raising seedlings in the nursery were also not sufficient to produce the prescribed quality of seedling from each nursery by each labour. The regular post maintenance of the nurseries created under projects landed with financing paucity. Thus the interim wages are made from plan fund or FDA. As a result, the quality of nursery maintenance is not met up to the desired standard. There is no financial support for watering, manure, technological inputs and other required facilities.

The attention on existing indigenous flora degradation and depletion was not paid. There are number of highly valued floral species which have started dwindling their population in the wild, which require human intervention with developed technology and scientific support.

Accordingly, status and assessment of the existing nursery maintained by different circles and division was worked out. Each division was asked to submit data and information regarding actual allocation of the nursery, total area in Hac, No. of M.R. hands, and selection of species for that particular nursery. The present stock of plantable seedlings as on 01/06/09 and capacity of the nursery to raise seedlings during 2009-10 were also obtained. The information were also sought for input requirements such as manure, water supply, nursery implement protection, poly bags, green house, source of seed supply, equipment etc. As per the information received from different sectors of the department, it was found that the following nurseries are being operated by them funded from Plan, HEP, FDA, EDC and Sikkim Ecology & Environment Cess.

Statement showing altitude-wise distribution of Nurseries maintained by different sections in Forest, Environment & Wildlife Management Department, Government of Sikkim as under:

Sl. No.	Circle/ Division	Altitude in mtrs.			Total (Ha.)	Remarks 5 labs./ha.
		457-1220	1221-2134	> 2440		
1	Territorial	19.20	38.50	1.00	58.70	293.50
2	Land Use	7.50	7.70	-	15.20	76.00
3	Social Forestry	7.00	4.50	-	11.50	57.50
4	Wildlife	-	3.00	1.00	4.00	20.00
5	Non-Timber Forest Produce	3.40	6.60	2.00	12.00	60.00
6	Sericulture	4.50	-	-	4.50	22.50
7	Silviculture	1.20	-	-	1.20	6.00
8	F.C.A	-	2.00	-	2.00	10.00
9	E.P.C	-	0.80	-	0.80	4.00
10	Parks & Garden	-	0.50	-	0.50	2.50
	(in Ha)	**42.80**	**63.60**	**4.00**	**110.40**	**552.00**

Note:-

- **27.40 Ha under State Green Mission**
- **17.00 Ha under CAT Teesta-V**
- **14.40 Ha under Forest Development Agency (FDA)**
- **51.60 Ha under others**

Total - 110.40 Ha

Cost of Nursery Maintenance

1. **Low altitude = 42.80 x 2.44 = Rs.104.43 Lakhs**
2. **High altitude = 67.60 x 2.80 = Rs.189.28 Lakhs**

Total = Rs.293.71 Lakhs

The total nursery area maintained by the department is 110.40 Ha. and produces appropriately 132.48 lakhs no. of seedlings per year composed of tree species, fodder, medicinal plants, soil conservation species and ornamental species. There is no specific guideline for maintenance of nurseries. Therefore, the total production of mixed seedlings out of the existing nurseries is estimated to 132.48 lakhs of different types of seedling. The practice of raising seedling in all the nurseries are of same type of species selection and no efforts have been made to raise species which are on threshold limit.

As these nurseries are raised on normal forestry practices vis-à-vis social services oriented, there is an immediate requirement of intervention of policy and technology application to produce quality planting material of highly valuable species. In order to raise the seedlings of rare local species, it requires number of parameters such as zonation of the plantation area relevant to raise the species being reduced, their population in the nature and so on. It is proposed to identify three broad based ecological, altitudinal and other factors viz. Upper Hill Alpine-Sub-Alpine zone, Middle Hill Temperate zone and Lower Sub-Tropical zone. The broad based zonation will ease out to select the species relevant to that particular area and altitude. Some of the proposed species such as Quercus family are extremely difficult to get satisfactorily germination rate. The Quercus seeds are subjected to entomological and fungi attack and viability of the seed is limited to 4-6 days. The growth rate of upper hill alpine, sub-alpine species is extremely slow and finds difficult to gain hardly 1-2 feet within a period of three years. A large number of species of all the zones have been selected with participatory approach and brain storming exercise.

In order to achieve the target fixed by the government to raise 1 crore QPM seedling beginning from the year 2009-10 for Greening Sikkim with the help of the existing M.R. hands and the regular staffs, it is observed that there is no need to create additional area of nursery. The existing nurseries have extensive area and manpower to generate the target seedlings. However, the financial support for scientific maintenance of the nursery is required as estimated. The total fund requirement for maintenance of the existing nursery is estimated to the order of Rs. 293.71 lakhs. (Composed of Rs. 189.28 lakhs for high altitude + Rs. 104.43 lakhs for low altitude)

The Modus Operandi for Scientific Management of Existing Nurseries with the Available Manpower is to be Implemented as follows:-

There are 67.60 Ha of nurseries located between 1221 m to 2440 mtr and 42.80 Ha of nurseries are located between 457-1220 mtr throughout the state. The following prescription of species should be raised in each zone by the concern division and ranges. A broad base selection of species relevant to the zone altitude has been considered to be raised in the nurseries. However, the concern DFO/R.O. shall collect relevant information on the status of the species proposed to be raised in each nursery. The information should be assessed and used to select only those species which are in the process of depletion of their population in the wild. The assessment of the species selection should also be considered depending upon the demand of the local community to meet the bonafide use. Commercially important species should be proposed in the nursery as well. The third important agenda for raising seedlings by NTFP division should be based on the prescription given by the NMPB (National Medicinal Plant Board). Efforts should be made to survey the status of medicinal plant along the landscape for the purpose of biodiversity conservation. As per the policies of the state government, ecotourism development promotion require beautification of spots with ornamental plants including flowering plants and foliage which are to be raised in the nurseries for creation of parks and gardens, view point and road-side ecological improvement.

Prescription of species to be raised in different nurseries of different elevation are as under:

Selection / Prescription of Species:

Sl. No.	Zonation /Altitude	Type of planting programme	Name of the Species	Source of Seed
A i	Upper Hill (Alpine, Sub – Alpine)	Artificial regeneration	Silver Fir- *Abies densa*, Dhengra Salla -*Taxus bacata*, Hemlock – *Tsugo spp*., Sprouce – *Picea smithiani*, Larch – *Laxin guaffithii*, Juniper – *Juniperous heerva*, *Juniperous psceodosobina*, *Juniperous prostate*, Chemal – *Rhododendron Spp.*, Sali, Lekh Saur- *Batula alnoidus*, Lekh Kapasi – *Acer campbellii*, Poplus, Sorvous, Chunde – *Pentapanax leschenauttii*, Ghoge Champ – *Magnolia campbellii* **Medicinal Herbs** – Bikh/Bikhma – *Aconitum ferox*, Chimphing – *Heracleum wallichii*, Jatamashi – *Nardostachys jatamansi*, Kutki – *Picrorhiza kurrooa*, Pakhandhed – *Bergenia ciliate*, Panch aunley – *Dactylorhiza hatagirea*	Seed stands, registered and recognized firms and nurseries
ii		Added natural regeneration	-do-	-do-
iii		Silvi-pasture development	Poplus, Maple, Lekh Saur, *Ficus species, Sorbus spp.*	-do-
iv		Regeneration of perennials medicinal herbs & shrubs	Kutki, Jatamansi, Attis, Gensing, *Panch awale*,	Local collection from seed stands

Sl. No.	Zonation /Altitude	Type of planting programme	Name of the Species	Source of Seed
B	Middle Hill (Temperate)	Artificial regeneration	Bhadrase- *Eleocarpus sikimensis*, Gante- *Gynocardia odorata*, Lapche phal- *Machilus edulis*, Dhar – *Bhomeria regulasa*, Katus – *Quarcus species*, *Ficus species*, Okhar – *Jugluns regia*, Utis – *Alnus nepalensis*, Aarupatey – *Prunus nepaulensis*, Rani Champ – *Michelia exclsa*, Khanakpa – *Evodia fraxinifolia*, Lapsi – *Spondias axillaries*, Nebhara – *Ficus hookeri*, Phusre Champ – *Michelia lanuginora*, Painyun – *Prunus cerasoides*, Pipli – *Bucklandia populnea*, Tooni – *Cedrella toona*, Amliso – *Thysanolaene maxima*, Paryang – *Cephalostachyum capitatum*, Nigalo – *Arundinaria falconeri*, Dudhilo – *Ficus nemoralis*, Khanew – *Ficus cunia*, Banana - *Musa spp.*, Ghurpis – *Leucosceptrum canum*, Argayle – *Daphne cannabina / Edgeworthia gardneria*,*Asare – Viburnum spp.*, Basak – *Dichroa febrifuga*, Raat Ki Rani – *Cestrum nocturnum*, **<u>Medicinal Herbs:</u>** Bhakimlo – *Rhus semi-alata*, Bojho – *Acorus calamus*, Chirowto- *Swertia chirata*, Lnkooree- *Fraxinus paxinia*, Majito – *Rubia cordifolio*, Nag beli- *Lycopodium clavatum*, Siltimmur-*Litsaea citrate*, Tambarki – *Stephania glandulifera*	Seed stands, registered and recognized forms and nurseries
		Added natural regeneration		-do-
		Silvi-pasture development		-do-
		Regeneration of perennials medicinal herbs & shrubs		Local collection from seed stands

Sl. No.	Zonation /Altitude	Type of planting programme	Name of the Species	Source of Seed
C i	Lower Hill (Sub-tropical)	Artificial regeneration	Pangra - *Entada scandana* Rudraksay- *Eleocarpus ganitrus* Chiwari- *Bassia butyracea*, Ambakay- *Eugenia jambosa*, Amphi- *Pyruaria edulis* Harra – *Termenila belirica* Barra – *Termenila chebula* Amla – *Emblica officeniles* Khamari – *Gmelina Arboria* Brahar – *Artocarpus species* Katus – *Capstonapsis species* Chelowani – *Schima waliichii* Tanki – *Bauhinia species* Bael – *Argle marmelos* Kabra – *Ficus benjamina*, *Ficus species*, Lampatey – *Duabanga sonneratioides*, Phaledo – *Erythina arborescens* Totola – *Oroxylum indicum*, Baldhengra – *Mucuna macrocarpa*, Panisaj – *Terminalia myciocarpa*, Teek – *Teetona grandis* **<u>Medicinal Herbs:</u>** Bojho – *Acorus calamus*, Majito – *Rubia cordifolio*, Totola – *Oroxyllum vulgaris*	Seed stands, registered and recognized forms and nurseries
ii		Added natural regeneration		-do-
iii		Silvi-pasture development		-do-
iv		Regeneration of perennials medicinal herbs & shrubs		Local collection from selected mother trees.

Maintenance of nurseries includes nursery technological intervention with modern techniques for getting QPM seedlings stock:

The following item of inputs may be utilized and the manager should also explore local innovations from the local residents. The efforts should also be made to outsource techniques from various scientific institutes and organization for improvement of the quality planting materials.

Proposed Nursery Inputs:

Sl.No.	Items
1	Jungle Manure and Cow dung.
2	Vermi-composting (Bio-fertilizer)
3	Collection & Procurement of Seed including treatment of seed.
4	Root trainer/Poly bags.
5	Water supply,Water tank, Pipes, sprinkles.
6	Nursery Sheds-Agro Net, Bamboo Net, Poly Sheds.
7	Hardening Shed- Green House.
8	Soil Testing.
9	Bio-pesticides, Insecticides

Simple guidelines to maintain the existing nurseries with basic common nursery management practice are prescribed below:

Forest nurseries are going to play a very important part in afforestation & re-afforestion programme and improvement of environment in the State. There are various categories of nurseries such as Forest Department nursery of permanent and temporary nature. There are non-departmental nurseries such as Kishan (farmer managed in own land), School (Student managed school compound) and other nurseries run by private organizations and voluntary association in the State.

The temporary nursery are cheaper and are established mainly to supply seedling for the season following. These types of nurseries do not require any permanent staffs, building sheds and other costly facilities and are managed on day to day basis. The Wildlife Circle has been managing some temporary nurseries at the fringe of the P.A. by EDC members.

It is also pertinent to provide training of local farmers, students, teachers and forest department staffs and labours in basic knowledge of nursery techniques to ensure quality of seedling production.

Basic Parameters and Techniques:

Site Selection: - The selection of the nursery is a very significant issue that should be looked into carefully. Hitherto the important considerations given to selection of sites for the department nurseries were physical aspects, namely the terrain, the nature of the soil, the presence of perennial water source, the likelihood of frost and the distance to the plantation sites. The nurseries now have to cater not only to small block plantations at a larger number of sites but also to farmers who plant in their own land. The site of the nursery, therefore, has to be related not only to the physical requirements of the seedlings to be grown but also to the area residents who are expected to plant them.

Location: - The first issue that needs to be sorted out in planning a nursery is the "general area" where it should be established. The general area for a farm forestry nursery should be such that the adequate planting area is available and in fact, demand for seedlings by locals too. The number of seedlings required should be assessed in advance by visiting the sites and farmers. In case the nursery is meant only for specific plantations of known sizes with accepted design and species mix, the question of demand assessment obviously will not arise.

Water: - The source of water should be perennial. The ideal sitting of nursery beds should be such that the water source is at a higher point, for irrigation by gravity. The efforts should be contended to improve the local waterholes, spring water by planting suitable species.

Soil: - Nursery soil should have sandy loam to loamy texture, good tilth, medium to small blocky structure, pH varying between 5.5 to 7.5, moderate fertility with a minimum organic content of 2.5%. Pebbles can be easily removed by sieving through a wire mesh. The water retentive capacity of a sandy soil can be improved substantially by

addition of compost manure (one part of manure to four parts of soil). Water logging in vertisols can be reduced by addition of quartzitic sand (one part of sand to every three parts of soil) and by in bed drainage measures. These points are mentioned here to stress the fact that most of the areas not having soil of desired quality can still be utilized through some ameliorative measures, the details of which should be experimentally worked out separately for each nursery site.

Aspect: In the hills, the aspect of the site plays a significant role in the success of a nursery. In the Himalayas, the aspects most congenial are the south and south west in the higher hills (beyond 1500 mts) and in the eastern and south eastern aspects in the lower hills. In the plains the beds should have longer sides in the east-west direction.

Techniques to be adopted for site selection, location, water and soil

a) The site of the nursery should be as near the planting site as possible. The nursery should lie within a radius of 2-3 km from planting sites in the rugged hilly terrain and 5km in case of plain sites.

b) For nurseries to be established partly or fully for general purpose, the number of seedlings should be determined by assessing demand for them in the surrounding villages within the prescribed radius.

c) The area of the nursery should be minimum about 0.4 ha (1 acre) for every 48000 seedlings.

d) The site should have perennial water supply of 200 litres per day for every 1000 plants. The water should have pH between 5.5 to 7.5 and salt less than 400 ppm. The water quality can be improved by amendments.

e) The soil should be well drained and fertile. Loam to sandy loam texture with good structure is preferred.

Preparation of Beds

The beds can be of four types:

(a) Seed flats or beds for germinating seeds, from which seedlings are pricked out either to containers or to other kinds of beds.

(b) Polypot containers with individual seedlings.

(c) Housing beds, in which individual containers with one or more seedlings in each are placed side by side.

(d) Transplanting beds, where plants are grown in the bed itself for eventual planting out.

It is obvious that the purpose of each of these categories of beds is different, and each requires separate treatment.

Techniques to be adopted for preparation of beds

(a) **Seed flats** used for germinating seeds can be in ground made of earthern pots, shallow wooden boxes, plastic trays, or wicker or bamboo baskets of a portable size (say 50cmx30cmx10cm). The growing medium should be disinfected quartz sand or sandy loan soil.

(b) **Polyethylene containers** are either open at both ends, called sleeves, or closed at one end, called bags. They should be transparent where the size of the container is small (less than 7.5 cm layflat) and the region is hot. In other cases, black polyethelene is recommended.

(c) **Housing beds** are sunk by removing top soil to house polythene containers. The depth should be equal to the length of the container. The floor of the bed should be provided with a black polyethelene sheet of 300-500 guage to keep seedlings roots from penetrating mother earth. The size of the beds is usually 10mx1.2m. However, it depends on the terrain.

(d) **Transplanting beds** are of 10mx1.2 m size, raised or sunk by 10-20cm. The soil is dug out, bigger particles removed (by sieving through wire mesh of 2 cm) and pulverized. One part of compost or dry cow dung manure to four parts of soil and 100 gms of 5% Aldrex thoroughly mixed with the sieved soil and put back in the dug out space, raised or sunken as the case may be.The number of beds required is approximately 1 bed of 12mx1.2m for 2000 seedlings. The seed flat area required is approximately 6% of the transplanting or housing bed area. But it differs with site to site condition.

Seed Collection

The source of seeds has to be from selected trees (phenotype or plus tree). Selection of phenotype is not an easy task as it requires technical skill. Since no attention is given today to the source of seeds, any effort in this direction, even if not technically perfect, will be a significant improvement. As detailed selection of phenotypes with all preferred characteristics may not be immediately possible, some trees should be selected which have one or two characteristic required for the purpose of which the planted trees will be utilized at the end. For example, if the trees are to be used as fuelwood, the trees putting up the maximum rate of biomass production, irrespective of the form, should be considered as the phenotype. This exercise should be done at the initial stages, at least for the most common and abundantly planted species. The quantity of seeds to be collected depends on the number of plants required at the end, germination percentage of seed, loss in pricking out, mortality in seedling container or transplanting bed and cull loss. Even though the germination percentage of various species is often known, it is better to find out the germination percentage of the specific seed lot by actual testing. This is

done for small size seeds by pulling a known number of seeds between two blotting papers and regularly moistening it. The percentage is known on the basis of the number germinated in a twenty day period. For larger seeds, the test should be done in a seed flat.

Seed Storage

The viability of seeds varies tremendously from species to species. Even though the viability of seeds may be high, their usefulness is ensured only by proper storage. If the seeds are moist during storage, they are affected by fungal pathogens. If the hygienic conditions of the storage facilities are not satisfactory, the seeds can be easily attacked by various insects. The most important factors in storage to keep the seeds viable are temperature, humidity and aeration. The seeds tend to germinate with high temperature and humidity. On the other hand, lack of aeration may kill the seeds by suffocation. Where good storage facilities are not available, the seeds should be sown as soon as possible after collection. If they are to be stored at all, they should be placed in gunny bags or in perforated black plastic bags on wooden platforms in well aerated huts. Before the seeds are bagged, they should be dried in the shade to remove surface moisture and mixed with prophylactics like gamaxene or neem leaves.

Seed Pretreatment

The nature of seed pretreatment depends on the hardness of the testa (seed coat). Seeds which have soft seed coats generally do not need any seed pretreatment. However, it is always advisable to put the seeds in water for 24 hours and dry them in the shade before sowing. Seeds with hard coats can be subjected to a number of treatments which can be classified as physical, chemical and biochemical methods. The physical methods include soaking and baking (e.g. *Terminalia beleica*), stratification i.e., storing of seed in moistened medium (e.g. walnut), scarification or rubbing of the seeds (e.g. *Leguminoseae species*), subjecting seeds to heat treatment by boiling in water for about a minute in case of seeds following soaking for 24 hours in the cooling water and to cold water soaking for 24 hours.

Techniques to be adopted

(a) The quality of seeds is determined by the quality of the tree from which they have been collected. Selection of the tree for seed collection should be done with utmost care.

(b) Seeds should be used as quickly as possible after collection. If they are stored, they should be sun dried, put in gunny bags or perforated plastic bags and kept on wooden platforms in well aerated huts. Before storing, the seeds should be mixed with prophyletics like gamaxene or neem leaves.

(c) Some seeds need pretreatment before sowing.

(d) Seeds should be sown in seed flats or in germinating beds if they are of small size. They can be sown directly in containers if they are of bigger size. In each pot, a maximum of 2 to 3 seeds should be sown.

Pricking out

Pricking out is a very delicate operation and should therefore receive much attention. The most important point that needs to be kept in mind is the way the small post emergence seedlings are handled.

Techniques to be adopted

(a) Prick out when the cotyledons have dropped off or atleast two leaves have formed and the seedling stem have reasonable strength to stand transplanting. This takes about 3 to 4 weeks after germination.

(b) The seedlings should be held with thumb and the forefinger by the leaves or just below the first pair of leaves and pulled up softly.

(c) Carry out the operation on a humid day, during rains or in the evenings.

(d) The distance between transplants will vary with the species. It should be 6cm x 6cm if the seedling is retained in the transplant bed for more than six.

Nursing

Nursing of the transplanted seedlings is necessary, till they are of the appropriate size for planting out. This included *watering*, *weeding, pest control* and *mulching*.

Watering: There is a tendency to do excessive watering, which is as harmful as under watering. Sometimes, however, what appears to be over-watering with repeated water sprinkling is in effect under watering because of faulty water administration. Watering of a plant means soaking the soil rooting medium to its field capacity. Field capacity is defined as that percentage of moisture which the soil can retain after the subsequent rate of drainage out of it has become negligibly small. This means that watering, when done, should be adequate for the entire soil medium. Inadequate watering, even if repeated, is of no help.

The quantity of water has to be calculated at the rate of about 200 cc per plant for watering. Continuous under watering creates a superficial root system for the plant which cannot stand adverse climatic condition.

Weeding: Weeding entails removal of unwanted plants. A suitable plan of periodic weeding should be worked out. A bed should be weeded at least once a week. It may also depend on the micro climatic condition of the site. During manual weeding, one has to ensure that seedling roots are not unduly disturbed. The pulled out weeds may be used as mulch. There is however the problem of these mulches decomposing by attracting pathogens which then utilize the soil nitrogen to the detriment of the seedling growth.

Pest Control: Pest control is necessary whenever symptoms of attack by virus, bacteria, fungi and insects are noticed. The pathogens are either carried in the seed, soil borne or air transmitted. Pretreatment of seeds, sterilization of soils and foliar spray are the methods of controlling these. Insect attack should be prevented by maintaining hygiene in the site, by keeping weeds in check and by maintaining the health of seedlings in optimum condition. However, insect attack, when it does take place, needs to be checked by application of bio- insecticide in individual nurseries.

Mulching: The mulching operation is a technique used to reduce water evaporation from soil, to provide aeration in the root zone and to reduce weeds.

Techniques to be adopted and followed for Nursing

(a) Both under watering and over watering are harmful. Every time watering is done; it should be adequate, which means that the soil should reach field capacity. Repeated watering without adequacy is of no help.
(b) The frequency of watering is about twice a day initially, followed up by once a day and finally once in four days. This has to be varied, depending on the climate and the weather of locality and also the species under treatment.
(c) The quantity of water should be calculated at the rate of 200 cc ($1/5^{th}$ of a litre) per nursery plant for each watering.
(d) The water should have low salinity (i.e. less than 250 micro mhos/cm of electrical conductivity) and low sodium class.
(e) Weeding in each bed should be done at least once in 8-10 days depending on the micro climate of the site.
(f) One should try to avoid pest attack by maintaining good hygiene. If the attack takes place, one should use fungicide and insecticide.
(g) Repeated mulching reduces rate of watering and boosts growth. Mulching should be carried out one day after watering.

Fertilization

Fertilization in the transplant beds and or in polypots can increase growth. Some of the soils are known to have deficiency. Fertilization can be done through organic or chemical manure. Organic manure includes dried cow dung, poultry guano and green manure. The in-organic fertilizers include urea (by spraying) ammonium sulphate or ammonium nitrate (dissolved in water) and NPK. However, application of inorganic fertilizer should as far as possible be avoided.

Dosages: The dosages for different fertilizers are given below. This will serve as guide but each nursery should standardize its own dosage.

(a) ***Transplant beds:*** 1 part dried cow dung or compost manure to 4 parts of soil.

(b) ***In container soils,*** prior to bag filling: 1 part farm yard manure or dried cow dung to 2 parts of soil. If farmyard manure is not available, use NPK 15:15:15 at the rate of 2 gms per bag (granules added in pots during filling, when bag is half full of soil) i.e. 2kg for soil filling 1000 bags.

(c) ***Top dressing:*** when seedlings 2 months old, whether in container or in transplant beds, NPK 15:15:15 mixed with water once in 30 days so that each seedling gets 2 gms. If each plant gets 500 c.c. of water, mix 2000 gms of NPK in 500 litres of water for irrigating 1000 plants.

(d) ***Foliar spray*** urea at intervals if seedlings need to be given a quick boost in length may be adopted.

Inoculation of Rhizobium and Mycorrihiza

Rhizobium bacteria in general do not show any host specificity in tropical areas. The same species of bacteria (native strains of rhizobium of the cowpea type) can be inoculated in most of the trees and shrubs of Mimosaceae and Papiolionaceae use in forestry. There is lot of knowledge gap in this field and the general statement made above may not hold well in all cases.

The factors that help success of nodular inoculation are good structured soils with free access of air and a moderate supply of moisture. Excessive watering reduces aeration which may kill rhizobium. Optimum light is necessary for maximum nodulation and nitrogen fixation. The best moisture situation is 75-80% of field capacity. Too much acidity may cause rhizobium mortality. Normal dosing of Aldrin-Aldrex-Dieldrin etc. do not cause any problem. A small addition of nitrogen is good for the growth but larger amount depress nitrogen fixation by nodules. Addition of phosphorous helps in nodulation and nitrogen fixation.

The present practice in the forest nursery for nodule and mycorrhiza inoculation is to collect soil from the root zone of the mature tree of the same species and to mix it with the soil of the nursery beds. This is one of the acceptable methods, but one has to follow it up to see that the inoculation has actually taken place.

A more dependable method of rhizobium introduction is through inoculation of seeds. Rhizobium available in the market is mixed with water and made into slurry. The seed is heaped on a concrete floor and the inoculums is added to it and thoroughly mixed with a shovel. The seeds are then spread in a thin layer in the shade and sown as soon as possible. The seeds may be affected by ants at this stage for which lime or rock phosphate is used as seed-coat.

Planting out

The sizes of seedlings become a very important issue on two counts. It is difficult to transport larger ones at low cost. Also, large seedlings are liable to more damage during transport. On the other hand, larger seedlings have a better chance of survival and growth. A compromise on size requirements is to standardize on 25cm for farm forestry distribution, 35cm for block planting areas subjected to grazing and 45 cm for the roadside and areas where weed is a problem. Another important point that one should bear in mind is that, collar size should be sufficient to keep the plant erect and the fibrous root system should be well developed in seedling.

In order to reduce the mortality of naked root planting, one of the nursery methods adopted is to harden the seedlings before lifting them. Hardening consists of root trimming at intervals, gradual reduction of watering (say, to once in 4 days) for the last two months of the seedlings life in the nursery and shoot and or side branch pruning, keeping one-third of crown intact.

Excluding those for which naked root planting is possible, all other seedlings are transported in containers which are removed before planting. The used bags should be safely disposed. The containers during its stay in the nursery should be shifted every fortnight to keep the roots away from penetrating mother earth.

Grading and Culling

All the seedlings in a bed do not grow at the same rate. At intervals they should be graded mainly on the basis of length and stem lignifications. The less developed ones can be given extra attention through larger dose of fertilizer to bring them up to the desired specification. In spite of that, some seedlings will not come up to the acceptable standard and should be rejected at the nursery stage. Only seedlings of desired parameters are to be planted out.

The total number of seedling at the end of the 1st year should have the following QPM.

Total no. of QPM targeted	-	132.00 lakhs
Add. Mortality in bed	-	10% (90% survival)
Add. for cull loss	-	15% (85% survival)

Therefore, Total no. of seedling at the beginning of the 2nd year should have	-	1,00,98,000 i.e 91,800 seedlings/ ha

However, the growth of seedling depends on elevation, micro-climate, nature of species and productive management of the nursery.

The production of QPM requires the above basic nursery techniques and common management practices which should be regularly followed and practiced by the nursery managers. The management of nursery should not be left with the malis and the labourers alone.

I. The distribution of responsibilities at the field level for raising quality planting material in a nursery.

>> Mali	-	100%
>> Forest Guard	-	100%
>> Block Officer	-	75%
>> Range Officer	-	50%

II. Division Level

>> ACF	-	50%
>> DFO	-	40%

III. Circle and above

>> CF	-	25%
>> CCF	-	15%

IV. Assignment of duties to each officer.

1. Forest Guard: Forest Guard (FG) should take the daily attendance of the labourers and sign in the attendance register. He should engage the labours for day to day engagement. In case of any absentee, FG should report to the B.O, who should mark absent in the register after inspection.

2. Block Officer: Block Officer (BO) should take the attendance of the labourers and sign in the attendance register twice in a week. BO should see that the labours are engaged with specific work, such as, watering, weeding, seed collection etc. and quantify their performance. BO should also check and verify the visit of the FG. BO should make assessment of the performance of each labour of the nursery.

3. Range Officer: Range Officer (RO) will visit the nursery site and inspect the performance of the nursery labours. RO will ensure supply of required inputs and materials. RO should check up the attendance of the labours and field staff. RO shall also make surprise visits.

At the District Level:

4. ACF: Assistant Conservator of Forest (ACF) should visit and inspect the nursery site at least twice a month and make overall performance assessment of the nursery and suggest improvement measures and provide technical inputs.

5. DFO: Divisional Forest Officer (DFO) should atleast visit and inspect the nursery once/twice a month and quantify the quality and quantity of work done by the labours. DFO should issues corrective measures to the RO and BO. DFO should sign in the register and call explanation in case of any deficiency.

At the Circle Level:

6. CF: Conservator of Forest (CF) should make visit and inspect the nursery once a month and get feedback from the field staff and provide inputs, suggestions and other measures for production of quality planting materials.

7. CCF/Ad.PCCF: Chief Conservator of Forest (CCF) / Additional Principal Chief Conservator of Forest (Add. PCCF) should obtain the monthly performance report of each nursery from the CF and make proper technical assessment and attempt innovation for improvement of the nurseries. They should also make surprise inspection of the nursery under speculation and find out the details and take appropriate action. The CCF/Addl.PCCF should plan to visit/inspect the nursery at least once in two months.

The above responsibilities should be adhered by each section and should exercise their duties with utmost sincerity and dedication for production of Quality Planting Material (QPM) as estimated.

Chemical composition and nutritive constituents of some tree fodder

Species	dry matter % of fresh matter	In % of dry matter					References
		crude protein	N-free extract	ether extract	crude fibre	total ash	
Albizzia stipulata	64	27.60	31.30	2.10	21.50	5.50	3
Artocarpus lakoocha	27	15.67	48.23	2.74	23.31	10.05	1
Azadirachta indica	36	15.04	57.03	3.02	13.77	10.61	4
Bamboosa indica	42	22.31	38.64	2.34	23.25	13.28	4
Bamboosa arundinaceae	57	18.64			24.06		2
Bauhinia purpurea	30	29.71	31.66	3.69	25.15	9.79	1
Bauhinia variegate	28	19.03	45.81	1.65	27.12	6.39	1
Brassaiopsis hainla	21	21.55	45.29	3.03	20.44	9.69	1
Buddleja asiatica	31	19.79	44.17	4.39	21.79	9.86	1
Castanopsis indica	35	14.84	47.93	2.58	29.40	5.25	1
Castanopsis tribuloides			43.00	2.50	30.60	3.60	3
Dalbergia sissoo	40	16.65	49.40	3.18	22.23	8.56	4
Eugenia jambolana	37	7.94	61.68	2.60	20.67	7.05	5
Eurya acuminata		7.40	62.50	2.30	11.40	4.40	5
Ficus bengalensis		10.39	49.08	2.48	24.89	13.16	5
Ficus cunia	35	11.89	50.84	2.10	23.96	11.21	1
Ficus glaberrima		9.43				8.29	2
Ficus clavata	32	17.99	40.58	3.33	20.47	17.63	1
Ficus glomerata		13.87	55.52	2.23	16.50	11.88	5
Ficus infectoria	40	10.18	52.25	2.67	22.77	12.14	4
Ficus lacor	37	13.76	40.36	3.64	32.09	10.15	1
Ficus nemoralis	30	13.36	51.14	4.26	19.04	12.20	1
Ficus religiosa	35	13.99	46.02	2.71	22.36	15.06	4
Ficus roxburghii	20	17.30	40.60	4.02	25.01	13.07	1
Garuga pinnata		10.00	52.80	4.95	17.77	14.48	6
Grewia tiliaefolia	35	19.50	46.55	3.34	18.68	11.93	1
Grewia oppositifolia	48	13.24	49.29	7.60	15.33	14.53	5
Gharaghuri		5.20	56.50	6.40	13.50	4.40	3
Ilex doniana		11.20	58.10	1.90	9.90	6.90	3
Litsea polyantha	37	16.69	47.90	4.16	23.69	7.56	1
Machilus gamblei	35	10.90	55.43	2.89	26.92	3.86	1
Mallotus philippinensis		13.37	44.64	3.65	29.65	8.69	5
Mangifera indica	44	8.08	50.57	2.71	28.03	10.02	4
Morus alba		13.99	49.70	6.80	15.71	13.80	5

Species	dry matter % of fresh matter	In % of dry matter					Refer-ences
		crude protein	N-free extract	ether extract	crude fibre	total ash	
Premna bengalensis	23	21.20	41.14	3.74	23.19	10.73	1
Prunus cerasoides		6.40	60.70	3.70	13.00	4.20	3
Quercus fenestrata		10.30	39.60	2.80	31.40	3.90	3
Quercus glauca		8.60	42.70	2.60	29.80	4.30	3
Quercus incana		7.10	44.20	4.60	28.70	2.30	5
Quercus lamellosa		10.00	42.90	3.80	26.20	5.10	5
Quercus semecarpifolia	55	7.30	46.60	3.90	26.90	3.30	3
Saurauia napaulensis		12.25	51.65	4.23	18.40	13.47	5
Sehima vyallichii		9.65				3.36	2
Shorea robusta		10.06	55.41	3.22	27.43	3.88	5
Silangi		9.30	61.40	1.70	11.60	4.00	3
Symplocos paniculata	43	9.90	50.50	1.40	15.40	10.80	3
Wendlandia exserta		8.06				5.30	2
Tamarindus indica	32	15.42	50.57	3.89	21.95	8.12	4
Ziziphus jujuba	41	15.41	57.90	2.69	13.95	10.24	4

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6. Joshi, Kidwai, 1971