TAMILNADU FOREST DEPARTMENT

STANDARD OPERATING PROCEDURES (SOP) FOR CARRYING OUT PLANTATIONS INSIDE AND OUTSIDE RESERVED FOREST AREAS IN TAMIL NADU

O/o - PRINCIPAL CHIEF CONSERVATOR OF FORESTS (HoD),
CHENNAI-15

INDEX

STANDARD OPERATING PROCEDURES (SOP) FOR CARRYING OUT PLANTATIONS INSIDE AND OUTSIDE RESERVED FOREST

CHAPTER – I

INTRODUCTION

Forests are home to an innumerable species of flora and fauna, constituting a significant part of biodiversity of any district/state/nation, in particular and of globe, in general. Forests are also home to millions of forest dependent people, especially the tribals, who are totally dependent on forests for their livelihoods.

Sustainable management of forests has been a challenging task since time immemorial. Growth in human population and meeting its developmental needs such as expansion of agriculture, hydroelectric projects, mining, roads and developmental projects for human needs result in deforestation and degradations of forests.

After the formulation of National Forest Policy, 1988, there was a sea change in forest management which contained the essence of Joint Forest Management. The department has gained lot of experience by way of feedback and evaluation of the planting programs. Many successful planting techniques have been established and followed in the field. Afforestation and Reforestation is one of the core activities of the department and there is an urgent need to codify successful practices, so that it serves as manual for all the field officers who are engaged in the task of afforestation. In addition uniform cost norms and model estimates for various types of afforestation works help in standardizing planting techniques across various schemes.

Need for planting more trees:

Trees are essential to life on earth. They create the very air we breathe and filter air pollution. Trees also build soil and help soak up storm-water before it can create a flood, and they offer energy-saving shade that reduces global warming and creates habitat for thousands of different species. Trees also help to reduce ozone levels in urban areas. Most importantly, trees sequester carbon, helping to remove carbon dioxide and other greenhouse gases from the air, which cools the earth. In fact, a mature canopy tree absorbs enough carbon and releases enough oxygen to sustain two human beings. The carbon storage capacity of forests is approximately three times as large as the pool of

carbon in the atmosphere. If forests are changed, reduced, or eliminated, the captured carbon goes into the atmosphere as *Carbon Dioxide (CO_2)*.

Impact on Climate:

Trees help cool the planet by sucking in and storing harmful greenhouse gases, like carbon dioxide, into their trunks, branches, and leaves, and releasing oxygen back into the atmosphere. In cities, trees can reduce overall temperature by up to eight degrees Celsius. With more than 50% of the world's population living in cities—a number expected to increase - overheating are becoming a real threat. Fortunately, trees can absorb up to 150 kg of carbon dioxide per year, making cities a healthier, safer place to live.

The Standard Operating Procedure of raising Nursery and planting of Tree seedlings and maintenance of the planted seedlings to the planting period for both Forest areas and Outside Forest areas will be of immense help to many agencies and people in executing a healthy planting with higher success rate. This document recommends such of those practices for raising Nursery and planting and maintenance of the planted seedlings for executing the tree planting work in various places.

Plantation is an important part of forestry practice. Plantations in Tamil Nadu started in the later part of the nineteenth century and have continued since then. Large areas have been planted under Teak, Casuarina, Eucalyptus, Gamhar, and Cashew quite successfully. The pace and volume of these plantations have increased considerably in the recent years. Plantations will continue to be one of the main activities of the State Forest Department. It is, therefore, necessary that uniform guidelines are laid down for the officers engaged in such activities.

The Health of the Nation relies with the wealth of the Forest. Hence, the sustainable development goal of the nation targets to achieve 33% green cover all over the states. According to the latest India State of Forest Report (ISFR), India has recorded a one percent jump of 24.40 % (8,021 square km) in overall forest and tree cover between 2015 and 2017 despite population and livestock pressures. In order to achieve the targeted goal, the plantations are encouraged within the reserve land and outside the reserve forest. Thus, it is necessary to have standard operating procedures for planning, organizing and establishing the proper plantations in order to to meet out the present day needs.

Tamil Nadu is the southern-most state of the country and covers an area of 1,30,060 sq km which is 3.96 % of the geographical area of the country. Forest Cover of the State as per 2019 assessment is 26,364.02 sq km which is 20.27 % of the State's geographical area (GA) of the State. Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Oct 2017 to Aug 2018, the Forest Cover in the State is 26,364.02 sq km which is 20.27 % of the State's geographical area. In terms of forest canopy density classes, the State has 3,605.49 sq km under Very Dense Forest (VDF), 11,029.55 sq km under Moderately Dense Forest (MDF) and 11,728.98 sq km under Open Forest (OF). Forest Cover in the State has increased by 83.02 sq km as compared to the previous assessment reported in ISFR 2017. The State has reported extent of recorded forest area (RFA) 22,877 sq km which is 17.59% of its geographical area. The reserved, protected and un-classed forests are 88.70%, 7.79% and 3.51% of the recorded forest area in the State respectively. However, as the digitized boundary of recorded forest area from the State covers 21,653.95 sq km. Area under forest cover within recorded forest area is 17,589 sq.km; forest cover outside recorded forest area is 8,775 sq.km. Tree cover of the State is 4,830 sq.km. The forest and tree cover of the State now is 31,652 sq km which constitutes 23.80% of the total geographical area of the State. So that to achieve the 33% green covers in a span of 10 years, plantation has to be raised in 13,000 sq.kms. Therefore for one year, 1300 sq.km (1,30,000 ha) area are to be planted. For planting 1,30,000 ha per year with average spacing of 3 metres nearly 14 crores seedlings are required per year.

Plantation establishment involves series of operation which ranges from seedling production to (tree) planting and maintenance and the exploitation or harvesting. In general, forestry plantation establishment is broadly divided into three management phases: seed collection and handling; nursery practices and plantation establishment; and management. The initial plantation establishment phase is divided into the following activities: species selection, site preparation and planting operation. The plantation management phase includes silvicultural activities as follows: protection, tending (weeding and fertilizing), pruning, thinning, felling and regeneration / replanting.

This is a compi1ation of only the salient points to be kept in mind while embarking on reforestation or afforestation works and to be used as a general ready guide by the field officer. For finer details, particularly in respect of non-indigenous or exotic

species, or various problems encountered while dealing with a particular species or a particular site, the forester should refer to more comprehensive publications on the subject concerned.

Fifty percent of success of plantations depends on raising of suitable planting stock. Therefore, "Seeds" and "Nurseries" have been dealt with at great length. Proper planning and correct budgeting are also essential for success of plantations. It is also essential that correct records of all operations including dates and cost of all such operations are maintained carefully to judge the results obtained and adopt measures where necessary. Emphasis has been laid on these aspects also and a separate chapter has been devoted to each.

CHAPTER – II

GENERAL

2.1. Forest Scope

The provision of this SOP applies to all plantations to be raised in the Forest Department.

2.2. Definitions

The words and expressions used in this SOP will have the same meaning as in the Forest Department Code and the Working Plan Code.

2.3. Types of Plantations

(i) Inside forest:

Plantations carried out by the Forest Department inside forest areas can be classified into three broad types, viz.-

(a) Reforestation

(b) Afforestation and

(c) Enrichment plantation

2.4. Reforestation

This is plantation over an area which had recently supported forest growth. This is usually done to reclose an area which has recently lost its forest cover, mainly due to biotic reasons.

2.5. Afforestation

This is plantation in areas which have not contained any forest growth at any time (e.g. Coastal sand dunes) or in the recent past. This operation is usually much more difficult than reforestation as it strives to reverse in a few years the ecological degradation which has taken place over ages. Fortunately species and methods have been forced out for certain areas like barren coastal sands but afforestation work in general is difficult and is fought with hazards of failure. Large scale afforestation should not be embarked upon in an area where-

(i) the problems have not been fully understood.

(ii) species which grow comparatively easily in the area have not been established, and

(iii) plantation technique has not been perfected.

2.6. Enrichment Plantations

These are usually carried out to increase the proportion of valuable species in the existing crop. Such species are introduced either in strips cleared or the purpose or in groups in gaps recently created. The latter operation is also carried out while rehabilitating degraded forests.

(ii) Plantations outside Forest

Outside Forest Areas:

The following kinds of plantations are taken up by Tamil Nadu Forest Department outside the Reserved Forest Areas:-

i. Planting along the **National Highways**
ii. Planting **along road side** under Tamil Nadu Road Sector Project (ODR)
iii. Tree Cultivation in **Private Lands**
iv. Agro Forestry
v. **Canal Bank** planting
vi. **Shelter Belt plantations** along the coastal areas of Tamil Nadu
vii. Raising **Mangrove** Plantations
viii. **Palmyrah** Plantations
ix. **Urban** Planting
x. Raising **Red Sanders** plantation in and outside forest areas

i. ***Planting along the National Highways***

The objectives of planting along the National Highways are –

- To reduce the impacts of air pollution and dust as trees and shrubs are known to be natural sink for air pollutants
- To provide much needed shade on glaring hot roads during summer
- To reduce the impact of ever increasing noise pollution caused due to increase in number of vehicles
- To arrest soil erosion at the embankment slopes
- Prevention of glare from the headlight of incoming vehicles
- Moderating the effect of wind and incoming radiation
- Reduce erosion on the road slopes and strengthening the slopes

Nursery:

Taller seedlings will be raised in the Nursery for planting along the National Highways. The seedlings will be of minimum 2m height with good collar thickness.

i) Seedlings are initially raised in smaller size bags of 13 x 25 cm
ii) Nursery site will be prepared as per the standard methods.
iii) Forming germination beds of size 10m x 1m x 0.3 m
iv) Preparation of soil mixture by breaking clods, sieving, mixing red soil, silt sand according to requirement and Farm yard manure in 4:1 ratio.
v) Shifting of container: The seedlings will be shifted to bigger size containers of 30 x 45 cm
vi) Preparation of Soil mixture as detailed in Sl. No. iv above.
vii) Vermicasting @ 35 gm per seedling
viii) Azospirilum @ 6 gm per seedling
ix) Phosphobacteria @ gm per seedling
x) The plants are tied with vertical sticks of size 2.5 mt height
xi) Pruning of side branches once in 2 months
xii) Watering the containers twice daily for 60 days

Planting:

i) Aligning and marking strip plantation including avenue
ii) Digging of $60cm^3$ pits
iii) Supply of Farmyard manure 1/3 of the pit
iv) Supply of sand silt and red soil according to the requirement
v) Vermicompost 1 kg / plant (1000 kg)

vi) Azosphyrillum 12.5 g per plant

vii) Phosphobacteria 12.5 g /plant

viii) Planting of seedlings by refilling the pits of size 60 cm in avenue

ix) Replacement of casualties (10%)

x) Mulching the planted seedlings at 100 gms coconut coir pith per pit

xi) Scrap weeding 1m dia and soil wor4king 15 cm depth around each plant and removing the grass roots away from the site by upturning the soil.

xii) Providing vertical casuarinas poles to the planted seedlings (2.50 mtr height per plant)

xiii) Watering the plants

The species that are recommended for planting along National Highways is given in **Annexure II**.

ii. Planting along road side under Tamil Nadu Road Sector Project

The State Highways Department while executing the work of road expansion, cut down the trees and when such tree cutting is done, and compensatory plantation is being taken up in 1 : 10 ratio. The Tamil Nadu Road Sector project authorities will sign a MoU with the State Forest Department on compensatory afforestation to develop green corridor in roads (NH & ODR) to have avenue plantation.

- The trees to be selected for planting should be site-specific taking into account the type of soil, features of the planting site e.g., for saline and alkaline soils and water logged area will require special attention and the species suitable for these areas will be planted.
- Ever green semi-evergreen species preferred to deciduous species
- In urban /sub-urban stretches of road, flowering trees should be preferred to add to aesthetics of the surround.

Taller seedlings will be raised in the Nursery for planting under Tamil Nadu Road Sector Project (along the State Highways).

i. Seedlings are initially raised in smaller size bags of 13 x 25 cm

ii. Nursery site will be prepared as per the standard methods.

iii. Forming germination beds of size 10m x 1m x 0.3 m

iv. Preparation of soil mixture by breaking clods, sieving, mixing red soil, silt sand according to requirement and Farm yard manure in 4:1 ratio.

v. Shifting of container: The seedlings will be shifted to bigger size containers of 30 x 45 cm

vi. Preparation of Soil mixture as detailed in S.. No.iv above.

vii. Vermicasting @ 35 gm per seedling

viii. Azosphirillam @ 6 gms per seedling

ix. Phospho bacteria @ gm per seedling

x. The plants are tied with vertical sticks of size 2.5 mt height

xi. Pruning of side branches once in 2 months

xii. Watering the containers twice daily for 60 days

xiii. Watering the containers once daily for 30 days

xiv. Watering the containers alternate days for 30 days

Planting:

i) Aligning and marking strip plantation including avenue

ii) Digging of $60cm^3$ pits / $75\ cm^3$ pits during rainy season

iii) Supply of Farmyard manure 1/3 of the pit

iv) Supply of sand silt and red soil according to the requirement

v) Vermicompost 1 kg / plant (1000 kg)

vi) Azosphyrillum 12.5 g per plant

vii) Phosphobacteria 12.5 g /plant

viii) Planting of seedlings by refilling the pits of size 60 cm in avenue

ix) Replacement of casualties (10%)

x) Mulching the planted seedlings at 100 gms coconut coir pith per pit

xi) Scrap weeding 1m dia and soil wor4king 15 cm depth around each plant and removing the grass roots away from the site by upturning the soil.

xii) Providing vertical casuarinas poles to the planted seedlings (2.50 mtr height per plant)

xiii) Watering the plants

Tree species recommended as per guidelines:

1. Azardiracta indica (Neem) – Tamil Name: Veppa Maram
2. Madhuca indica (Mahua) – Tamil Name: Iluppai
3. Tamarindus indica (Imli) – Tamil Name: Puliya Maram
4. Dalbergia sisoo (shisham) – Tamil Name: Sissoo
5. Mangifera indica (Mango) – Tamil Name: Maa
6. Safed siris – Tamil name: Vagai Maram

Tamil Nadu Road Sector Project - Nursery

Tamil Nadu Road Sector Project – Pitting work

Tamil Nadu Road Sector Project – Planting work

iii. Tree Cultivation in Private Lands

The scope for Tree Cultivation on Private Land (TCPL) is determined by availability of fallow land in general and its availability with focus on small and marginal farmers.

Objectives of TCPL

The proposed objectives of the TCPL programme are as follows**:**

a) To contribute to the national goal of bringing 33% of the geographical area under forest and tree cover by increasing the tree cover in the community lands in the villages.

b) To increase the supply of wood and non-wood products from private land for industrial as well as household consumption contributing to reduction of pressure on forest land.

c) To establish tree-based farming system as a sustainable and viable economic enterprise for farmers.

d) To strengthen technical capabilities of the farmer to create farm plantations.

The Tamil Nadu Forest Department has undertaken planting in farmers land under Tamil Nadu Biodiversity Conservation and Greening Project.

IV. Agro Forestry

In order to make agriculture less vulnerable to climatic aberrations, Government of India formulated the National Agroforestry Policy in 2014. The policy recommends for setting up of a Mission or Board to address development of agroforestry sector in an organised manner. The Sub-Mission on Agroforestry (SMAF) under NMSA is an initiative to this end. The aim of the submission is to expand the tree coverage on farmland in complementary with agricultural crops. Agroforestry not only provides environmental services, but also economic gains, as about 65% of the country's timber requirement is met from the trees grown outside forests. The Agroforestry Policy has identified various factors those have impeded the growth of the sector like non availability of quality planting material, prohibitive legal frame work particularly for felling and transit regulations, inadequate extension mechanism, lack of proper institutional support and focused programme for its development etc. The Tamil Nadu Forest Department is the Nodal department for implementing the Sub-Mission on Agro Forestry in Tamil Nadu.

Objectives:

- To encourage and expand tree plantation in complementary and integrated manner with crops and livestock to improve productivity, employment opportunities, income generation and livelihoods of rural households, especially the small farmers.
- To ensure availability of quality planting material like seeds, seedlings, clones, hybrids, improved varieties, etc.
- To popularise various Agroforestry practices/models suitable to different agro ecological regions and land use conditions.
- To create database, information and knowledge support in the area of agroforestry.
- To provide extension and capacity building support to agroforestry sector.

The interventions under the sub- mission are:

- Nursery Development for quality planting material (NDQPM)
- Peripheral and Boundary Plantation (PBP)
- Low Density Plantation on Farm Lands (LDPFL)
- High Density Block Plantation (HDBP)

Under the Sub-Mission on Agroforestry -

1) The Small nursery will have a minimum capacity to produce 25,000 plants per year.
2) The Big nursery will have a minimum capacity to produce 50,000 plants per year.
3) The High-tech Nurseries will have a minimum capacity to produce 100,000 propagules per year

Nursery Development for quality planting material (NDQPM)

Assistance shall be given for nurseries (small, big & hi-tech nurseries) for producing quality planting material to meet the requirement of planting material.

Peripheral and Boundary Plantation (PBP)

To make potential use of the area occupied by these bunds around the periphery of the farmers fields, tree species can be grown as peripheral/boundary plantations to add more income to the farmers' basket. This will not only make effective use of the precious land for livelihood support but also for generating additional income opportunities to the farmers. It will also help in stabilising the bunds and reducing soil erosion.

Low Density Plantation on Farm Lands (LDPFL)

Low Density Block Plantation(HDBP) ranging from more than 100 plants/ha to more than 500 plants/ha without sacrificing the yield of the existing crops/cropping systems, shall be incentivized at the proportionate rates as applicable to per plant expenditure.

High Density Block Plantation (HDBP)

High density Block Plantations on farm lands(HDBP) will be supported as a complementary source of income to the farmers. Differential planting densities ranging from more than 500 plants/ha to 1500 plants/ha as intermediate blocks / strip plantations /wind breaks would be supported. Farmers can take up block plantation in waste and degraded land not suitable for growing crops to make productive use of these land in creating livelihood and income opportunities for them. In addition, the tress will help in enriching the soil and making it fertile & more productive thereby bringing land under crops in times to come.

V. Canal Bank Planting:

Padugai Teak Project is one of the oldest and most successful afforestation schemes of the Tamil Nadu Forest Department. The project has been in operation in Thanjavur delta area since 1956. Under this project, teak plantations are being raised on the banks of rivers and canals in Cauvery delta. The plantations are being raised in PWD lands instead of the traditional Reserved Forest areas. The River and canal banks are under severe threat of encroachment and raising teak plantations is one way of preventing further encroachments. Teak plantations along canal banks also provide different kind of protection and these areas are found to be wider and stronger.

Outcome:

- Protection of Riverbanks and preventing Soil Erosion and strengthening canal bunds
- Employment Generation.
- Meet the domestic demand for quality teak timber.
- Improve bio-diversity of commercially important timber species and enhanced tree cover outside forest areas.
- Continuous improvement of Seed quality
- Generating Environmental Awareness

Planting technique:

The planting technique currently followed in Padugai Teak plantations is briefly described below:

Site selection:

Plantations are raised preferably on the edges and slopes of canal banks, leaving space in the middle for vehicle movement, padugai lands and other lands.

Young Teak Plantations

Raising nursery:

a) Teak stumps of 10 months to 1 year old are prepared for transplanting in 13 x 25 poly bags.
b) 8 to 10 inch long teak stumps, with thumb size thickness at the collar region, are prepared.
c) After transplanting in poly bags, the saplings are ready for field planting after about 3 months.
d) The ideal height of the teak saplings for field planting is 1 foot.

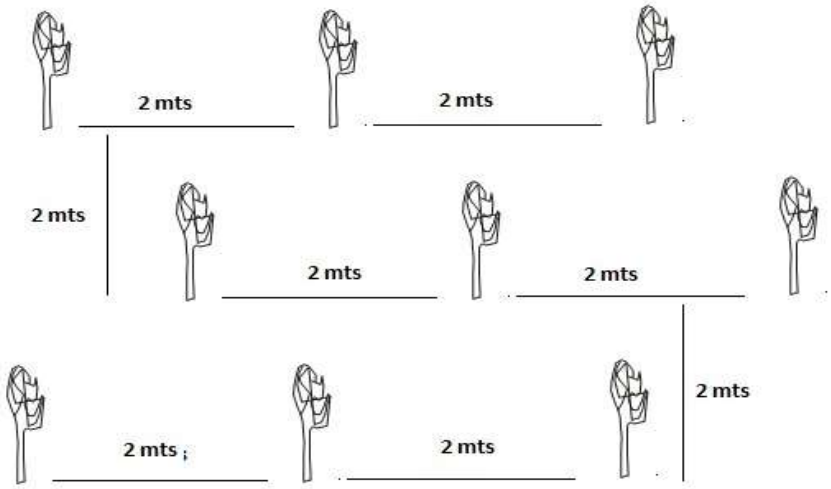
Teak Nursery

Planting:

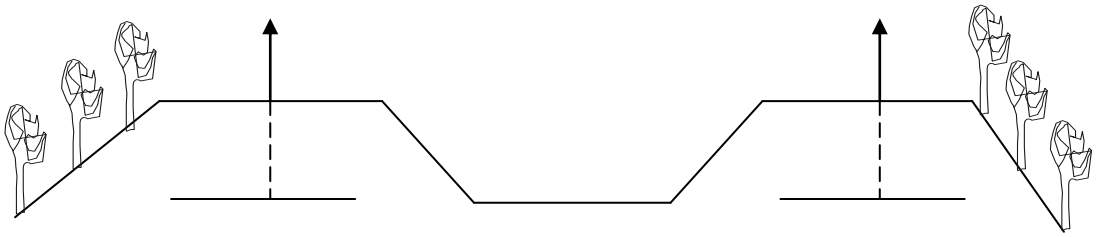
- ✓ Area selected for planting is first cleared of unwanted growth.
- ✓ 45 cm^3 pits are dug at a spacing of 2m x 2m.
- ✓ Farm yard manure or poultry manure to be applied in the pit before planting.
- ✓ The best time for planting is just before the onset of north east monsoons.

- ✓ The espacement is taken as 2m x 2m as prescribed in Working Plan.
- ✓ Stock density will be 200 plants per ha as per the Model Estimates.
- ✓ As teak plantations are proposed to be raised in Canal Banks and padugai lands where linear planting will be taken up and hence the stock density cannot be calculated as in the case of Block plantations.

ELEVATION



CROSS SECTION



Canal

Post-planting care:

- After care includes watering, casualty replacement, weeding and soil working, DAP application, fencing and protection by plantation watchers.
- Teak responds well to fertilizer application

Silvicultural operations:

- Field conditions do warrant minimum silvicultural operations for better growth and for optimum girth increment in the subsequent years.
- To ensure that Teak trees belong to CI class as much as possible the following silvicultural operations are suggested in addition to the existing practices, i.e., without defects in the timber such as bent boles, holes, knots, lower girth, disease, etc.
- NPK fertilizer application, twice a year during soil working in Raising, 1st and 2nd maintenance years.
- Weed removal to be carried out during soil working operations.
- Planting to be carried, out of stumps prepared and raised from seeds with known provenance.
- Being a strong light demander, Teak plants grow straight up and boles are mostly well established. Higher spacing shall permit better incremental growth in the standing plants. Thinning is therefore essential.
- On completion of 4 years following planting, silvicultural thinning of the plants be carried out in the 5th year. Roughly 50% of the trees needs to be removed to ensure that spacing between the trees is increased to 4m x 4m. The final ground spacing between the promising trees may vary from the prescribed 4m x 4m spacing in some cases.
- Besides thinning, removal of side branches to half the height of the plants needs to be carried out so that the trees puts on maximum bio-mass on the main trunk. Cutting of the side branches close to the main stem may result in some fungal infection of the main stem. However, this can be avoided by leaving a stump of about 4 inches from the main stem.
- Subsequent silvicultural thinning needs to be carried out during 10th year and 20th year.
- 10th year silvicultural thinning should aim at removal of another 50% of the less promising trees to increase spacing to 8mx8m so that sufficient space is created for crown development and spread of the side branches.
- After 10th year thinning, most of the less promising trees shall be removed. During 20th year, only selective removal of defective trees, if any, should be carried out.

Linear Teak Plantation

Leaves & flower of teak

Seed pods of teak

A detailed Model Estimate is given Annexure

VI. Shelter Belt Plantations along the coastal areas of Tamil Nadu:

Objectives

- Coastal Shelterbelt plantation will be raised to avoid soil erosion
- to reduce velocity of cyclonic wind.
- Help in augmenting the ground water and the rain water re-charge capacity will be improved in the abutting agricultural fields.

Species

Tree species like –

Casuarina equisetifolia,
Dendrocalamus strictus,
Derris indica,
Azadiratcha indica,
Zizyphus zuzuba,
Techoma undulata, etc.

Nursery for raising Casuarina

- Seedlings will be raised in 10 x 20 x 200g bags
- Preparation of Soil mixture
- Vermicasting @ 15 gm /container
- VAM @ 8 gm / container
- Bio-fertilizer such as Azosphirillum and Phosphbacteria

Planting

- Aligning and marking.
- Espacement 2 x 1.5m.
- Digging of 30 m^3 pits.
- Scrapping of 1 m dia and soil working 15 cm depth around each plant and removing grass roots away from the site of upturning the soil

VII. Raising Mangrove plantations:

The word "Mangrove" is considered to be a combination of the Portugese word "Mangue" and the English word "grove". Mangroves are salt-tolerant plants of tropical and subtropical intertidal regions of the world. These are highly productive but extremely sensitive and fragile.

Mangroves are dominant feature of tropical coastline, located between land and sea particularly in places where fresh water mixes with seawater. However, mangroves cannot be seen in all parts of the coastal area because mangrove eco system require protection against high energy waves for the seedlings to settle and grow. Large quantity

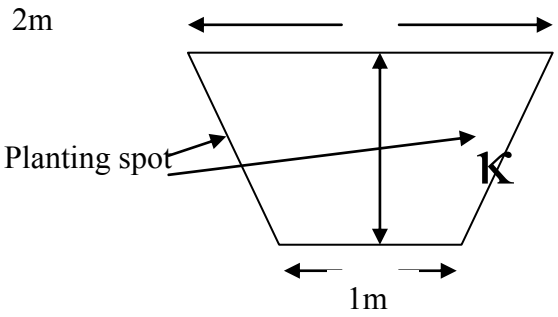
of fresh water flow for longer duration since mangrove trees grow well only in low saline condition and larger tidal amplitude and gently sloping coastal topography.

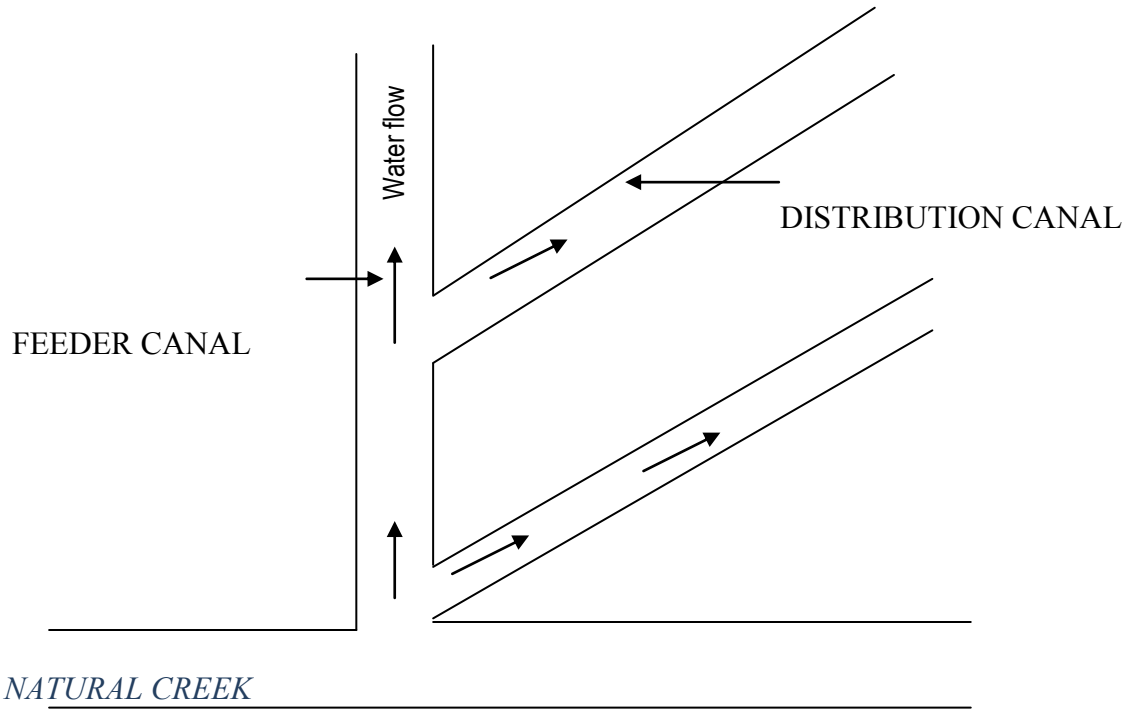
Tamil Nadu has a coastline over a length of 1076 kms. of which more than 90% lies in the East coast and about 64 kms on the West coast (Kanniyakumari district). The coastal corridor covers 13 districts that share the coastline viz., Chennai, Tiruvallur, Kancheepuram, Villupuram, Cuddalore, Tiruvarur, Nagapattinam, Thanjavur, Pudukottai, Ramnad, Thoothukudi, Tirunelveli and Kanyakumari. Along the coastline major mangrove wetlands are present at Pichavaram in Cuddalore district and Muthupet region in Thiruvarur-Thanjavur districts. Small patches of mangroves are also present along the Palk By near places like Vedaranyam, Kodiakarai (Point Calimere) and also in some of the islands of the Gulf of Mannar in Ramnad District.

Method of treatment

Mangrove planting involves two basic steps, viz, formation of Feeder and Distribution canals followed by planting on the canal banks. The canals have to be formed preferably before the rains to facilitate leaching of excess salinity through flooding. This is necessary for creating conducive conditions for establishment of the young mangrove propagules. Planting of propagules / seedlings will be carried out depending on water level in the canals. Creation of canal is necessary in Tamil Nadu as the tidal fluctuations do not exceed 2 feet and no mudflats are exposed for direct dibbling.

The ground layout of Feeder and Distribution canals in *one hectare plot* is given below:





Each hectare of fresh regeneration area shall have 100m of Feeder canal of the following dimensions:

Top width = 2 m; Bottom width =1 m; Depth =1 m.

There shall be 4 Distribution canals of length 100m each, laid out in fishbone pattern as shown in the diagram shown below. The dimensions of the distribution canals are as follows:

Top width = 2 m; Bottom width = 1 m; Depth = 1 m.

The Feeder canals are of wider dimension as they have to draw maximum tidal water for optimum flushing in the regeneration areas. Fishbone pattern of canal layout is

proposed to permit easy inflow of tidal water into the regeneration area and minimize canal bank erosion.

Planting will be carried out on the slopes of the canals in the intertidal region with 0.50m spacing. 2000 seedlings shall be planted on 500 running meters of canal banks.

VIII. Raising Palmyrah plantations

Tamil Nadu is pioneer in development of Palm products industry in India. Palmyrah is declared as the "State Tree" of Tamil Nadu. In general, it is the only crop that can survive successfully under tropical conditions. It can survive in drought prone areas. Unique about palmyrah trees is that they are the tallest among all trees. Palmyrah trees were vital source of livelihood for the rural populace. They were important source of raw material for numerous subsidiary micro enterprise.

Planting:

- Procurement of good quality seeds.
- Dibbling of palmyrah nuts in 0.5 mt deep pits
- Watering to be provided for 60 days daily and 120 days alternately.

Planting of Palmyrah

XI. Urban Planting

Introduction:-

Urban Planting scheme is to improve the tree cover in major cities and to await pollution and enhance the micro climate.

The Urban Greening is necessary to increase the Forest cover / Tree cover from 17.59% of the Geographical area to move towards the goal of 33% forest and tree cover. In the present context it is not easy to increase the area under Reserved Forest but we can increase the tree cover in the private lands / community lands and lands owned by Government Departments other than Reserved Forests.

Scope for the work:-

Under the scheme the species selected will be of native species applicable to that area. The well grown seedlings of good collar thickness will be planted in the 60 c.m. cube pits. The site specific seedlings will be selected for planting and to marginalize the survival percentage. The species for planting will be selected such of those will hold good for the dry summer. This urban planting program will be a comprehency environmental management which also conserve the bio-diversity of the region. It will abate the pollution level enhance and improve the micro climate in and around thickly populated cities.

Objectives:-

The objectives of this Urban Greening will be as follows.

- This will increase the tree cover in the public places which are vacant at present.
- Improved moisture region and enhanced bio-diversity of the area.
- Quantum of rain water harvest will increase and recharged into the ground.
- Improved ground vegetation will result soil retention and erosion.
- Enhanced and improved carbon sequestration.
- Absorption of pollutants.
- Improved nutrient cycling.
- Micro climatic regulation.

Works to be carried out for Urban Greening will be as follows:-

i. Nursery:-

In order to ensure the development of Urban Greening, taller seedlings nursery will be raised by selecting miscellaneous species / native species will be raised in poly bags of size 13x25 cm and shifted to 30x45 cm poly bags. The containers will be filled up with farmyard manure, river sand and silt at 1:1:1 ratio in order to raise good quality taller seedlings.

ii. Planting Operations:-

- 60 c.m. cubic pits will be dug up for planting the taller seedlings in community lands and 75 c.m. cubic pits will be dug up for planting the taller seedlings in roads.
- Taller seedlings (of minimum 2mtr. height) will be planted in the pits during the rainy season and refilled with the dug up earth.
- Weeding and soil working will be carried out around the planted seedlings once in a month during November – December.
- Individual fence around each plant with Bamboo Tree Guards will be provided for the seedlings planted.
- Watering the plants during the non-rainy period from January – March at 20 litres per seedlings @ once in 6 days will be done.
- Replacement of casualities at 20% of the planted plants or the actual casualities whichever is less will be done.

- Provision has been made for 20% casualty replacement for 1st year maintenance.
- Protection mazdoor at 1 mazdoor for 500 plants will be engaged to protect the plant.

X. Raising Red-sanders plantation in and out outside Forest areas:-

1. General Information:-

Pterocarpus santalinus, with the common names red sanders, red sandalwood, and sanderswood, is a species of Pterocarpus endemic to the southern Eastern Ghats mountain range of South India. This tree is valued for the rich red color of its wood.

2. Extent and Geographical Distribution:-

Pterocarpus santalinus occurs in the forest formation which is classified as "5A/C3 Southern Tropical Dry Deciduous Forests" as per Champion and Seth Classification and falls in the eco-terrestrial region IM1301 Deccan Thorn Scrub Forests and as well as IM0201 Central Deccan Plateau Dry Deciduous Forests. It is generally found at altitudes of 150-900m. It grows on dry, hilly, often rocky ground, and occasionally found on precipitous hill sides also. It prefers lateritic and gravelly soil and cannot tolerate water logging. In natural habitat the tree experiences hot, dry climate with normal rainfall of 88-105 c.m. received from north-east and south-west monsoons.

The principal tree association is Pterocarpus marsupium, Chloroxylons wietenia, Terminalia chebula, T.tomentosa, Albizzia lebbeck, Hardwickia binata, Anogeissus latifolia and Delbergia latifolia. Red Sanders many times occurs gregariously as pure patches also.

Red sanders has a highly restrictive distribution in the South Eastern portion of Indian peninsula to which it is endemic. The Palakonda and Seshachalam hill ranges of Cuddapah Chittoor districts of the State of Andhra Pradesh are its principal geographical range which extends slightly into neighbouring Anantapur, Kunool, Prakasam and Nellore Districts of Andhra Pradesh. Sporadic wild populations occur in the adjoining districts of the neighbouring states of Tamil Nadu & Karnataka.

The Red Sanders bearing formations are estimaed to extend over approximately 5160 km^2 in its principal geographical range. About 23% of the Red Sanders formation is dense, 34% has moderate cover and the remaining is open.

3. Uses of Red Sanders:-

- The wood has historically been valued. Due to its slow growth and rarity, furniture made from Red sanders is difficult to find and expensive. It has been one of the most prized woods for milllennia.
- Red Sanders is said to be used in the making of oriental musical instruments like Shamisen, Koto and Erthu.
- Heartwood of Pterocarpus santalinus is used in traditional herbal medicine as an antipyretic, anti-inflammatory, anthelmintic, tonic, hemorrhage, dysentery, aphrodisiac, anti-hyperglycemic and diaphoretic.
- It has disinfectant as well as anti-microbial qualities that effectively heals and restores the health of the skin.
- It works as an anti-inflammatory agent which boosts the circulation of blood in skin.
- Red sanders can effectively heal ulcers.
- Red sanders oil has astringent qualities that are useful for strengthening of the gums and it prevents natural teeth loss.
- Oil extracted from sandalwood may be used in aromatherapy to deal with hypertension and also to decrease stress.
- It is best used for skin problem like acne, sun tan etc.
- Red sanders have many uses for the hair, feet, skin and a variety of ailments. It helps promote a clean and clear skin tone, and maintain a good complexion.
- In manufacturing, red sanders is used as a flavoring in alcoholic beverages.

4. Objectives:-

- To increase the forest area under Red sanders plantations.
- To increase the avenues of revenue for the farmers by plantation of Red sanders on farmers land
- To increase the forest cover and biodiversity outside forest area.
- To increase the medicinal use of Red sanders.
- To facilitate research in Red sanders species.

5. Project Implementation:-

The project is implemented over a period of 7 years in which plantation activity is over a period of 5 years and maintenance of the raised plantation over a period of 2 years. This Red sanders plantations activity will be carried out in the forest area and private lands, preferably 50% plantation will be done on the farmers land. In case of non-availability of private lands after consultation with the farmers the plantations will be raised in forest areas. This will be decided according to the availability of private lands.

6. Program of the Plantation:-

i. Nursery:-

Seedlings will be raised in the 16x30 c.m. polythene bags.

ii. Plantation:-

Well grown seedlings will be planted in the 45 c.u. c.m. pits. Number of seedlings per ha will be 200 since it will be the gap plantation.

iii. Maintenance:-

Maintenance of the plantation is proposed for the two years. 10% casualty replacement is proposed during the maintenance along with the soil working.

7. Expected Outcomes:-

The implantation of this project is expected to give following outcomes.

- Increasing the forest area under Red sanders plantations
- Increasing the interest of the farmers in Red sanders species as additional avenue of revenue.
- Increasing the use of Red sanders species for medicinal and timber purpose.
- Increasing tree cover outside forest area.
- Increasing biodiversity in and outside forest area.

When plantations are raised in outside (RF) areas, the procedure laid down by Government in that regard from time to time shall be followed. As regards special plantation schemes like the "Compensatory Afforestation Scheme" the procedure shall be as laid down in the scheme approved for the purpose by the Government. If no such special procedure has been laid down, the general procedure shall be followed.

2.7. Agencies for carrying out plantation

Plantations shall be carried out either by the D. F. Os. of the territorial divisions or by DFOs, of the Social Forestry Divisions, both inside and outside reserve forests.

2.8. Plantation Schemes

Plantations in areas covered by working plans or schemes shall be carried out strictly in accordance with prescriptions in such plans or schemes. In certain areas it may be expedient to take up plantations where plantations have not been prescribed in the working plans or schemes. All such cases shall be examined closely. If after such examination it is decided to take up plantation in such areas, sanction to deviation from the working plan prescriptions shall be obtained from the appropriate authority. Plantations shall be taken up only after all the above formalities have been completed. It shall be the responsibility of the Divisional Forest Officer who carries out plantations on these sites to see that these formalities are properly observed. These formalities shall be completed preferably by the end of September but not later than December of the year previous to the one in which the plantation will start.

2.9. Plantation in Areas not covered by Working Plans

Where it is necessary to carry out plantations in areas not covered by working plans or schemes the following procedure shall be followed before plantations are started :-

(i) The area shall ordinarily be a large contiguous one so as to support a viable planting series, except in case of areas taken up for mixed plantations under special forestry schemes or coastal belt plantation

(ii) If the area shall be demarcated and surveyed. A trace map shall be prepared for the area.

(iii) If the area is not under control of the Forest Department it shall be alienated in favour of the department provided that in cases where plantations are carried out in areas belonging to other organization or individuals under special schemes with the approval of the Government, alienation will not be necessary.

(v) The above formalities shall be completed within the time limit.

CHAPTER – III

CHOICE OF SPECIES

3.1. General Consideration

The species for plantation should be chosen very carefully. It will depend mainly on

(i) the object of plantation,

(ii) soil and 'moisture condition,

(iii) climatic influences, and

(iv) biotic factors.

3.2. Object of Plantation

The objects of present day plantations are precise, the most important being production of wood for specific industrial uses, e. g., joinery, ship building, pulp and paper, etc. These are productive or **"Commercial Plantations".** The other broad class of plantation is **"Protective Plantations".** The objects of the latter are mainly-

(i) to maintain a vegetational cover and thus to conserve soil and moisture so that reservoirs are not silted up quickly and the life of cosuy river valley projects are prolonged.

(ii) to protect valuable agricultural fields against sand blown from Coastal sand dunes, and

(iii) to maintain ecological balance of the tract as in the Case of Compensatory plantations. Some plantations like those of Casuarina on coastal sand can be both protective and productive.

The five year plantation schemes can be divided under these broad classes as follows:-

(a) Productive schemes-

(i) Economic plantations

(ii) Plantation of Quick Growing Species

(iii) Plantation of Minor Forest Produce

(b) Protective schemes-

(i) Plantation in the Coastal belt

(ii) Plantation for soil conservation in the coastal sand dunes

(iii) Plantation for soil conservation in the river valley projects

The social forestry schemes can be classed broadly as productive schemes though the usual economic viability tests cannot be applied to these plantations.

3.3. Locality factors

Having decided the purpose for which a plantation is to be raised the locality factors, e.g., soil, moisture, climate, biotic influences shall be looked into. Productive plantations shall be confined to the best of soils available for plantation. Large scale tree planting shall not be attempted on refractory soils. e. g., shallow laterite soil with hard pan underneath, stone outcrops, boulder and gravelly hillsides with little soil, black cotton soils, heavy clay with lime nodules, etc., unless, as stated earlier, species and planting techniques for the area, have been established and are easy to adopt both technically and financially. Existing growth usually indicates the fertility status of the soil including that of soil moisture and the species that may be suitable for the site.

Climate is a very important factor which shall be taken care-off. A species which is suitable for coastal climate will not ordinarily be suitable for the dry districts. Again, the natural vegetation provides indication as to species suitable to the local climate of the plantation area. On dry hilly areas aspect is an important factor and shall be kept in mind when deciding on the species to be planted. Similarly, due notice of altitude shall be taken note of and if plantations are undertaken at more than 500 m to 600 m only species suitable for such altitudes shall be chosen. Frost hardy species shall be chosen for areas visited by frost. Ordinarily such areas shall be avoided.

Grazing and browsing are important factors. A species which can be subjected to browsing shall not be planted unless browsing can be eliminated and measures to ensure that are contemplated. Similarly, it shall be ensured that the plantations raised are not damaged by human agency or plants stolen when they grow to a size suitable for any use.

3.4. Choosing species for Plantation

All the above factors shall be taken into consideration while choosing a species for plantation in a particular area. The choice should be confined to species, successful large scale plantations of which have already been raised in the State. No new species shall be planted on a large scale unless it has been successfully raised on experimental scales and its plantation technique standardized.

3.5. Choice of Species

The species for plantation should be chosen very carefully. It will depend mainly on -

- the object of plantation
- soil and moisture condition
- climatic influences and
- biotic factors

Having decided the purpose for which a plantation to be raised the locality factors, e.g., soil, moisture, climate, biotic influences shall be looked into consideration. Productive plantation shall be confined to the best of soils available for plantation. Large scale tree planting shall not be attempted on refractory soils, e.g., shallow laterite soil with hard pan underneath, stone outcrops, boulder and gravelly hillsides with little soil, black-cotton soils, heavy clay with lime nodules, etc.,

Climate is a very important factor. A species which is suitable for coastal climate will not ordinarily suitable for the dry western districts. On dry hill areas aspect is an important factor and shall be kept in mind when deciding on the species to be planted. Similarly, due notice of altitude shall be taken and if plantation are undertaken at more than 500 m to 600 m only species suitable for such altitudes to be chosen.

Grazing and browsing are important factors. A species which can be subjected to browsing shall not be planted unless browsing can be eliminated and measures to ensure that are contemplated. Similarly, it shall be ensured that the plantation raised is not damaged by human agency or plants stolen when they grow to a suitable size for any use.

A species selected for planting should possess the following silvicultural characteristics.

1. Ability to survive and remain healthy under the given conditions of site and cultural treatment. Adaptability to local climate including annual variation in climate, and to a range of local soil variation.

2. Resistance to local hazards, including pests, diseases, fire, browsing and trampling.

3. Ease of seed procurement, handling and storage.

4. Ease of handling in the nursery and establishment stages.

5. Ease of regeneration for later rotations, e.g., the advantages of coppicing or prolific seeding species.

6. Absence of undesirable biological side-effects such as the harbouring of agricultural pests or competition with agricultural crops by surface-rooting species.

7. For production planting, biological productivity under the given conditions of site and cultural treatment. In the case of wood production, yield data are commonly expressed in terms of volume.

8. For rural communities, productivity in the early years is more important than later productivity, since it allows short rotations and early returns on the initial investment in planting. 'Quick starters' are preferable for this and most of these are ecological pioneer species, rather than members of climax communities.

9. For protective planting, special characteristics may be required: e.g., crown shape for shelterbelts; rooting system for soil stabilization.

In deciding on the species best suited for planting in rural communities, as much use as possible should be made of local experience and research within the country. It is possible to make use of research carried out by the national forest service, universities, etc.

In the case of exotics, which play an increasingly important role in plantations, useful guidance may be obtained by matching local climate and soil with those of other areas where a given species has performed well as an exotic. Comparison with site conditions within the natural range of the species is also useful, but gives less indication of its adaptability to new environments than does its performance as an exotic.

There is much evidence that, for certain species, the provenance or geographic location from which seed was collected may be as important a factor in adaptability and rate of growth as the taxonomic species itself. Where such knowledge is available, it may be as important to select the right provenance as the right species.

3.6. Species Selection

Plantation inside the Reserve Forest: In natural forest, natural regeneration is assisted by planting seedlings as gap filling based on the canopy density. Tamil Nadu state has been divided into seven agro-climatic zones.

Sl. No	Ecological zones of Tamil Nadu	Districts covered	PREFERRED SPECIES
1	North Eastern zone	Chennai, Kanchipuram, Thiruvalur, Cuddallore, Vellore, Thiruvanamalai, Villupuram	*Casuarina equisetifolia, Thespesia populnea, Pongamia pinnata, Lannea coromondalica, Anacardium occidentale*
2	North western zone	Dharmapuri, Krishnagiri, Salem and Namakkal	*Delonix elata, Pongamia pinnata, Ailanthus excelsa, Albizia amara and Tamarindus indica*
3	Western zone	Erode, Coimbatore, Karur, Dindigul and Theni	*Hardwickia binata, Holoptelia integrifolia, Ailanthus excelsa, Acacia leucophloea, Acacia ferruginea, Santalum album*
4	Cauvery Delta zone	Tiruchirapalli, Perambalur, Pudukottai, Thanjavur, Nagapattinam and Thiruvarur	*Thespesia populnea, Bamboo, Acacia nilotica, Prosopis juliflora, Ailanthus excelsa, Casuarina equisetifolia, Eucalyptus tereticornis*
5	Southern zone	Ramanathapuram, Tirunelveli, Madurai, Pudukottai, Sivagangai, Virudhunagar and Thoothukudi	*Acacia planifrons, Ceiba pentandra, Bassia latifolia, Prosopis juliflora, Tamarindus indica, Eucalyptus tereticornis, Azadirachta indica*
6	High rainfall zone	Kanyakumari	*Rubber, tamarind, Calophyllum inophyllum and Albizia falcataria*
7	Hilly zone	Nilgiris, Shevroys, Elagiri javadhu, Kolli, Anamalai, Palni and Podhigai Hill ranges	*Grevillea robusta, Eucalyptus globulus, Terminalia*

3.7. Need for further species trials

The planting 'technique of mostly exotics either new or long naturalized in the State are only known and have been standardized. There are many useful indigenous species which could yield almost as much as the exotics and non-indigenous species and at the same time be much more useful to the local people. The methods of artificial regeneration of these species have not yet been perfected. Experimental plantations can be raised by the research wing of the State.

CHAPTER – IV
ORGANISATION OF PLANTING WORK

4.1. Planting Plan

The area which has been earmarked for plantation as per the Working Plan Or the Special Plantation schemes shall be inspected in detail, preferably after the area has been cleared and burnt. Ordinarily a major part of this area will be suitable for the main species for which the area has been selected but there may be obvious variations like eroded patches. Portions liable to seasonal water-logging, comparatively infertile patches inside a generally fertile site require special treatment. Such 'Variation shall be shown in the map and a planting plan prepared indicating the treatment to be given to the abnormal patches.

A treatment map' shall invariably be prepared where protective plantations particularly for soil conservation in the River Valley Projects are taken up as these are mostly degraded areas with great variation in typography. Soil and fertility requiring varied treatments. Where necessary trial pits shall be dug and soil profile examined. Species to be planted and treatments to be applied to the different patches should be carefully planned and shown in the treatment map and planting plan. This plan shall be followed when actual planting is carried out with slight modifications where necessary.

The planting plan shall be prepared by the Range officer in charge of the plantation. The DFO shall check at least 10% of the Planting Plans in the field and approve all the planting plans of his division before actual planting is taken up. There shall be no deviation from this provision particularly in case of the protective plantations.

4.2. Organization of Staff and Labour

All operations in connection with plantations shall be carried out on time. The staff engaged in such work’ shall be given definite assignments by the Range Officer concerned under the guidance of the DFO. DFO shall be responsible to see that these assignments are made well in advance and are duly completed.

Forest plantation operations generally clash with agricultural operations. Therefore great care is necessary to organize adequate labour supply. The labour required for various operations shall be carefully estimated and arrangements for procuring the labour shall be made well in advance. This will be we responsibility of the Range Officer.

4.3. Plantation Time Table

As has been stated earlier all operations in connection with plantations are time bound. If any one of the operations concerned is delayed the success of the whole plantation is jeopardized, A late start is almost certain to have serious consequences. It is, therefore, necessary to work out a detailed tlme-table for all items of work in connection with plantation and to adhere to it strictly.

In certain cases it may be necessary to start preparations two or three years before the actual planting takes place. In case of pine plantations the seedlings should be at least one year and a half old before being transplanted into the field. Nursery work, therefore, should start at the latest in October of the 2nd calendar year preceding the actual year of plantation. Similarly work on Teak nursery should start latest in March of the year preceding the one in which the plantations to be carried out. In cases where potted plants are used that nursery work can start in October preceding the plantations.

Ordinarily the time schedules shall be strictly followed. Local variation depending mainly on the micro-climate of the area may be necessary. The DFO in such cases as also in cases which have not been mentioned in the model time-table shall draw up a detailed time-table and get it approved by the Circle level Officers. This time-table shall be adhered to strictly.

CHAPTER V
SEED PROCUREMENT AND TREATMENT

5.1. Seed required to be correctly estimated

The total quantity of seeds required for raising seedlings for plantation shall be very carefully estimated. i.e. during November and December of the said year preceding the year of plantation. A liberal margin against replacement of casualties immature and infertile seeds, damage during storage etc. shall be given. The following formula can be used:-

$$Q = 125 = X \frac{n\,A}{P\,W} + C, \text{ Where}$$

Q = Quantity of Seeds require in Kg.

n = Number seedlings for stumps planted per Hectare.

A = Total area to be planted in hectare

P = Plant percent

W = Number of seeds per Kg.

C = Extra quantity to be procured as a safeguard against wastage

The seed weight shall be checked by sample weighments of seeds already collected and if necessary larger quantity of seeds than estimated with standard seed weight shall be procured. The extra quantity required as a safeguard against wastage will vary with species and is left to the judgement of the Divisional Forest Officer who shall himself estimate the seed requirements of his division.

5.2. Seed Sources

Forest tree seeds shall be collected from trees with genetically superior traits. Collection of such seeds shall never be made from low quality. As far as possible individual mother trees of desirable shape, size and age or group or stand of such trees shall be marked for seed collection and seed collection shall be confined to these Sources.

5.3. Mature seed to be collected

Only ripe and large, plump, healthy seed shall be collected. Usually fall of seeds indicates ripeness. But seeds that fall first and last shall be avoided, seed which ripen in the middle period shall be collected. Collection shall not be delayed unnecessarily especially with light seeds and those produced from capsules.

5.4. Agency of Collection

A far as possible seed collection shall be done under the supervision of a trained Forester or an experienced Forest Guard. Collection through contract labour may be resorted only if it is absolutely impossible to engage the staff as indicated above in the work.

5.5. Seed Extraction

Most seeds are collected from the ground or trees, are more or less ready to use for sowing or for storing. Dry fruits, c.g., cones, capsules, pods or beads require appropriate treatment to extract the seed. The commonest and simplest procedure is to dry the fruits in the sun on a cement platform until those open up and then rake, roll, or beat the fruits as seems best to separate the seed from the fruit. The infertile debris are then raked, picked, winnowed, sieved off.

The pulp of tile pulpy fruits shall be removed. If this is not done the germination percent will drop. After the pulp is removed the seed shall be dried under shade. The fruits obtained from deciduous forests, however, may be dried in the open under the sun. The dried seeds shall be cleaned of all foreign material such as fragments of fruit and cones, husks, empty or unsound seed, particularly when the seed is swept off the ground. Water separation followed by re-drying is a simple and useful method. When immersed in water the vegetable debris and immature seeds float on the water whereas sound seed along with mineral impurities sink to the bottom. As soon as a local seed is collected at-least the germination per cent shall be cheeked so that correction in the estimates of seed can be made while seed collection is still going on.

5.6. Seed from outside State

If sufficient seed is not available from reliable sources in the State, good quality seeds may be obtained from sources outside the State. But in all such cases careful equity

should be made regarding the origin of the seeds. Seeds of notoriously bad origin shall not be obtained. In all cases of procurement of seed from outside sources, the seed certificate prescribed by the FRI, Dehradun shall be insisted upon. This certificate shall also be furnished for all seeds collected inside the State, particularly if the seeds are collected by an agency other than the one which uses them.

5.7. Seed Storage

Some seeds germinate before they fall (e. g. mangroves), and others only after long storage i.e: after the period of dormancy e. g. Teak, mahogany and most leguminous. Again every year is not a good seed year. Therefore, it is essential that large quantities of seeds are collected and stored properly so that these seeds can be used in following years. Adequate arrangements for storage are, therefore advantageous. Each Range engaged in plantation work shall have at least one seed store, which may be a long cool, well ventilated room with shelves in tiers where seeds can be stored in earthen pot (Casuariua), tins (Eucalyptus and other minute seeds) or sacks (Teak and other medium or large seeds). The floor shall be cemented and damp proof. The whole area shall be kept scrupulously clean. Rats and squirrels shall be kept out by providing wire nettings at all openings. Containers of minute seeds shall be sealed properly. All seeds shall be dried and cleaned thoroughly before being stored. The seeds may be treated with insecticides or fungicides as necessary.

The Success of a sowing of the seed either in the field or in the nursery depends on prompt and even germination whereas most seeds may not show any problem in this regard. Woody fruits like those of Teak and seeds of most leguminous species which have hard test will require pretreatment before sowing.

5.8. Precautions required during seed collection and storage

- Seeds must be stored in a dry cool place. Store large and soft seeds in open baskets
- Do not place the freshly collected seeds in the sun. They may get killed due to excessive heat
- Never store seeds on the ground. Store seed bags on shelves in a rat proof shed
- Do not leave seeds in the rain, or in wet areas. Seed will root and die.

5.9. Seed Treatment

The germination problems experienced by problem seeds can be overcome by the following seed treatment methods:

5.10. Type of Seed Treatments

1 .Hard seed coat

(a) Soaking in hot water

(b) Acid scarification using commercial grade conc. H_2SO_4

2. Fibrous or hard shell

(a) Alternate soaking and shade drying

3. Seeds with fatty oils

(a) Sowing immediately after collection and extraction of seed from fruit.

4. Chemical hindrance

(a) Collect from the tree before fully nature and soaking in cold water for a day or two and then take up sowing.

5. Immature embryo

(a) Cold or hot stratification.

5.11. Hot Water Soaking Method

Take three times of water when compared with the volume of seeds in a container and boil it. Remove the container from the oven and put the seeds into boiling water. Keep the seeds as such overnight and use them for sowing the next day morning. Care should be taken to see that the seeds are not dropped into the container when the water is boiling and do not exert pressure on the seed coat while sowing for it will lead to the expulsion of the cotyledons.

5.12. Acid Scarification

For acid scarification, commercial grade concentrated H_2SO_4 is used. Depending upon the seeds, the quantity of acid and duration of scarification will vary. Example**,**

Species Concentration Duration

1) *Prosopis* 150 ml / Kg 3 minutes
2) *Acacia*s 200 ml / Kg 20-25 min
3) *Cassia*s 200 ml / Kg 30-35 min
4) *Delonix* 250 ml /Kg 40-45 min

Seeds are placed in glass or plastic containers and the measured quantity of acid is added to the seeds and the seeds are stirred for a specific period. The seeds are then washed 8-10 times in cold water to remove the acid and then used for sowing.

5.13. Alternate Soaking and Shade Drying

In some tree species, fruits are used as sowing material instead of seeds.

Example: Teak, *Terminalia* etc.

To facilitate easy germination, the fruits are initially soaked in cold water for 24 hours and then shade dried for 24 hr and this process is continued for 5-7 times before the fruits are sown. This process will cause swelling and shrinking of fruits which will lead to cracks on the hard shell and will allow water and air to enter the fruit and hence facilitate quick germination.

5.14. Other Methods of Pre-treatment

(i) For pest and disease control

The seeds are dipped or coated or fumigated with suitable insecticide to avoid insect damage after sowing.

(ii) Seed hardening

After initial scarification, the seeds are soaked in 5% salt solution followed by drying and used for direct seeding which may facilitate for drought hardiness.

(iii) Seed Pelletization

Seeds are pelletized with fertilizers and insecticides using a filler and gum and used for aerial seeding.

(iv) Treatment with microbial cultures

To produce robust and healthy seedlings, seeds are sometimes treated with Rhizobial cultures, shade dried and used for sowing. This will help in fixing atmospheric nitrogen. Phospho-bacterial cultures, *Frankia*, Ecto and Endomycorrhiza are some of the beneficial microbial organisms which could produce healthy seedlings. Seed treatment with microbial cultures should be provided after seed scarification.

CHAPTER VI

NURSERY TECHNOLOGY

Nursery is an area where seedlings are produced for the purpose of planting out for afforestation and reforestation purposes. Success of plantations depends to a very large extent on good planting stocks, which in turn can be raised only if nursery work is properly organised. This work shall, therefore, be carried out with utmost care.

6.1. Importance of Nursery

- Nursery is very important in the development of plantations both for domestic and commercial utility.
- It helps to produce seedlings of small, medium and tall plants to cater the needs of industrial / social plantations, urban and recreational programmes.
- Nursery helps to produce quality and healthy seedlings
- Nursery grown seedlings ensure higher survival and early establishment.
- Nursery grown seedlings are amenable for both dry and irrigated plantation development programme.
- Nursery grown seedlings are mostly free from pest and diseases and thus help in establishing a hygienic plantation while planting out.

6.2. Types of Nursery

Nursery established for tree seedling production plays a vital role in the plantation development programme. Based on the need and the management requirement, tree nurseries are classified into the following types-

(i) Based on longevity/duration of operation

a) Temporary nurseries
b) Permanent nurseries *e.g.:* Clonal nursery complex, FCRI, Central Plantation nursery, TNPL.

(ii) Based on water availability

a) Dry nursery
b) Wet nursery

(iii) Based on the purpose and location

a) Centralized nursery

b) Decentralized nursery / Site specific nurseries *e.g.:* Decentralized nurseries

6.3. Nursery site selection:

The following factors are very essential for locating a nursery.

(i) Location: The area chosen for nursery should be centrally located for economic transport of materials and easy lifting of nursery stock.

(ii) Light: The seedling should not be raised under tree canopy which cause total shading.

(iii) Slope: Nursery should be gentle and flat to ensure good drainage facilities for proper growth and establishment of the seedlings.

(iv) Size: The size of the nursery should be decided based on the seedling demand, availability of water and other infrastructural facilities. The size of the nursery can extend upto 4 hectares (10 acres).

(v) Soil: The soil pH between 6.5 and 7.5 is preferred for production of quality seedlings.

(vi) **Water:** The pH of water should be around 7.0 .

(vii) **Labour:** Nursery activities demand huge volume of labour requirement to cater the needs of input transportation, loading and unloading, mother bed formation, sowing, bag filling, transplantation, watering, pest and disease management etc. Continuous availability of labour sustainable work force is essential for successful establishment and management of the nursery. Nowadays due to mechanization, the labour requirement has been drastically reduced. Nurseries should invest on necessary infrastructure particularly micro irrigation facility, mechanized filling operations etc. to manage the labour problem.

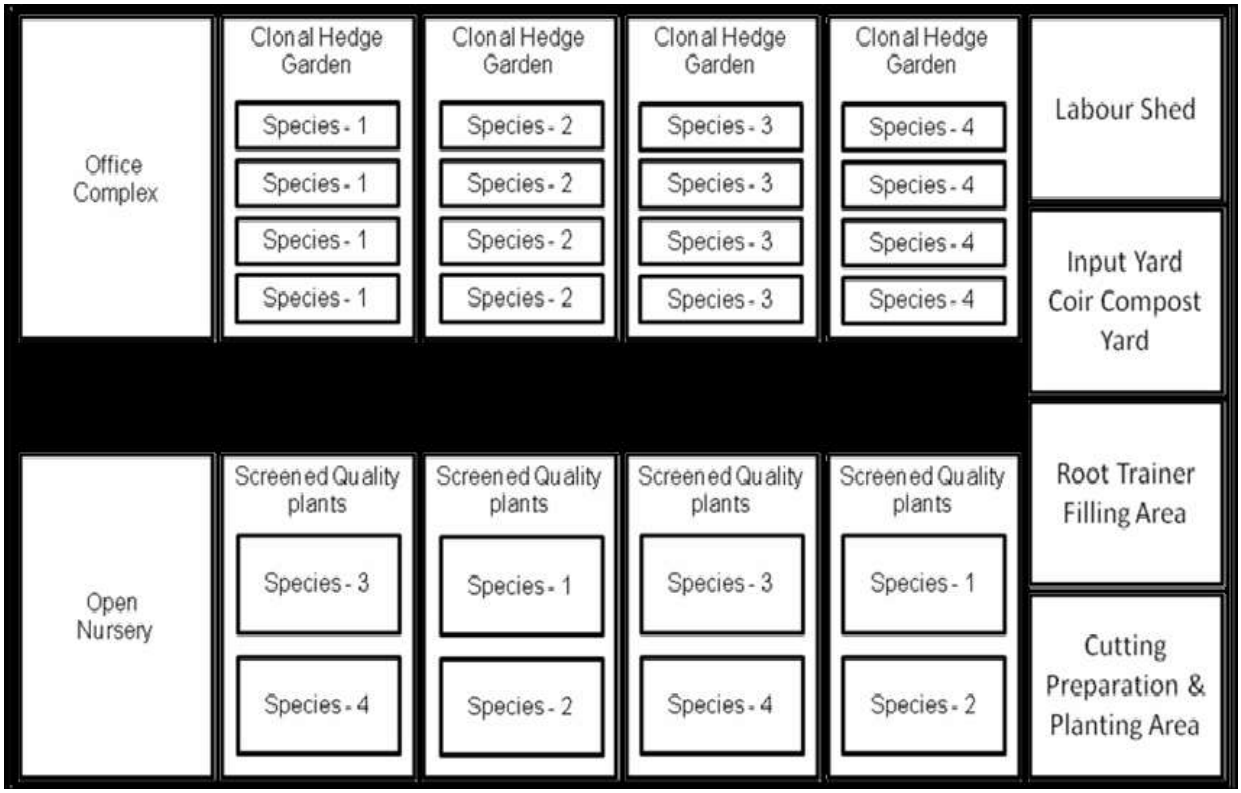
(viii) Flood: The site should not be located in the areas prone to periodic and recurrent flooding. Sites with heavy clay soil is prone to water logging and flooding and hence this site should be avoided.

(ix) Frost: Nursery site should be avoided when the area is subjected to frost and snow.

(x) Wind: Areas subjected to strong winds should also be avoided. Alternatively, such areas when selected for want of other facilities should be protected by establishing one or two rows of windbreaks or a site specific shelterbelt depending on the prevailing wind speed.

(xi) Nursery Layout: Once the nursery area is identified and selected, proper planning is essential to establish the nursery. A modern and centralized nursery should have all infrastructure to support seedling production.

Nursery Layout



6.4. Nursery site

A permanent nursery shall be located as centrally for the plantation areas as a good site is available. It should, preferably be near a range or at-least a forester's headquarters. The soil should be light deep and well drained. It is necessary to locate a nursery on a hill side, a moderate slope preferably on the northerly aspect shall be chosen. A permanent nursery shall be close to a permanent water source. If a natural source is not available wells shall be dug out as to supply sufficient water during the dry weather. Newly cleared forest land shall be chosen for this purpose. The nurseries shall be sited neither on natural blanks in the forest nor on areas which are likely to get waterlogged.

6.5. Nursery Establishment

The site should be cleared properly by removing all stumps, roots, lops and tops. Stones collected from the site may be used for metalling the main nursery road. Thorough ploughing or hoeing to a depth of 30 cm should be done, especially in places where plants

are to be raised in the nursery beds. The soil should be leveled to form an even slope or, if a site is flat, should be slightly domed. The beds are laid out in rectangular shape with their length east to west to avoid shade affect. As far as possible, removing of top soil must be avoided. Drainage channel should be dug as early as possible to avoid soil erosion. Drains should be dug on both sides of the paths and connected to main drain. In plains, drain should be adequately sloped and steps should be used in hills to check the flow of water. The nursery bed should be oriented in East-West direction in the plains and should follow contours in the hills.

6.6. Kind of nurseries

Nurseries are of two kinds, i.e., (a) temporary and (b) permanent. Temporary nurseries can either be 'rab' nurseries or those containing bed.

6.6.1. Rab nurseries

Rab nurseries shall be laid for Teak if well trained Staffs are deficient and plenty of seeds are available. These shall be laid within the plantation area which originally contained a forest cover and where soil is fairly deep and light. Grassy blanks shall be scrupulously avoided. The site shall have good burn and three repeated ploughings to produce a thorough soil working to a depth of at-least 25 cms. One hectare of rab nursery shall be laid for every 40 hectares of plantation.

6.6.2. Other Temporary nurseries

Temporary nurseries with regular bed can also be established either inside or close to the planting area. Stumps and/or potted transplants can be raised in these nurseries. The same principles as for rab nurseries shall be followed as far as possible on flat ground. All other prescriptions for permanent nurseries shall apply mutatis mutandis to these nurseries also. Where potted transplants are used for plantation the planting stock, shall be raised in temporary nurseries established according to the above principles except where large mechanised nurseries with full equipments for easy transport of seedlings are established.

6.6.3. Permanent Nurseries

Permanent nurseries shall be established where large supplies of planting stock are wanted annually, provided communications are good for getting the stock quickly to the planting site and it is not convenient to lay out rab or temporary nurseries.

6.7. Site preparation

The site shall be cleaned in the winter, thoroughly burnt during April/May. The whole site should be thoroughly ploughed or howed to a depth of 45 cms. and all stumps, roots, deeper grass roots and stones removed. It is advisable to complete this work at the end of the rainy season when the soil is soft and the area kept fallow till the following season. But the site also can be used during the same season. In that case removal of stumps, roots, stones, etc., shall be completed by about the end of May. Terracing where necessary on hill sides shall also be completed by the above date. Clods and stumps shall than be broken and the whole are smoothed.

(a) Stump nursery – A fully stocked standard bed 12.2 m x 1.2 m (40'x4') in size can yield sufficient planting stock for 0.4 hectare (1 acre). The total number of beds that should be laid out in the nursery for the area planned to be planted shall be calculated in this manner. Ten percent more beds shall be added as reserve against failures in the beds and for providing stock for replacement of casualties. There shall be space for double the number of the beds required for annual plantation as calculated above so that the nursery work is started on time in the following year.

(b) Pot nurseries – potted plants arranged in a nursery bed of standard dimensions of 12.2 m x 1.2 m. (40'x4') shall suffice to plant one hectare with standard spacement of 2.6 m x 2.6 m. This also takes care of failures in the nursery if any and replacement of casualities (unless there is great variation in the annual plantation area). There shall be sufficient extra space for laying out seed-beds and shifting of potted plants and following. Space for about 30 percent more beds than those necessary for pots will be sufficient.

6.8. Preparation of Potting Mixture

A fine mixture of soil, sand and manure in the ratio of 6:1:3 should be prepared. Before mixing, the soil and sand should be sieved and pebbles and other undesirable

material separated. The manure should not be sieved but rubbed with hands to make it fine and twigs and other impurities should be removed. Insecticides in the prescribed proportion should be mixed in the mixture.

The main characteristics of a good potting mixture are:

a) It must be light in weight
b) It must be well drained and not hold too much water
c) It must be free from insects, diseases and weed seeds
d) It must not contain clay soil or large amount of ashes and

All materials must be well decomposed.

Each permanent nursery shall have paths for free movement and sufficient space for mali shed, tool shed, seed store, seed treatment yard, well, compost pits, yard for keeping sand, manure, imported soil, etc. In a properly laid out nursery with provision of space for all the above items, there will be 250 to 300 standard nursery beds per hectare of nursery space. A convenient size of a permanent nursery is 4 hectares. Smaller or larger nurseries are, however, not ruled out. Ordinarily, it shall not be less than 2 hectares.

The nursery shall be rectangular or square in shape, except on the rare occasions when it is located on hill slopes. It shall have well laid out beds in blocks of equal size separated by permanent paths. The main paths along the fence and the two central ones shall be 2 m to 3 m wide according to the size of the nursery. The other paths in between beds shall be 0.5 m wide for free movement around the beds for weeding, watering, etc. The beds as far as possible shall be laid out with their length east to west. In dry areas and in coastal sand seed beds shall be sunken below the level of the paths. Seed beds in most localities and beds intended to produce stumps shall be raised 15 cm to 22 cm above ground level.

6.9. Soil preparation

Nursery soil shall be prepared very carefully as success of the nursery depends largely on this work. This soil shall be a mixture of earth, washed river sand and manure in the proportion of 6:3:1. Another good soil mixture for the nurseries is that of screened local soil, some charcoal, wood ash and organic manure. If the local soil is heavy a liberal top dressing of washed river sand shall be given. The best manure is leaf mould collected early in the cold weather and stored under shelter after shifting. Mature farm yard manure

or compost will do as well. Sufficient quantities of cow dung shall be collected, heaped in a place assigned to it in the nursery and allowed to rot for about a year before being used. Un-decomposed cow dung shall not be used as it attracts termites and other insects into the nursery. The manure when used should be free of grubs, white ants, etc.

Compost also takes about a year to mature. Therefore, pits shall be filled as quickly as those are emptied of nature compost for use in the nursery of the current year. This work is best done in winter. Organic manure in required quantities shall be mixed thoroughly with the top soil. On rare occasions when no organic manure is available mineral fertilizers may be used but before using these fertilizers the dosage to the used for various species shall be carefully determined as small seedling of some species like Eucalyptus are susceptible to heavy doses of inorganic manure, best results are obtained by spraying a dilute solution of a nitrogenous fertilizer like urea after the seedlings are a few week old.

6.10. Nursery Beds

As has already been said the nursery beds shall lie with long side from east to west. The surface of the beds shall be flat or slightly convex but never concave. The edges of raised beds shall be protected from crumbling of eroding during rains by supporting them by flattened bamboos, brush wood, sawn off-cuts or whatever cheap material is readily available for the purpose, as otherwise the effective area of the beds will decrease considerably and the expected number of seedlings will not be available.

In case of Pines and Casuarina, the nursery beds or small seedlings shall be inoculated by appropriate mycorrhyza or symbiotic bacteria. This can be done by obtaining soil from old plantations of the species in question and mixing it with the soil in the nursery bed or by planting a line of large seedlings in the middle of the bed (in case of pine).

6.10.1. Types of Nursery Beds

a) Raised bed
b) Sunken bed

6.10.2. Nursery Bed Preparation

- Seedbeds are to be prepared must be ploughed, levelled and sloped
- Soil in the seedbed is light.
- The surface of the seedbed should be made firm by sprinkling water and then using a wooden plank.
- Height or depth of bed 15 cm
- The upper portion of the mother bed (2.5-5 cm) is prepared with a soil composition of Red earth, sand and FYM sieved with a 2 mm sieve and mixed in the ratio of 3:1:1.

6.11. Quantity of Seed

The quantity of seed to be sown per bed can be roughly estimated by using the following formula:-

$$W = \frac{AxD}{PxN} \times 100$$

where W = Weight of seed required in gms.
A = Area of bed in sq.cm.
D = No. of plants required per sq.m.
P = Plant percent of seeds
N = Number of seeds per gm.

Some margin shall be provided for errors in plant percent, seed weight, etc, when in doubts are more.

6.12. Sowing

Based on the size of the seeds and germination percentage, seeds are sown directly into the transplanting bed from where they are out planted or sown in mother bed and then transplanted into the transplanting bed.

For example seeds of *Eucalyptus*, *Casuarina* etc. are very small in size or light and difficult to dibble into polybag containers and hence they are raised in mother beds and then transplanted into polybag containers.

Though certain tree seeds have high germination percentage (80%), due to improper collection or storage, the germination percentage is usually low and if these seeds are directly dibbled into polythene bags, re-sowing has to be done in those empty bags which is not only a costly affair but also will lead to different aged seedlings in the nursery. In this case, the seeds may be prior tested for its germination percentage and the type of nursery technology to be adopted may then be decided. Seeds of tree species should be pure, graded and tested for its germination percentage before they are sown in the nurseries.

6.13. Methods of Sowing

Large seeds (e.g. Teak) shall be sown individually in drills running across the width of the bed. Drills are conveniently laid by pressing down and "drilling board" on the prepared bed. This is a board of the width of the bed and of a convenient length to mark out says 6 drills, battens of the required width, thickness and shape being nailed to the lower side at the required spacing. Each permanent nursery shall be equipped with a few such (say three) drilling boards. The drills are evenly spaced, the space depending on the species. For Teak it should be 10 cm. to 15 cm. Small seed may be drill sown in the above manner or broadcast over the seed beds. The latter procedure may be followed in cases where seedlings are to be pricked out into pots as in the case of casuarinas and Eucalyptus.

(i) Broadcasting

In this method, seeds are spread uniformly over the mother bed and covered to thickness of the smallest diameter of the seed. This is usually taken up for small seeds (*Eucalyptus*), light seeds (*Casuarina*) and seeds with poor germination percentage.

(ii) Line sowing

Line sowing is adopted to prevent overcrowding of seedlings due to improper spreading during broadcasting and also to produce healthy seedling through proper spacing of seeds in the mother bed. This is also used in places wherein seedlings are directly taken out from the mother bed to the main field. In this method, lines are drawn on the mother bed and seeds are sown in these lines and covered. The distance between lines depend upon whether the seedlings stock used for transplanting into the transplanting bed are directly planted into the main field and also based on the

germination capacity of the seeds. For seedlings that are to be transplanted, the line distance is close when compared to those which is taken directly for out planting from the mother bed. Line sowing is usually recommended for the species which has high germination percentage.

(iii) Dibbling

This method of sowing is adopted for bigger sized seeds with high germination percentage (80%). In case of seeds with low germination, seeds are dibbled with increased number per drill in which case the quantum of seed requirement will be high. In this method, seeds are sown into the containers by making a hole to a depth of one centimetre. Seeds dibbled at greater depth will have delayed germination or in some cases it may be killed due to lack of water or air.

Points to be noted,

(a) Sowing should be taken up early in the morning or late evening.

(b) Beds and containers should be watered and soaked thoroughly before sowing.

(c) Sow the seeds shallow rather than deep and cover the seeds to the thickness of the smallest diameter of the seeds.

(d) Treat the seeds with some fungicides like Agrason or Bavistin to prevent fungal disease and ant removal.

(e) Scarified seeds should be given a coating of microbial cultures like *Rhizobium* to produce healthy seedlings.

(f) Species like *Terminalia*s with the fruits partially exposed to the sunlight will give early germination.

(g) When pre-sprouted seeds are used (will prevent gap after sowing due to non germinated seeds), care should be taken to see that the sprouts are not damaged while sowing.

(h) For those tree species which are amenable for transplanting, at the time of direct sowing into polybag containers a portion of the seeds may be sown in the mother bed of sand media and after 15 days, the germinated bags could be pricked with the seedlings from the mother bed. This will help in preventing different aged seedlings in the nursery and will not require grading at the time of planting.

6.14. Time of sowing

The month in which seeds of more important species shall be sown as per detailed silvicultural characters, species where potted plants are used for planting are sown between January to march and those where stumps are, required, during previous May-June. When sowing is done in hot weather the top layer of the seed bed shall be thoroughly soaked before sowing is carried out and surface soil kept as uniformly most as possible till germination starts.

6.15. Pre-germination

Where germination is irregular pre-germinated seeds shall be drilled into the seed beds. This is possible in large sized seeds or fruits (Teak). These are almost invariably treated before sowing. In such cases it is advantageous to sow the seed as it sprouts after treatment. This will ensure full and even stocking of beds. This is unnecessary in case of seeds not requiring pre-sowing treatment.

6.16. Covering the seed

Seeds sown shall be covered to a proper depth. This may be done by raking over the soil in case of large seeds. In case of small seeds the seeds shall be covered thinly by shifting sand, fine sub-soil of leaf mould. The depth of the cover shall be equal to the minimum diameter of the seed or fruit (Teak). Seeds like cashew, khair, etc are better sown directly into the container, without resorting to transplanting.

6.17. Shade

Shade shall be provided only as necessary. It may be necessary only in cases where small seed is sown in winter, particularly in dry areas. It is not necessary for casuarinas. Shade shall be provided in localities liable to be affected by frost and where small seeds are sown during the monsoons. Shade is essential for Eucalyptus.

Branches of evergreen species, thatch, Palm leave, bamboo mats or chicks, grass can be used for shade. One of the best materials that can be used for shade is mat prepared of coconut palm leaves (locally known as Thennai mattai or Keetru). These mats can be prepared easily as Coconut trees are available almost throughout the state. Where shade over nursery bed is necessary supports at appropriate heights shall be provided to spread the shades.

6.18. Temporary shade houses

To protect the top surface of the soil from drying up and protect the young seedling from scorching sunlight and dispersal by sudden down pour, temporary shade houses are erected over the mother beds. Sometimes, these shade houses can be erected permanently to cater the protection needs of germinating seedlings.

6.19. Watering

Beds should be kept constantly moist at the time of seed germination. During the early stages, the beds should be given a fine spray of water using rose can. In case of fine seeds which are thinly covered, straw or twigs should be placed over the bed before watering. Watering should be done daily twice till one month after germination and then reduced. Depending upon the species and area for which they are raised, watering should be regulated to harden the seedlings in nursery.

Watering is done at intervals of 1-7 days and subsequent watering is usually done by noticing the seedlings at ready to wilt stage. In large scale nurseries, sprinkler irrigation may reduce the cost of watering when put up on a permanent basis. After plants are grown up, watering can be done by percolation or hand splash or by rose can.

Watering shall be carried out skill-fully as both over-watering and under watering are harmful. Watering cans with fine roses shall be used, particularly on seed beds where fine seeds have been shown. These beds shall never be flooded. Watering by percolation is the best method, particularly with species like Teak where development of tap-root is essential for preparation of stumps. In this case, however, care shall be taken to see that percolation reaches every part of the bed. As a thump-rule no point in the bed shall be more than 30 cm. away from the irrigation furrow. Thus a longitudinal furrow in the middle of every 1.2 m wide bed may be dug before sowing of seed where percolation is contemplated watering by cans may be continued until the seedling are a few week old and then the marginal drains and the central furrow of the bed flooded. Once the seedlings either in the beds or in the pots have reached the required size watering shall be done sparingly just for the seedlings to subsist until being planted out. Watering shall be done ordinarily in the afternoon when the sum is low and occasionally early in the morning particularly where damping off is a problem.

6.20. Damping off

Damping off is liable to occur in seedling beds till the stems are lignified. Watering, therefore, shall be sparing until the seedlings are large enough. A little formaldehyde or acetic acid shall be mixed with the water used on the nursery beds where damping off is a problem. A 4% solution or copper sulphate can also be used.

6.21. Pest and disease control

To seeds are treated with quinylphos dust to protect them from ants. Young seedlings are often attacked by leaf eating caterpillar and leaf webbers for which any systemic insecticides can be used. Common diseases in the nursery are **damping off** and **root rot**. Avoiding overcrowding of seedlings and allowing sunlight to reach the bed can control such diseases. At times when damping off is observed, avoid irrigation and apply Bavistin or Blue Copper @ 2 gm/lit of water and drench the bed. Pre treating seeds with agrason, thiram, captan will help to control the disease.

6.22. Hardening off

When shades have been used it is important that the seedlings are hardened off before being pricked-out and/or planted out in the field. Seedlings shall not be exposed to full sunlight suddenly. The shades shall be removed for a gradually increasing period daily, beginning with an hour or two early in the morning or when the sun is low.

6.23. Weeding and soil working

Weed control in nurseries a very important. A well-kept nursery should be weed free. It is desirable to sterilize the beds before sowing. This can be achieved to some extent by burning vegetable refuse on the beds. This is essential in cases where minute seeds are sown.

Weeding in beds containing small seedlings shall be done by using pointed sticks, loosening the soil at the same time. This work shall not be done when the soil is wet particularly in case of heavy soil. Caked soils shall be worked at regular intervals even if there is no weed. Care shall be taken to see that root of the small seedlings are not severed either at the time of weeding or soil working. Ordinarily weeding shall be done as soon as germination is complete and as often thereafter as necessary to keep the seedlings free from weed competition. Lined-out beds or drill sowings require weeding about once a

fortnight. With teak where germination continues ever a long period weeding may start as soon as the bed has about 30 % of the expected number of seedlings where seedlings stand too crowded they shall be thinned out during weeding.

The most convenient container available now is the polythene bag. Experiments are being conducted to standardize the techniques for producing biodegradable containers to replace the plastic / polythene containers to raise the seedlings as per the directions of the MoEF&CC.

The ordinary size of the bag shall be 13 cm x 23 cm. Smaller bags shall not be used. Ordinarily bags made of 100 gauge sheets shall be used. Where large seedlings are used for planting the bags may be 15 cm x 25 cm. In that case bags shall be made of 150 gauge sheets. When these bags are used attention shall be paid to aeration and drainage by punching holes along the sides and near the base. The soil mixture used in the pots shall be light, porous and not too rich. Liberal proportions of saw dust or sand shall be used to obtain required porosity. A very diluted manure may be used. Forest humus, farm yard manure or compost shall be preferred to mineral fertilizers.

The site where the containers are kept shall be very permeable and perfectly drained. In most areas it may be necessary to keep the containers on raised platforms. The D.F.O shall decide, if this is necessary. For healthy growth, the seedling should be free from weeds which may affect the plant growth if they are not removed at the right time. Proper knowledge to distinguish weeds from the tree seedlings is a must at the early stages of weeding. Based on the intensity of weeds, the time of weeding should be decided by the nursery men.

6.24. Pricking out

Pricking out into the containers shall be done under shade. It shall be done under high shade where the weather is neither hot nor windy. Each seedling shall be carefully separated from its neighbours. If its roots are crushed or too long, they shall be trimmed. The seedling then shall be placed in the centre of the pot and surrounded by the soil mixture in the pot. The soil shall be heaped around the seedlings which shall be covered slightly above the base of the stem and plentifully watered. The seedlings thus transplanted into the pots shall be left under shade for a few days for recovery. They shall

not be over watered at the stage. Thereafter they can be arranged in the open or under shade according to the species and the local conditions.

Seedling from the mother bed is pricked out into the transplanting bed from where they are planted out. The following points should be kept in mind at the time of pricking out of seedlings.

(i) Prepare and keep ready the transplanting bed by watering it the previous day of pricking and erecting a shade net over it.
(ii) Water the mother bed the previous day.
(iii) Seedling shall be pulled out form the mother bed early in the morning or late evening and planted in the transplanting bed.
(iv) The seedlings should be pricked without folding the roots and it should be well compacted.
(v) The root portion of the pulled out seedling should be kept inside water in a container till they are planted.
(vi) Water the seedlings daily twice, in the morning and in the evening.

The age of pricking will vary from species to species and this should be strictly followed or else the seedling may not survive after pricking.

Eg. *Eucalyptus, Casuarina, Ailanthus:* 30-40 days after sowing.
Acacia nilotica, A.leucophloea etc.: 15-20 days after germination.
Bamboo: 40-60 days after sowing.

6.25. Root and shoot Pruning

The tap roots of the seedlings raised in pots shall not be allowed to grow beyond the pots. This is achieved by shifting the pots once every month and inspecting the tap root. The tap root escaping young adventitious growth about by spreading over the free surface of the pots a layer of fine rich soil mixed with well-diluted manure about a month before planting out.

6.26. Shifting

Shifting of the potted seedlings and sorting them out periodically before planting also minimises suppression of the seedlings. Seedlings which are lagging behind or

suppressed are freed from suppression and given a chance to grow up to the size of the better grown once (ones) and thus a planting stock of uniform size is prepared. While shifting the potted seedlings great care shall be taken to see that the ball of earth in the bag is not disturbed. Besides cutting the roots, pruning the crown of the seedling particularly in case of Eucalyptus, at a height of 30-40 cm. also encourages even growth of foliage and roots at planting time. The pots shall be kept scrupulously clean of weeds until the seedlings are planted out in the field.

Shifting of containers from its original place is a must to prevent the root from striking into the soil and also to break the top clogged soil caused by continuous irrigation which will prevent the entry of water and air. Fifteen – twenty days after germination or planting, check one or two seedlings at random in the bed and see whether they have struck roots ground and if so, do the shifting. After the first shifting operation, shifting of seedlings should be done once in 15-20 days interval. Weeding also should be combined with the shifting operation to minimize the cost of seedling production. Protruding roots out of the container should be pruned at the time of shifting to keep the roots compact and prevent them from penetrating into the soil.

6.27. Thinning and Culling

In case of overcrowding of seedlings due to sowing of more number of seeds in the polybags or sowing of high germination percentage seeds on mother beds, thinning is advocated to produce healthy seedlings. Thinning should be done once the germination has been completed. While thinning care should be taken to retain those seedlings which have germinated earlier and are healthy, attention should be directed towards removal of late germinated and unhealthy seedlings. To increase production at the time of last shifting, weak, pest and disease attacked seedlings are culled out to retain only healthy plants in the nursery for out planting. The culling percentage can go up to 30%.

6.28. Maintaining fertility of the nursery site

This important aspect shall not be lost sight of. The fertility of the nursery soil can be maintained by following use of organic manures and supplementing the latter by judicial doses of mineral fertilizers.

6.29. Manuring

The size of the container and the nutrients in the soil will not be adequate to nourish the seedling for a long period. After three months of growth in the containers, these seedlings may be given irrigation with cow dung solution. For this, one part of fresh cow dung is mixed with 4 parts of water and kept in a container for 2 days. On the third day, the supernatant solutions is taken and to this, add 10 times of water and use this for irrigating the seedlings once in 15-20 days before shifting. Seed treatment with rhizobial cultures, VAM, Phospho bacteria, *Frankia* and spraying of Urea 1% or DAP application @ 2.5 gm/ polybag containers is also given to boost up the seedling growth. It is better to prefer organic form of fertilizer which will nourish the seedlings slowly and steadily and will help it to survive on waste lands which are characterized by poor nutrition.

6.30. Fallowing and green manuring

Sufficient fallow space shall be provided in the permanent nurseries. This area shall get a year's rest. In addition suitable crops, e.g., those of *Sesbania aculeats, chrotalaria juncea*, *Tephresia candida*, *Vigna catjung* shall be raised for green manuring and turned into the soil. These crops shall be dug into the soil shortly before flowering. Green manuring is not recommended for nurseries where irrigation is not available. Green manuring is most effective in combination with artificial fertilizers. A green manure crop grown on fertilized soil and later turned into it makes nutrients available over a longer period in slowly mobilized non-toxic organic forms.

6.31. Composting

All permanent nurseries shall have compost pits of suitable sizes. The pits shall be large enough to accommodate about 125 tonnes of leaves and other vegetable waste per hectare. Large quantities of leaves from nearby forests and other sources shall be obtained and arranged in flat heaps in the pits. These heeps shall be impregnated with bacteria for breaking the waste down. This can be done by adding matured organic manure of the last prepared stock or specially prepared material such as ADCO and kept thoroughly wetted. Weeds or cultivation shall not be used for composting. Similarly thick hard leaves shall be avoided.

6.32. Quantity of organic manure required

About 30-40 tonnes of organic manure is required per hectare. It may not be possible to produce this quantity of compost in the nursery. It is, therefore, necessary that farm yard manure in good quantities is also prepared in the nursery.

6.33. Mineral fertilizers

As organic manures always do not return enough mineral to the soil, artificial fertilizers may have to be added. Several patent mixtures are available in the market. The recommended dose for an average nursery soil is 500 kg. basic slag, 125 kg. of potassium chloride and 125 kg. of Ammonium sulphate per hectare. The mixture shall be applied to the soil in the form of a solution of 7.5 kg of salt in 500 litres of water. The dosage shall be modified according to the species to the species to be raised in the nursery.

6.34. Type of planting stock

The following types of planting stocks can be produced in the nursery.

(i) Bare rooted seedlings or naked

Bare rooted seedlings or naked seedlings are used for planting in sandy loam soils where water table is high or areas with high rainfall or with irrigation facilities. Here the seedlings are transplanted from the original mother bed to the transplanting bed at wider spacing from where they are pulled out and planted in the main field. Care should be taken not to injure the roots or keep the plants in the open so that the roots get dried up at the time of planting.

Example: Casuarina, Terminalias, Bamboos etc.

(ii) Polythene Containerized seedling

This is a common method wherein seedlings are raised in some containers for the prescribed period and then planted out.

Example: Eucalyptus, Casuarina, Acacia, Albizia etc.

(iii) Stumps

In this method, the seeds are sown on the mother bed and seedlings are raised. After the prescribed period, these seedlings are pulled out and the shoot portion (2.5 cm)

root portion (22.5 cm) and side roots are pruned off and the left out material called the stump is used for planting.

Example: Teak

(iv) Root trainer seedlings

Seedlings are also raised in various types of root trainers and are used in commercial agro forestry plantation establishment.

Example: Casuarina, Eucalyptus etc.

6.35. Nursery machinery, tools and materials

Tractor with trailor, Tanker, Plough and Trowel Trolleys

ii) Nursery Tools

Mummutty, Spade, Shovel, Digging fork, Rake, Hand fork, Watering cans, Spraying pumps, Pen knife, Dudding knife, Secateurs, Measuring tape, Ranging poles, Stakes, Budding tapes, Dibbler (pointed stick) crowbar, Pickaxe etc.

(iii) Nursery Materials

Polybags, growth regulators (IAA, IBA), Fertile top soil, sand, FYM, seedlings brought out from the mist chamber before they are kept in the open

6.36. Nursery records

- Planning register
- Seed register
- Operation register
- Input register
- Forecast register

6.37. Fencing and sign board

All nurseries shall be properly fenced. Brush-wood and bamboo fence with a wicket gate shall be sufficient for temporary nurseries. Permanent nurseries shall be more elaborately fenced. A six stand fencing of barbed wire with treated wooden or angle iron posts shall be erected with a main gate and a wicket gate at the rear. A sign board of a suitable size, number of beds, and species of seedlings raised and where possible a plan of the nursery shall be affixed at the main gate of the nursery.

6.38. Stock Register

The beds in the nursery shall be numbered and a small board or plate showing the name of the species sown or planted, origin of the seed, date of sowing or planting and quantity shall be fixed at each bed. It shall always be kept in mind that the object of nursery management is to produce strong plants of the right size in required number at the right time.

CHAPTER VII

PREPARING THE PLANTING SITE

7.1. Demarcation of the area

The planting area shall be properly demarcated. If it is inside or adjoining an existing forest it shall be demarcated by a 3 m. wide clear line on all sides where there is forest or shrub growth. A boundary post shall be fixed at each corner, at each place where the boundary line of the site crosses a road or a prominent path and at each other prominent point. It shall not be a stone cairn or of the same type as the reserve forest boundary pillar as the pillars demarcating the plantation area are some-times confused with the reserve forest boundary pillars. It shall consist of a flat stone or cut stone post or a R.C.C. post 120 cms. tall, 40 cms wide and 15 cms thick. The name of the Block or locality, species, year of plantation and area shall be engraved on each boundary post. The area demarcated for plantation shall be accurately survey 'A' map in the scale 1:15,000 (10 cms = 1.5 kms) shall be prepared showing inspection roads and paths to be constructed. Treatments to be applied to each part of this area and species to be planted shall be shown in this map.

7.2. Clearing the site

After the unwanted trees are taken out, the remaining standing growth and refuge shall be felled and spread uniformly over the plantation area. Care shall be taken to cover the maximum ground surface with the available waste material piled to about 0.1 m to 0.4 m height. This work shall be completed preferably by the end of February and latest by the end of March. The above material shall then be allowed to dry for a month or two.

Burning shall start as soon as the material is dry enough to give a good clean hot fire. The fire shall be started up the wind and shall be worked round the periphery so that the area burn mostly inwards and up the wind with a minimum risk to the surrounding forest and plantations, if any. The un-burnt material shall be collected in heaps, if possible over patches which have not received a good burn and re-burnt. Burning and re-burning shall be completed as early as possible as but not later than the end of May. These operations shall not be delayed till rain begins to fall, when only a patchy fire is possible. If timely burning is not possible it is worthwhile postponing plantation to the next season when it can be carried out after a timely burning. Effective elimination of bamboo clumps

is important; Branch wood shall be piled over and around the bamboo stumps and burnt. If necessary this operation shall be repeated. A satisfactory burn is absolutely essential to a good plantation, where there is insufficient combustible material it may be necessary to protect the area from fire for a few years so that enough material accumulates for a satisfactory burn but this may not always be possible. Lack of a good burn can be compensated by intensive soil working.

An area shall not be left fallow after burning. In other words, if there is any possibility that planting may not be done in an area in the planting season soon after burning; burning shall not be carried out in that area. Where planting is done in pits and burning slash material is scarce, the available material shall be heaped on the pits and burnt.

7.3. Spacing

The usual spacing for all plants shall be 2.5 m x 2.5 m except where a different spacing has been prescribed in any special scheme or by the working plan. In the casuarina plantations in the coastal areas the spacing in the wind belt shall be 1.5 m x 1.5m (around in a quincunx fashion) for the first 20 rows from the sea and 2 m x 2 m for the next 60 rows. Similarly in arid areas, the spacing shall normally be 5 m x 5m particularly for the soil conservation plantations. The number of plants required per hectare at the above and a few other spacing will be as follows-

Spacing	No. of plants per hectare
1.5 m x 1.5 m	4,360
2 m x 2 m	2,500
2.5 m x 2.5 m	1,600
3 m x 3 m	1,111
5 m x 5 m	400
6 m x 6 m	278
8 m x 8 m	156

Immediately after burning, staking shall be done at the prescribed spacing. The plantation area shall be divided into 4 hectare sections. When staking is done at the spacing of 2.5 m x 2.5 m the 80^{th} line in either direction shall be left blank. Thus, a 4 hectares section formed. Where possible the last line (79^{th} line) on all the four sides of the block shall be planted with a species other than the main species planted in the block. By

doing this not only the demarcation of the block is made more distinct but also required segregation of blocks against insect attack is achieved to a good extent.

Where staking is done at a spacing of 5m x 5m the 40th line on either direction shall be planted with a species other than the main species planted in the block. No line need be kept blank in this case. Where it is not possible to plant a different species to demarcate the planting block it shall be demarcated by posts made of either stone or R.C.C 75 cm long and with a cross section of 15 cm square. Half of this post shall be buried below ground level.

Where the planting area is irregular in shape, two bare lines for staking at right angles to each other shall be laid at the widest part of the area and the staking lines started from there. The planting blocks near the boundary line may be irregular in shape. Efforts shall be made to keep these blocks as near 4 hectares as possible. The planting blocks shall be shown in the plantation maps. The exact area of each block shall be indicated in the map.

7.4. Digging of Pits

Where the area is barren and there is no forest growth which will be cleaned and burnt, digging of pits shall be completed in the winter preceding the planting season. In areas where existing forest growth has been cleared and burnt, digging of pits shall start simultaneously with staking i.e., immediately after burning is over. It shall be completed preferably two months before or at least a month before planting starts and the interior of the pit as also the dugout soil exposed to the sun. Pits shall not be dug just at the time of planting except in the sandy coastal areas. While digging pits, the soil of the top half of the pit shall be kept separately. When the pit is filled up this half shall be put in the bottom of the pit and the rest of the soil at the top. Before the pit is filled in 5 percent Aldrine dust shall be sprinkled in the pit and mixed with the soil. All roots, stones, etc., shall be removed from the soil before it is replaced in the pit.

(a) The usual size of pits on normal sites and in moist locations shall be 30 cm. cube.
(b) It shall be 45 cm. cube in the following cases:-
    (i) degraded sites.
    (ii) dry areas, particularly soil conservation plantations in such areas, and
    (iii) Plantations of fruit bearing trees including cashew nut

(c) In case of Casuarina and Eucalyptus on the coastal sand the pit shall be deep and wide enough to hold the ball of earth in the polythene bag containing the seedling and shall be dug at the time of planting.

7.5. Mounds

In wet soils or areas liable to inundation or water logging, the soil shall be raised into mounds for planting. This shall be done in all types of land from coastal sand to low lying areas inland. The width of the mounds shall be such that the soil of the mound is not washed during the rains as to expose the roots of the seedlings planted, the height depending on the maximum depth of water logging or inundation.

7.6. Soil preparation on slopes

(a) When the slope is gentle a half – moon trench-ridge shall be provided on the down-hill side near each pit.

(b) When the slope is steep, plantation shall be carried out along contour trenches 45’ wide at the base and 45’ deep on the down-hill side. The trenches shall be 7 m long each interrupted by un-worked lengths of 3 m. The distance between two trenches along the slope shall be 5m. The soil of the trench shall be replaced in the trench partially, the remaining part being heaped on the down-hill side. The portion of the hillside on which this soil is heaped shall be broken by pick-axe before-hand. The trenches shall be staggered. It is ideal to dig the trenches at the beginning of the year previous to that of planting and allow those to be partially filled by silt during the rains and exposed to weather for about a year. If, however, it is necessary to plant during the same rains the soil in the planting pit shall be enriched by an appropriate dose of manure.

7.7. Plantation Methods

The block planting method is a full planting used where there is no existing forest. Enrichment planting (line conversion planting, gap planting, under-planting) is a method to improve an existing secondary forest.

Sl. No	End products	Plantation systems	Planting methods
1.	Timber	Large-scale industrial plantation Small-scale community plantation	Block planting, Enrichment planting
2.	Posts / boundary	Agro-forestry system	Trees planted individually or in line
3.	Food	Agro-forestry system	Trees planted individually or in line
4.	Fodder	Agro-forestry system	Trees planted individually or in line
5.	Medicinal products	Agro-forestry system	Trees planted individually or in line
6.	Shade	Agro-forestry system	Trees planted individually or in line
7.	Land reclamation	Large/small-scale non-industrial plantation	Block planting/Nitrogen fixing species
8.	Aesthetics / Biodiversity	Large/small-scale non-industrial plantation	Enrichment planting

CHAPTER VIII

SOWING AND PLANTING

8.1. Direct sowing

Plantations of Cashew, Mango, Jack Fruit and Tamarind can be done by this method. Generally these seeds retain viability for a very short period. Therefore, fresh seeds shall be collected from the ground as soon as they fall and sown immediately in furrowed lines. This operation shall be repeated thrice at a week's interval to get a good population of seedlings in the sown lines. Larger seeds like those of Mango, Cashew nut, etc., can be dibbled in pits as soon as the first showers of rain fall. Fresh seeds collected during the same season shall be sown as these seeds usually do not retain viability for long. Planting potted seedlings of these species is however the surer and better method.

Plantation of mangrove species are also raised by direct sowing. Seeds of these species usually germinate while still on the trees or soon after they fall on water. The germinated seeds are collected carefully by nets from the water and sown in the field. Sowing is best done between the new moon and the full moon when the tide is the lowest.

8.2. Season of Planting

A time table shall be drawn up for all operations including planting for each plantation and followed strictly. The following considerations shall broadly govern the planting time.

a) Stumps shall be planted just before or with the first pre-monsoon showers.
b) Potted seedlings shall be planted soon after the regular monsoons have set in and the soil has become moist. Planting shall, however, be completed before the 21st October or within the 3rd week from the start of the regular north east monsoon rains.
c) On the coastal sands plantings shall commence two weeks after the monsoon starts, i.e., after the soil (sand) temperature has come down considerably, but shall be completed by the 1st week of November at the latest. Planting of potted seedlings, particularly of delicate species like Mahogany, Eucalyputs, etc., shall as far as possible be carried out on dull (cloudy) or even wet days.

8.3. Planting Stock

Planting stock, as has been said earlier is of two main kinds, viz., stumps and potted seedlings. Stump planting shall be the usual method for Teak and Rose-wood. Stumps can also be used for Gamhar, Mahogany, Vengai and Albizzia species, but these stumps will do better in moist localities. This method may be employed in any other case where the seedling grows a good thick taproot. In all other cases potted seedlings shall be used except in case of mangrove species. Great care shall be taken in preparing the planting stock before planting out.

8.4. Stump Planting – Preparation of stumps

Seedlings with a collar diameter of 10 mm and a long, straight, single taproot shall be selected for preparing stumps. A few odd seedlings up to 20 mm. thick at the collar, but not thicker, may be included. In case of Rose wood thinner seedlings (7-8 mm. thick at the collar) may also do. The selected seedlings shall be pulled out of the nursery carefully by hand after watering the nursery profusely. Any seedling with broken branched or forked taproot shall be rejected. The remaining seedlings shall be pruned down with a sharp instrument to a stick consisting of 20-25 cm of taproot and 2 to 6 cm. of shoot. The minor lateral roots shall be pruned flush with the taproot. In case of Simal the entire fleshy taproot shall be included in the stump. In all cases the shoot length shall be 2 to 4 cm. Whereas if simal and mahogany stumps are planted the shoot length shall be 5-6 cm.

8.5. Pre-sprouted Stumps

Thinner stumps can be planted into polythene pots at the same time as stumps are prepared for planting and watered till monsoon starts. Those sprout in the polythene pots and can be used for replacing casualties with very satisfactory results. While preparing these stumps use of suppressed seedlings of the beds from which the majority have been removed for stump planting shall be avoided. Pre-sprouted stumps may also be used as the general planting stock if it is apprehended that most of the seedlings in the nursery will not grow up to the proper size for stump planting. In these cases stumps shall be prepared in February – March planted in the Polythene pots and watered till those are planted out in the field at the beginning of the rains. Pre-sprouted stumps shall be raised

in polythene pots arranged in a number of small temporary nurseries distributed in the plantation area.

8.6. Carriage of Stumps to the planting site

Stumps of different species (if more than one species are used for planting) shall be packed separately in bundles of 100 to 200 in moist gunny bag cloth. These bundles shall then be transported to the site of planting and kept moist until the stumps are planted out. There shall be as short a time log as possible between preparation of stumps and their planting.

8.7. Stump Planting

The stumps shall be planted ordinarily in crowbar holes in light soils. The hole shall be just long enough to hold the stump up to the collar or a little more. The stumps shall then be jammed down to the bottom of the hole and the soil around it well compacted. This is best done by making a second thrust of the crowbar into the soil about 7 to 10 cm away from the planting hole and pressing the intervening soil against the stump. Planting in crowbar holes shall not be done in heavy soils. In the latter soils, if at all stump planting is necessary; it may be carried out in previously prepared planting pits. Pre-sprouted stumps kept in polythene pots shall be planted in pits as in case of polythene potted seedlings.

8.8. Planting potted seedlings preparation of stock

The seedlings shall be at least 45 cm. tall when those are planted out. Taller plant will be necessary in dry areas. Pots shall be lifted very carefully so that the ball of earth in it is not broken. The seedlings shall be watered generously before being lifted from the nursery. As has been laid down earlier shifting of the pots in the nursery would have discouraged tap roots from growing out of the pots. While preparing these potted seedlings for planting any roots escaping from the pots shall be trimmed. In case of delicate seedlings shall be stripped of the large leaves leaving only a few at the apex. Large side branches if any shall be pruned cleanly. In case of delicate seedlings and seedlings with small leaves like Eucalyptus the shoot shall also be pruned above 30-40 cm from the collar, pruning of the shoot (topping) shall be done 25-30 days before the seedling is lifted from the nursery for planting.

8.9. Transport of stock to the planting site

They shall be transported from the nursery to the planting site as speedily as possible after being lifted. The planting pits shall be kept ready before hand. The pits shall be sprinkled with 5% Aldrine dust. The soil which is to be sued to fill the pit shall also be mixed with a small quantity of the above dust. The seedlings shall then be taken directly to the pits. There shall not be kept at any intermediate place. Light wooden, bamboo or wire trays with a capacity of 20 to 100 polythene pots shall be used for transporting the pots to the planting site from the nursery. The plants shall b transported carefully. It shall be seen that the ball of earth is not broken during transport. Potted plants can also be transported to the site by trailers drawn by jeeps or tractors. When doing so the seedlings shall be will packed, otherwise the stem will work loose and the ball of earth even inside the container will disintegrate. The plants shall be loaded on and unloaded from the tray or trailers with extreme care.

8.10. Container Planting

The polythene covering of the balls of earth shall be carefully removed before planting. In case of large pots it shall be sufficient to slit the bottom of the pot open. Care shall be taken to see that the ball of earth is not broken while doing so. The seedling with the ball of earth is not broken while doing so. The seedling with the ball of earth shall then be placed firmly in the pit and buried at such a depth that the root collar is well below the surface of the soil. The soil around the plant shall be well compacted with the heal as a final step so that there is a proper bond between the ball and the surrounding soil. The earth close to the collar shall be slightly elevated so that rain water does not accumulate very close to the plant.

8.11. Deep Planting

Deep planting shall be carried out in dry localities and on sand dunes. A part of the stem (10 to 15 cm) shall be buried under the earth (including sand) so that the seedling takes advantage of soil moisture for a longer period. Casuarina and other seedlings planted in coastal sand shall be watered soon after planting if there is no rain at the time of planting. This will continue every fourth day until there is a good shower for rain. The wind belt along the sea coast, whether it is of casuarina or of any other species

shall be planted behind a palisade to about a meter high made either of palm leaves or of brush wood which is easily and cheaply available near the site.

8.12. Planting with naked roots

On rare occasions it may be necessary to plant seedlings with naked roots. While transporting such seedlings to the planting site care shall be dug from the beds, working from one end so that earth will fall away easily, and bundled after rejecting the small, undersized, suppressed ones. The roots shall be dipped in a thin clayey puddle, the bundles racked in wet moss or similar material and put in a basket. The basket shall be kept covered with wet sacking ready for taking out to the site. Depending on condition they may be lifted in the evening and transported by night ready for next morning's work, or they may be lifted early in the morning taken out and planted with the minimum delay. Planting shall be done preferably on a rainy day. While planting seedlings with naked roots care shall be taken to see that the tap roots are not doubled up. The planting pits shall be as deep as the roots are long or a little deeper. The plant shall be held centrally and a little of the soil shall then be pushed back into place and pressed gently but firmly against the lower most roots. This process shall be repeated until all the soil has been replaced, supplemented if necessary by an additional amount from the surroundings, the roots remaining as far as well compacted with the heal as a final step. If the plant is easily pulled out of the ground it indicates that the roots have not properly spread or the soil sufficiently compacted. Only good moist mineral soil and not light humus shall be used for filling the planting pit. When planting is done on sunny days or in a soil not quite wet enough some of the leaves of the seedlings shall be plucked off to reduce transpiration losses. This operation shall not be carried out if not absolutely necessary.

8.13. Branch and stem cuttings

Plantations of some species like Salai, Mal, Simal can also be raised by branch or stem cuttings. This method can be followed in dry localities, particularly for soil conservation plantations. Cuttings shall be obtained from young trees and plants, preferably 1-3 years old. They shall be planted just before the monsoon (windy areas with the start of monsoon) so as to given as long a first growing season as possible. The size of the cutting shall be height 21/2 to 30cm and basal diameter 5 to 10 cm.

8.14. Planting of Bamboos

Potted bamboo seedlings can be raised as in the case of other species in the nursery. Seedlings with undisturbed root stock may also be collected in winter from the forest after a gregarious or near gregarious flowering (Sporadic flowering in large patches) transplanted in large size polythene pots and nursed in the nursery till they are planted out in the field in the next planting season. Before planting the shoots of the bamboo seedlings in the polythene pots shall be drastically pruned above 10 cm from the collar. The method has given very good results. Bamboos can be propagated also by planting off sets. Culms one year old shall be cut through with a slanting cut about 90 to 120 cm. from the ground and the rhizomes to which they are attached shall be dug up with the roots intact. The rhizome then shall be cut-off to a length sufficient to include a well developed bud. These offsets shall be planted sufficiently deep to cover the first two or three nodes. Planting of off-sets shall be carried out along with first pre-monsoon showers. This method of propagation shall be adopted only as a last resort as it depletes the existing clumps to a large extent.

8.15. Mixtures

Mixtures in the plantation shall be as prescribed in the schemes concerned.

8.16. Water and soil conservation measures

Planting on slopes shall be carried out along contours. The measures prescribed are sufficient for forest plantations. In addition, small gullies may be plugged by rubble and check dams also of rubble may be erected on small nalas where those run along steep slopes. The spacing of the check dams shall depend on the slope and shall be at the discretion of the Divisional Forest Officer who shall visit the area personally before allowing these structures to be built. In very dry areas, where the rain fall is low and plantation is carried out on slightly sloping ground, two channels each about a meter long shall be made in a ‘v’ shape up-slope near the pit to lead moisture into it in addition to the half-moon trench-ridge.

CHAPTER IX

POST PLANTING CARE

9.1. Replacement of Casualties

As soon as the main plantation operation is over the entire area shall be gone over in the same order as plantation was carried out and casualties if any shall be replaced. It is often convenient to combine this operation with the first weeding. One year and two year old plantations shall be visited early in June-July. Pits or places where casualties have occurred shall be marked with new stakes. The area around the new stakes shall be cleared. Pits shall be re-dug and prepared for planting. Replacement of these casualties shall be carried out simultaneously with main plantation operation of the year.

Healthy and good sized stumps, pre-sprouted stumps or seedlings shall be used for replacements. The usual tendency to utilise rejected seedlings for replacement shall be drastically checked. Where stump planting has been carried out pre-sprouted stumps or vigorous potted seedlings shall be used for replacement in the current year's plantations. Stumps may be used in the older plantations provided planting is carried out at the time suitable for stumps.

9.2. Weeding and Soil Working

Regular and efficient weedings are essential for the success of a plantation. Weeding shall start immediately after sprouting of the stumps is complete or after the seedlings have started throwing up new buds. Thereafter weeding shall be almost a continuous process keeping a gang of labourers continuously engaged in the work. The first weeding shall be carried out over the entire area of the plantation. The soil around the plant, unless it is too clayey or too wet, shall be worked loose and weeds pulled out along with their roots, rhizomes, stumps, etc. This shall be done in a diameter of about one meter and a half. In the rest of the area, the weeds shall be cut close to the ground. Weeding shall be done only when the soil a sufficiently dry to be shaken off the weed roots. Care shall be taken to see that removal of soil with the weeds does not result in lowering the soil level round the plants.

The second weeding may be done in the planted strips with a width equal to about half the spacing between the plants, particular attention being given to the area around the

plants. This weeding shall be carried out in early August. The third weeding in the current year's plantation shall be carried out in late December. If the weed growth after the second weeding is still heavy, the third weeding shall also be carried out in strips. Otherwise this weeding may be carried out only around the plants in a diameter of 1 ½ meters.

Soil working around the plants is a must at the time of the last weeding and shall be carried out invariably. Soil working shall not be done either when there is a monsoon down pour or when there is a long hot drought. Bamboo clumps those have not been killed in the burn shall be carefully watched and dealt with. All new shoots shall be repeatedly cut as low as possible. The planted seedlings or sprouts from the planted stumps shall be kept scrupulously free from creepers and climbers. Those shall be pulled out with their root stock at the time of each weeding. Thereafter it shall be the duty of this plantation Guard to free the shoots from creepers and climbers during his round of the plantation. This work may be carried out through the plantation watcher where one such is employed.

9.3. Manuring the Plantation

On degraded sites urban compost or farm yard manure wherever available, shall be added to the soil while refilling the pits. As regards artificial fertilizers the minerals required and dosage will vary from site to site. In most sites however, 50 grams of – patent mixtures like N.P.K. (2:2:11) shall be applied in two split doses one in September and the other in December. Artificial manure shall be applied to the plants with great care. This work shall be done only on a rainy day. The manure shall not come in direct contact with any part of the plant, particularly the roots. It is advisable to apply fertilizers in frequent small doses and not few large doses. Where watering is carried out soon after planting, fertilizers may be added to this water to make a dilute solution or suspension. This also may be done when the transplants are watered in the nursery just before being put out into the field. In the later case planting shall be carried out during light rain.

9.4. Mulching

Mulching improves soil climate to a very great extent. Among other things it controls, soil temperature, helps condensation, prevents runoff, soil erosion and loss of soil moisture through evaporation. Organic mulches enhance microbial activity, leading

to higher nutrient availability and encourage soil fauna which results in improvement of soil structure and thereby soil aeration. Mulching suppresses weeds therefore, mulching shall be attended to in all plantations. This operation is essential in dry climates. Mulching may be carried out at the time of each weeding, the weeds pulled out from around the planted seedlings forming the mulch. But it shall invariably be carried out with the last weeding.

Mulches can either be organic, natural inorganic or artificial. It will not be necessary to use the last kind of mulch in our conditions. In moist localities organic mulches, which will be available plentifully, shall be used. These may be branches, twigs, leaves, leaf litter, grass, weeds, etc. In dry localities mulching can be done by breaking 5-8 cm. of the top soil layer into clods, immediately after rains. Mulching effects can also be obtained by spreading murrum or flat stones around and plants in dry and boulder localities immediately before and after rains. In termite infested areas, particularly in dry localities, the soil around the plant shall be treated with Aldrine dust (5%) or an emulsified concentrate of the insecticide and the mulch shall be placed slightly away from the plants.

9.5. Watering

Plantations raised on sand shall be watered during the first and second dry seasons, after planting, each beginning with the 1st of January. Watering shall be done weekly once. Watering may have to start earlier than January, if rains have been deficient. Usually sand remains most till December. But if it becomes dry to a depth of 20-25 cm. the seedlings will require to be watered. Watering if required earlier than 1st of January, shall be carried out with the approval of the Circle level officers shall be created around the plants for watering.

9.6. Protection from grazing

All plantation shall be rigidly protected from grazing and browsing for five years. No fencing shall ordinarily be necessary for Teak, Eucalyptus species, Casuarina, Samania Saman, Terminalia species etc., but fencing shall be provided for other species. Particularly when these are raised under ‘Economic Plantation’ and ‘Plantation of Quick Growing Species”. Fencing shall be provided for all plantations raised for soil

conservation in the catchment areas, particularly in the dry zone (western districts) and as prescribed in the scheme concerned.

Wherever fencing is necessary, trench fencing shall ordinarily be provided. Trenches shall be 120 cm deep, 120 cm wide at the top and 60 cm. wide at the bottom unless otherwise prescribed in the scheme concerned. The earth dug out from the trench shall be heaped as a ridge on the inner side. Thorny species like Agave may be raised on this ridge as a further line of defence.

Wherever it is not possible to dig trenches and plenty of rubble is available, a dry rubble wall 1.2 m high may be erected, provided it is cheaper than wire fencing. Where absolutely, necessary a four strand two ply barbed wire fence 1.5 m high, with the first three strands at 15 cm, 45 cm and 90 cm from the ground, may be provided. The fence posts shall be properly treated. The portion that will remain under or near the ground shall be charred and the portion above smeared thoroughly with coaltar. The posts shall be 4 m apart. Where no fencing is provided and in areas near large cattle populations a plantation watcher may be provided for each 25 hectares of new plantation. This watcher shall also be responsible for watching one year and two year old plantations close to current one.

9.7. Fire Protection

All plantations shall be rigidly protected from fire. A fire line shall be cleared all around the plantation and burnt in the month of February. If necessary, clearing and burning of this line shall be repeated at the end of March. This second burning, where carried out, shall be done very carefully under strict supervision. Fire should not be allowed to enter the plantation. The wide of the fire line will depend on the situation and age of the plantation. The fire line adjacent to an existing forest or a plantation more than 5 years old shall be 5 meters. In all other cases it may be 3 meters. In addition to the above external fire lines, 1 ½ meters on either side of each roads, inspection path and section lines inside the plantation shall also be cleared and kept clean throughout the fire season.

CHAPTER-X

COST AND BUDGETING

10.1. Components of Plantation Cost

As described in the earlier Chapters, the following are the detailed items of work carried out in respect of a forest plantation.

A. Pre-planting operations

a) Identification, demarcation and survey of the plantation area,
b) Clear felling existing growth in the area,
c) Burning and re-burning of the felled Material,
d) Staking,
e) Diggings of pits and advance soil working.

B. Raising of planting stock in nurseries.

C. Sowing or planting including carriage of planting stock from the nurseries to the planting site.

D. Post planting care including.

a) Replacement of casualties,
b) Weeding,
c) Manuring and application of insecticides,
d) Mulching,
e) Watering,
f) Water and soil conservation measures,
g) Protection from grazing (Fencing),
h) Fire protection,
i) Laying out inspection paths, and
j) Providing sign boards, etc.,

E. Plantation sheds

Item B above, i.e., Raising of planting stock in nurseries itself covers a number of operations e.g:-

a) Selection of site, demarcation and survey,
b) Preparation of site including clearance, burning of felled material, Soil working, removal of stumps, roots, stones, etc.,

c) Fencing and providing sign boards, etc.
d) Laying, out beds,
e) Seed treatment and sowing,
f) Providing shades,
g) Preparing soil for containers,
h) Filling up containers and arranging those in beds,
i) Pricking out seedlings into containers,
j) Watering,
k) Weeding,
l) Shifting of containers and hardening off,
m) Manuring and application of insecticides,
n) Composting etc., and
o) Nursery sheds,

Besides the above operations involving usually, in manual labour, the following materials are required:-

A. Nursery-

i. Fence posts,
ii. Fencing farmyard e.g. barbed wire, woven wire, bamboo matting etc.,
iii. Seeds,
iv. Manure farmyard manure, compost, artificial fertilizers,
v. Insecticides,
vi. Containers e.g. polythene bags,
vii. Implements,
viii. Pumps,
ix. Sprayer for insecticides and artificial fertilizers like area and
x. Other miscellaneous materials e.g. rope, watering cans, empty tins, earthen jars, etc.

B. Plantation

i. Manure including artificial fertilizer
ii. Insecticides
iii. Fencing materials, etc.,
iv. Sprayers for fertilizers and insecticides, etc.,

All the materials listed above may not be necessary for all plantations. These will vary in number and intensity according to species, type of plantation, existing vegetation, soil, micro-climate including humidity, etc. Again post planting operations may have to be repeated for one or more years after the formation year according to the plantation time-table. Therefore a list of operations and materials those are actually necessary for the plantation concerned shall he carefully prepare before making an estimate of cost.

The cost on each item of work will vary from place to place. Cost on clear felling existing growth will deport on the nature and density of such growth. Cost on weeding will be more in moist areas than in dry areas. Similar will be the case with the other items of work. Therefore a detailed estimate of cost shall be prepared for each area.

10.2. Plantation cost

The overall cost of plantation per unit area for the entire state shall be as fixed by government from time to time on the recommendation of the Principal Chief Conservator of Forests. This also will be the overall average for each circle.

The Divisional Forest Officer shall prepare a detailed item wise estimate of cost for the plantation of his division and submit it to his Circle level Officers, who in turn shall examine these estimate in detail and approve the details and the total cost per unit for each of his Division, provided that the total estimate for his circle shall not exceed the amount arrived at as per the cost approved by the Government.

10.3. Plantation Project

When large scale plantations are taken up under any scheme a plantation project shall be prepared for every 10,000 hectares. The period of such a project shall ordinarily be 10 years and it shall be executed by one Social Forestry Division with an annual target of 1,000 hectares of plantation.

The project report shall include;

i. The back ground.
ii. A statement of the area to be covered,
iii. Technical details, and
iv. An estimate of cost which shall include.

a) Cost of plantation with a detailed analysis of such cost,
b) Cost of buildings and their maintenance,
c) Cost of equipments including vehicles.
d) Cost of salaries, and
e) Office and travel expenses,

Projects also may be smaller in size than as indicated above, particularly when the work is to be carried out on behalf of another department, agency, corporate body, etc. The project report in these cases also shall contain all details as per the proceeding paragraph. In these cases the duration of projects may be less than 10 years.

When a Social Forestry Division is specially created to execute a project on behalf of another department, agency or corporate body, the entire, cost on salary, contingencies, tools and plants, etc., shall be borne by the said Department, agency or corporate body. Besides, pensionary charges at the rate of 1 percent of the cost of work shall also be charged to the department, Agency or Corporate body.

When a Social Forestry Division is engaged on a project executed on behalf of another Department, Agency or Corporate body, for which they do not provide any expenditure on staff, etc., departmental charges at the rate of 16 percent of the cost of work shall be included in the project estimate and recovered from the Department, Agency or Corporate body.

10.4. Annual Budget

The Annual Budget for plantations shall cover the following items of work-

i. Post planting operation in the 3rd year,
ii. Post planting operation in the 2nd year,
iii. Balance pre-planting operations for the current year's plantation,
iv. Balance nursery operations for the current year's plantation,
v. Planting during the current year including post planting operation in the year of formation.
vi. Nursery for the plantations to be carried to be carried out in the following year, and
vii. Pre-planting operation for the plantations to be carried out.

The Divisional Forest Officer shall submit his budget for plantation works for the following year well in advance. The Conservator of Forests shall submit the estimates for his circle to the Principal Chief Conservator of Forests immediately. These dates may be modified by the Conservator of Forests and the Principal Chief Conservator of Forests as the case may be.

CHAPTER XI

MISCELLANEOUS REGULATIONS

11.1. Plantation Register

A permanent leather bound register of all plantations carried out in a Range and in a division shall be maintained by the concerned Range and Divisional Forest Officer in prescribed form. A map min the scale 1:15000 (4=1 mile approx) showing precise boundaries shall be affixed against each entry in the register. In case the plantation is carried out according to the prescription of an approved working plan or scheme a reference to the appropriate paragraph of the plan or scheme shall be sufficient.

If a plantation is carried out in an area outside the Reserved Forests a separate register with maps shall be maintained for such plantations besides the one prescribed above. In case a Social forestry Division or any division other than the Territorial division carries out any such plantation, the Divisional Forest Officer of the former division shall, before actual plantation is carried out, send information's in respect of each such plantation in the form above along with a map of the area to be concerned Territorial D.F.O. with copies to his Circle level Officers. Territorial District Forest Office on receipt of such information from the Social Forestry Division or other District Forest Officer shall enter the information in the concerned register maintained for his division.

11.2. Nursery Journal

A journal for each nursery whether permanent or temporary shall be maintained in a prescribed form. A detailed sketch map of the nursery in scale 1:400 (16'=1mile Approx.) shall be affixed to each such journal showing all important features of the nursery. The detailed information's as required in the prescribed form shall be scrupulously and precisely given in the journal. The journal shall be available at the nursery with a copy each with the Range Officer and the Divisional Forest Officer.

11.3. Plantation Journal

A Journal for each plantation shall be maintained in the prescribed form. A sketch map in Scale 1:1,000 (4*1 mile approx) shall be affixed at the appropriate space. The detailed information's as required in the prescribed form shall be scrupulously and precisely given in the journal. The journal shall be kept with the Forester in charge of the

plantation with a copy each with the Range Officer and the Divisional Forest Officer. The officer who has the charge of the nursery or the plantation journal shall post the journals up-to-date. He shall invariably produce the journal before a higher authority when such an authority visits the nursery or plantation and obtain his remarks. These remarks shall be posted in the other copies of the registers concerned as early as possible. The other copies shall also be posted up-to-date with reference to the journal in the field. The above journals shall be produced before the Divisional Forest Officer or the Circle level Officers at the time of office inspection.

Site Specific Plantations:

(a) Afforestation in Coastal Belt

This scheme is undertaken for raising plantation along the sea-coast as an anti-cyclone measure with a view to protecting life and land of the people from the periodic ravages of cyclone. This is complementary to the scheme for afforestation for soil conservation on coastal and dunes. The scheme will be executed over a 1 k.m. wide strip along the sea coast in all the coastal districts which will be covered under the scheme, Afforestation for Soil Conservation in Coastal sand Dunes. Only lands which can be spared by the Revenue Authorities can be planted under this scheme.

(b) Farm Forestry

This scheme has been taken up for raising plantation of suitable firewood species in small patches of land available near the village, namely lands notified for reservation under section 4 of the Tamil Nadu Forest Act. Government lands situated on road sides, and canal banks, barren, semi barren lands, hills and hillocks which can be planted with suitable species; for supplying fuel-wood to the villagers where there is dearth of firewood. For road side and canal side lands, permission would have to be obtained from the competent Revenue Authority before taking up plantation. Such plantations can also be taken up in Government waste lands which are unfit for cultivation or for homestead purposes. Such land selected for the purpose should be free from any encroachments.

(c) Development of Non Timber Forest Produce

Plantation of Non Timber Forest Produce is to be carried on under this scheme. These plantation may be raised mostly inside the reserved forests and lands already

notified for reservation under section 4 of the Forest Act. Lands which are earmarked in land records as village forest can also be used for this purpose. Medicinal plants of economic value can also be planted under this scheme.

(d) Afforestation for Soil Conservation in Coastal Sand dune

This scheme is complementary to the scheme "Afforestation in Coastal Belt" Plantation under the scheme may be taken up on Government lands within 1 K.M. of sea shore that can be spared by Revenue Authorities in all the Coastal District of Tamil Nadu.

(e) Social Forestry – Mixed Plantation

The scheme aims at raising mixed plantation of timber and firewood species to meet the requirement of the people. This plantation may be taken up on hills, hillocks and road sides and canal side lands only or lands notified for reservation under section 4 of the Forest Act. No other land should be used for the purpose.

(f) Reforestation of degraded forests

The scheme aims at rehabilitating depleted reserved forests and reserved lands to meet the requirement of small timber and fire-wood to the rural people with priority in scarcity areas. Plantation will be taken up in reserved forests and reserved lands within the meaning of the Forest Act and on lands notified for reservation under section 4 of the Forest Act and lands earmarked in the land records as village forests.

Types of plantations and its operating procedures:

Artificial Regeneration

1. Railway Line Plantations

Plantations raised along the railway lines are called railway line plantation or linear plantations.

Objectives

The objectives of planting along railway lines are,

i. Stabilization of railway track and protection of railway track against erosion.
ii. Optimum utilization of the land for tree cultivation to produce products needed by the local people.
iii. Checking the illicit encroachment on this land.
iv. Incidental shelterbelt effect of these plantations and
v. Checking of the shifting sand in desert areas getting to the railway tracks.

Orientation

- The safety of the railway traffic, the nature of the land available for planting, the position of the telephone and electric lines, etc. should be considered while planting along the railway lines.
- From the point of view of the safety, the first row of trees should not be planted very close to the railway track.
- The first row of trees is recommended to be planted at a distance of about 7.5 m from the centre of the track.
- Further, the trees in the first row should be such that it may not attain a height more than their distance from the railway track so that in the events of the wind throw the tree tops may not reach the railway line and create traffic hazard.
- The inner side of the curves should not be planted to ensure clear visibility of the track.
- On either side of an unmanned level crossing a length of about 100 m should be left unplanted. No planting should be done under the telephone line while planning orientation of tree lines.

Spacing

- The spacing between the lines and between the tree in a line may be 5 m, 3 m or 2 m depending upon the species to be planted, the fertility of the site and the objects of management.
- Commercial timber species to be harvested at comparatively longer rotations of 30 years or more may be planted at 5m X 5m spacing. Fast growing species like Eucalyptus may be planted at close spacing of 1.5 m X 1.5 m or 2 m X 1.5 m.

Planting

For railway line planting tall seedlings of 3 – 6 ft height are preferred. The pit size should be 60 cm X 60 cm X 45 cm. The pits have to filled with 2 kgs of farm yard manure, 100 grams of neem cake and 50 grams of DAP as basal application. After planting the seedlings have to be irrigated daily till their establishment using tractor mounted tankers. Monsoon planting is preferred for this purpose.

Choice of Species

- The choice of species depends on climatic and site factors and the products required to be produced from such areas.
- Ornamental trees should be planted near the towns, railway stations, road crossings and places of scenic beauty or of tourist interest.
- Trees with brittle stems or branches should not planted especially in the first row. Wind firmness is a desirable character for the species for railway line plantation.
- The plantations along the railway lines are prone to accidental fires originating from engine spark especially in areas infested with tall grass or bush growth The species to be planted in such areas should be able to resists such accidental fires.
- Examples: *Acacia, Bauhinia, Casuarina, Dalbergia, Eucalyptus, Pungam, Neem, Peltophorum, Erythrina, Butea, Polyalthia* etc.

2. Canal bank plantations

Plantations raised along canal banks to augment the aesthetic value and stabilizing the canals are called canal bank plantations.

Objectives

The objectives of canal bank plantations are,

i. Stabilization of canal banks against erosion.
ii. Checking of shifting sand getting into the canal in desert areas.
iii. Utilization of the available land for tree cultivation and production of tree products, particularly fuel wood and small timber for local people.
iv. Provision of comfort to travelers using canal side road
v. Checking water logging in strips along canals and in adjoining areas.
vi. Shelterbelt effect on adjoining areas.
vii. Improvement of aesthetics in the area.

Orientation

The number of rows to be planted and the position of the first row depend upon the width and nature of the land available for planting along the side of the canal. The first row of trees is generally planted about 7.5 m from the berm of the canals in the case of multiple row planting. Subsequent rows are spaced at 5m or 3m or 2m depending upon the species to be planted and the objects of management of such canal bank plantations.

Spacing

- The spacing between the trees in a line depend upon the species selected for planning and the desired end product. The first row of trees should preferably be of shade trees.
- Ornamental trees may be planted in the first row or in groves near towns, villages, rest houses, picnic spots, places of tourist interest and crossings of the roads.
- A spacing of 2m x 2m and 3m x 3m are preferred for most species.

Planting

Planting in canal banks may be carried out during non-monsoon season or during summer season which will ensure early establishment and the seedlings will be adaptable during monsoon season with excess water flow. Deep planting is preferred for canal bank establishment. A pit size of 45 - 60 cm3 is preferred.

Choice of Species

- For planting in the first row, the trees with a strong taproot system should be preferred.
- For subsequent lines the species may be selected to provide many tree products needed by the local people. The choice of species also depends on climate, site conditions, object of planting, etc. In places where the plantation strips suffer from water logging, species tolerant of water logging should be selected.
  Example : Teak and *Dalbergia sissoo* as in Tanjore canal bank plantation

3. Tank Bed Plantations

Significance of Tank Bed

1. Tanks are rainwater collection community irrigation reservoirs.
2. The size of tanks range between one and several hundred hectares and are designed to supply irrigation water to a small agricultural community.
3. These tanks are usually situated at the edge of a village and have the appearance of a large natural depression partly filled with water.
4. Most tanks are completely empty during the driest months of the year and full for 15-30 days at the peak of the rainy season so that the whole area of the bed is submerged.
5. As water is let out during the dry season to irrigate the surrounding farmland, the level in the tank drops and an increasingly large area of foreshore is exposed.
6. The tank foreshore consists of the gradually sloping sides of the tank. In many villages, these areas of temporarily exposed ground are the only substantial areas of common land on which fuel wood plantation might be established.
7. Afforestation of tank foreshores is the largest component of the afforestation of communal lands project.
8. Most tank foreshores are productive sites because of the availability of moisture. Regular deposition of silt helps to maintain soil fertility.
9. The proximity of each tank foreshore to a village is another advantage, both labour and consumer are nearby.
10. At the same time, the proximity to village increases the risk of damages by human being and livestock and consequently village co-operation and community involvement are essential for the creation of successful plantations and their

proper protection and maintenance. Further, it is a high visibility activity with good demonstration value.

Objectives

(i) To reduce the pressure on the forest and produce fuel and fodder for village community.

(ii) To convert the wastelands into economically productive lands,

(iii) To create financial resources for panchayats to take up welfare measures for community purpose.

(iv) To make village panchayats also shareholders in community forestry.

Orientation

The species can be planted as block model as an area of tank bed runs from one ha to several ha. It can be treated as irrigated land for all plantation establishment purposes.

Spacing

The spacing adapted for tank bed plantation may vary from 2m × 2m to 3m × 3m.

Planting

Planting in tank beds may be carried out during summer season devoid of water. The pit size of 30 cm3 is preferred along with planting seedlings with 2 – 3 feet height.

Choice of Species

- The main species being used for planting on tank foreshores is *Acacia nilotica*. It has the essential characteristics of being capable of surviving prolonged submersion and periodic flooding.
- It grows quickly and produces an excellent fuel wood. It is one of the most important tree species of Social Forestry Programmes in India. It has a very wide distribution right from the semi arid regions of Rajasthan to Tamil Nadu and in eastern most part of Bihar and Orissa.
- It also grows in riverain beds. Every part of the tree is used in one or the other way by the villagers.

Example : *Acacia nilotica* in tank beds of Tamil Nadu.

4. Roadside Plantations

The plantations established along the roads with the primary objective of providing much needed shade to the travelers, particularly during the summer months are called roadside plantations.

Objectives

The roadside plantations are required to meet the following objectives,

(i) Provision of comfort to the travellers

(ii) Aesthetics and landscape improvement

(iii) Stabilization of roadsides and checking of the shifting of sand to the road from adjoining areas in the desert

(iv) Improvement of ecological conditions

(v) Maximization of the productivity of the site to meet the requirement of the local people.

Design of Roadside Planting

- The planting systems usually followed are of the following types : viz., balanced line, unbalanced continuous line, unbalanced discontinuous line, sporadic system and parkway system. Of these, the first two are most widely practiced.
- The balance line system produced with continuous green wall of uniform size trees. Unbalanced continuous line produced as a result of alternating avenues of different species interspersed by ornamental trees should be more desirable.
- It should also be ensured that the avenues should not shut out of vie the spots of scenic beauty, important land marks and places of tourist interest, lakes and canals, beautiful hill or country features and snow peaks, etc. At some selected spots the parking system of planting may be adopted to develop picnic spots or resting places for the travelers.

Orientation

- The position of the first row of trees and the number of rows to be planted on either side of the road depend upon the category of the road. Single row planting is normally done along village roads and other district roads while more than one row can be planted in the case of highway roads.

- In the case of multiple row planting the first row is generally of shade and/ or ornamental trees and the remaining rows may be planted with fast growing trees on short rotation to produce tree products to meet the requirement of the local people.
- The spacing of the first and also of the subsequent rows may need adjustment with respect to the position of telephone or electric lines or drains or other structures along the road.
- Trees should not be planted under electric or telephone lines. Bushes and short ornamental trees can, however, be planted in such places. Trees in the first row are normally planted at least 6m away from the electric or telephone line.

Spacing

- The spacing may vary from high density to low density i.e. 1m × 1m to 5m × 5m depending on the space availability and based on the choice of species.
- The spacing between the trees in the first row of shade or ornamental trees should be wider than that between the trees in the remaining rows. The crown spread of the species to be planted determines the spacing.
- For shade trees normally having broad crowns a spacing of 12 to 14 m is suggested. While too wide spacing may defeat the object of providing shade to the travelers, too close spacing may adversely affect the visibility. Planting of shade trees in the first row at wider spacing may result in patchy avenues as a result of the mortality. It may, therefore, be desirable to keep the initial planting closer in order to provide for mortality and selection of better trees for final retention.

Planting

- Planting should be done during monsoon season preferably from September to December. Planting of tall seedlings of 6 - 8 ft is considered ideal for planting along the roads. Deep planting by digging 60 cm3 pits is essential for good survival and establishment. Watering should be mandatory till their establishment.
- Planting at about half the desired spacing is, therefore advocated and when the crowns of trees begin to touch, less promising ones should be thinned to leave the remaining trees at the desired spacing. Too close spacing along hill roads particularly on the curves is dangerous.

- The trees should not obstruct the view at places where the pedestrians or domestic animals might usually be crossing the road near the villages.

Choice of Species

- The choice of species is broadly determined by the climate, site conditions, object of planting, intensity of damaging agents, etc.
- The site conditions vary depending upon the soul and the modifications brought about in it in the course of the construction of the road.
- Removal of topsoil for road construction leaves only subsoil and also creates waterlogging conditions in many areas as the level of the roadside strip becomes lower than the adjoining land and road and at many places the construction of the road obstructs natural channels of drainage.
- Choice of the species has to be kept in view all such modifications brought about in the site. Further, the choice of species is determined by the objectives of avenue planting whether for shade, ornamental or production of tree products needed to meet the local demand.

Example : *Ailanthus excelsa, Albizia lebbeck, Albizia procera, Anthocephalus chinensis, Azadirachta indica, Dalbergia sissoo, Ficus glomerata, Kigelia pinnata, Madhuca longifolia, Mangifera indica, Melia azedarach, Mimusops elengi, Peltophorum pterocarpum, Pithecolobium saman, Pongamia pinnata, Samanea saman, Spathodea campanulata, Syzygium cumini, Tamarindus indica, Terminalia arjuna, Terminalia catappa.*

5. Bamboo Plantations:

Bamboo is considered as “poor man’s timber”. India is the second largest producer in the world. Yearly around 3.23 million tonnes of bamboo is being produced in India. Bamboos are most integrated part of Asian culture and used as a substitute to woods.

Objectives

- To increase the area under bamboo plantation in non-forest, government and private lands.
- To supplement farmers income and contribute towards resilience to climate change.
- Bamboo can also arrest the pace of land degradation. Since 30% of land in india comes under degraded category

- Bamboo absorbs corbon di oxide and releases 35% more oxygen in to atmosphere than an equivalent stand of hardwood trees.

Orientation

Bamboo can grow well on moist soil, but deep porous fertile soil with high moisture content and a PH of 5.5 is preferable. The planting hole should be positioned in a north south orientation. This will provide an optimal distribution of sunlight to all plants.

Planting

Planting should be coinciding with the start of rainy season.

Spacing

For commercial bamboo timber plantations staggered planting in a Triangular grid is recommended (Spacing 5m× 5m× 5m).

For general bamboo plantations spacing should be 5×4 m.
if the objective is to plant bamboo for erosion control along river banks the spacing can be 3×3 or 2.5×2.5 m

Number of plants per acre is 200.

Pits

For general purpose, as a thumb rule the larger the pit better the growth of rhizomes offsets and rhizomes should planted in pits measuring 60×60×60 cm to 100×100×100 cm.

For seedlings and branch cuttings the size can be reduced to 30×30×30 cm to 45×45×45 cm.

Choice of species

Dendrocalamus giganteus, Dendrocalamus strictus, Bambusa bambos, Bambusa vulgaris.

ANNEXURE - 1

COST NORM FOR RAISING 1000 SEEDLINGS WITH MAINTENANCE UPTO THREE YEARS

COST NORM INCLUDES 20% CULLING COST (i.e. CAUSALITY IN NURSERY STOCK)

Sl. No.	Item of work	Unit	Unit cost	No. / Quantity	Labour Cost (Rs.)	Material Cost (Rs.)	Total Cost (Rs.)
A. COST FOR 8 MONTHS OLD SEEDLINGS							
1	Cost of poly pot (6"X10"X225 gauge)	Kg	135	4.3	0	577	577
2	Potting mixture (Soil, Sand and CDM in rate of 2:1:1)						
	(i) Soil @ Rs.8/Cft	cft	8	35	0	280	280
	(ii) Sand @ Rs.10/Cft	cft	10	16	0	160	160
	(iii) FYM @ Rs.14/cft	cft	14	17	0	238	238
	(iv) Insecticide (Thimet) - 2 Kg @ Rs.70/Kg	kg	70	2	0	140	140
3	Preparation of potting mixture including pulverization and straining	MD	426.4	2	852.8	0	852.8
4	Filling and setting	MD	426.4	2	852.8	0	852.8
5	Collection of seed, grading and treatment	MD	426.4	2	852.8	0	852.8
6	Preparation of germination bed, dibbling / transplanting and provision of shed	MD	426.4	2	852.8	100	952.8
7	Watering (December to March)	MD	426.4	12.5	5330	0	5330
8	Maintenance of Nursery including Fencing	MD	426.4	8	3411.2	300	3711.2
9	Watering for 3 months (April to June)	MD	426.4	9	3837.6	0	3837.6
10	Sorting Weeding, Grading and resetting over one year period	MD	426.4	3	1279.2	0	1279.2

Sl. No.	Item of work	Unit	Unit cost	No. / Quantity	Labour Cost (Rs.)	Material Cost (Rs.)	Total Cost (Rs.)
11	Application of insecticides	MD	426.4	0.2	85.28	0	85.28
12	Contingencies	No.	0	0	0	170	170
	Total				**17354.48**	**1965**	**19319.5**
B. FIRST YEAR OPERATION							
1	Watering (October to March)	MD	426.4	19	8101.6	0	8101.6
2	Sorting Weeding, Grading and resetting over one year period	MD	426.4	9	3837.6	0	3837.6
3	Application of insecticides	MD	426.4	0.2	85.28	30	115.28
4	Contingencies	No.	0.25	1000	250	250	500
	Total				**12274.48**	**280**	**12554.5**
C. SECOND YEAR OPERATION							
1	Poly pot (12"X16"X300 gauge)	Kg	139	16.66	0	2315.74	2315.74
2	Potting mixture						
	(i) Soil @ 8/cft	cft	8	112	0	896	896
	(ii) Sand @ Rs.10/Cft	cft	12	56	0	672	672
	(iii) CDM @ Rs.14/cft	cft	16	56	0	896	896
	(iv) Insecticide (Thimet) - 2 Kg @ Rs.70/Kg	Kg	70	2	0	140	140
3	Preparation of potting mixture including pulverization and straining	MD	426.4	2	852.8	0	852.8
4	Filling of polythene bags including repotting and setting	MD	426.4	25	10660	0	10660
5	Watering for 9 months (April to June & October to March)	MD	426.4	28	11939.2	0	11939.2
6	Weeding, shifting and grading through out the year	MD	426.4	2	852.8	0	852.8
7	Application of insecticides	MD	426.4	0.2	85.28	0	85.28
8	Contingencies	No.	0.5	1000		500	500
	Total				**24390**	**5420**	**29810**

Sl. No.	Item of work	Unit	Unit cost	No. / Quantity	Labour Cost (Rs.)	Material Cost (Rs.)	Total Cost (Rs.)
D. THIRD YEAR OPERATION							
1	Watering etc for 3 months (April to June)	MD	426.4	9	3837.6	0	3837.6
2	Weeding, shifting and grading through out the year	MD	426.4	6	2558.4	0	2558.4
3	Application of insecticides	MD	426.4	0.2	85.28	30	85.28
4	Contingencies	No.	0.5	1000		500	500
	Total				**6481**	**530**	**6981**
ABSTRACT							
A	0th year operation				17354	1965	19319
B	1st year operation				12274	280	12554
C	2nd year operation				24390	5420	29810
D	3rd year operation				6481	530	6981
	Total				**60500**	**8195**	**68665**

Wages Rate : Rs. 426.40/- per day

ANNEXURE - II

PER HECTARE COST NORM FOR BLOCK PLANTAITON @1600 PLANTS / WAGE RATE Rs.426.40/- DAY

Sl. No.	Item of work	Person Days	Labour Cost (Rs.)	Material Cost (Rs.)	Total Cost (Rs.)
0TH YEAR (ADVANCE WORK) PRE-PLANTING OPERATION					
1	Survey, demarcation and pillar posting	2	852.8	0	852.8
2	Site preparation	8	3411.2	0	3411.2
3	Alignment and stacking of pits	2	852.8	0	852.8
4	Digging of pits (30 cm cube)	40	17056	0	17056
5	Nursery cost (8 months old seedling) part	80	34112	6000	40112
	Total	**132**	**56284.8**	**6000**	**62285**
1ST YEAR / PLANTING YEAR					
6	Nursery cost (8 months old seedling) balance	16	6822.4	300	7122.4
7	Carriage & Planting, CR, manuring, insecticide appln.	21	8954.4	0	8954.4
8	Cost of insecticide and fertilizer	21	0	3150	3150
9	1st weeding (Complete weeding)	7	2984.8	0	2984.8
10	Manuring	5	2132	0	2132
11	2nd weeding (Complete weeding)	5	2132	0	2132
12	Soil working (50 Cms, Radius arouond plants)	7	2984.8	0	2984.8
13	Fire line tracing & inspection path	3	1279.2	0	1279.2
14	Soil conservation measures in the form of staggered tranches of 2m.L X 50 cm. D	10	4264	0	4264
15	Watch & Ward	7	2984.8	0	2984.8
	Total	**102**	**34538.4**	**3450**	**37988**
2ND YEAR MAINTENACNE					
16	Causility replacement with cursery cost	12	5116.8	0	5116.8
17	Weeding (Complete weeding)	6	2558.4	0	2558.4
18	Application of fertilizer	4	1705.6	0	1705.6
19	Cost of fertilizer	12	0	1800	1800

Sl. No.	Item of work	Person Days	Labour Cost (Rs.)	Material Cost (Rs.)	Total Cost (Rs.)
20	Soil working (50 cms, Radius around plants)	7	2984.8	0	2984.8
21	Fire line tracing (2 m. wide fire line over 400 m long)	3	1279.2	0	1279.2
22	Watch & Ward	15	6396	0	6396
	Total	**59**	**20040.8**	**1800**	**21840.8**
3RD YEAR MAINTENANCE					
23	Weeding and application of fertilizer	7	2984.8	0	2984.8
24	Cost of fertilizer	12	0	1800	1800
25	Soil working (50 cms, Radius around plants)	7	2984.8	0	2984.8
26	Fire line tracing (2 m. wide fire line over 400 m long) Prunning	3	1279.2	0	1279.2
27	Watch & Ward	15	6396	0	6396
	Total	**44**	**13644.8**	**1800**	**15444.8**
4TH YEAR MAINTENANCE					
28	Fire line tracing (2 m. wide fire line over 400 m long) Prunning	3	1279.2	0	1279.2
29	Watch & Ward	15	6396	0	6396
	Total	**18**	**7675.2**	**0**	**7675.2**

ABSTRACT

Year	No. of Person Days	Cost of Labour	Cost of Material	Total Cost (Rs)
0th year	132	56285	6000	62285
1st year	102	34538	3450	37988
2nd year	59	20041	1800	21841
3rd year	44	13645	1800	15445
4th year	18	7675	0	7675
Total	**355**	**132184**	**13050**	**145234**

ANNEXURE - III / 1

PER HECTARE COST NORM FOR AIDED NATURAL REGENERATION (ANR) 200 PLANTS / HA / WAGE RATE Rs. 426.40 / DAY

Sl. No.	Item of work	Person Days	Labour Cost (Rs.)	Material Cost (Rs.)	Total Cost (Rs.)
0TH YEAR					
1	Survey, demarcation and pillar posting, GPS Reading with mapping	2	853	0	853
2	Site preparation	2	853	0	853
3	Silvicultural Operation including clearance of weed, climber cutting, high stump cutting, singling of shoots	5	2132	0	2132
4	Raising Nursery @ 220 seedling / ha. (including 10% cauality replacement) and wach & ward (part-1)	8	3411	1500	4911
5	Contingency and Unforeseen Expenditures	0	0	500	500
	Sub Total	**17**	**7249**	**2000**	**9249**
1ST YEAR					
1	Maintenance of Nursery (Balance)	4	1706	0	1706
2	Pitting 30 cm cube size	7	2985	0	2985
3	Carriage and planting including causality replacement	4.5	1919	0	1919
4	Complete weeding, soil working, manuring	5.5	2345	0	2345
5	Cost of Vermi compost and insecticide for plantation	0	0	1000	1000
6	Cost of Chemical fertilizer	0	0	500	500
7	Fireline tracing and inspection path	3	1279	0	1279
8	Silvicultural operation involving clearance of weeds, cutting of climbers, singling of shoots etc.,	15	6396	0	6396

Sl. No.	Item of work	Person Days	Labour Cost (Rs.)	Material Cost (Rs.)	Total Cost (Rs.)
9	Soil conservation measures	20	8528	0	8528
10	Watch & Ward	8	3411	0	3411
11	Contingency and Unforeseen Expenditures	0	0	300	300
	Sub Total	**67**	**28569**	**1800**	**30369**
2ND YEAR					
1	Casuality Replacement including cost of seeding, carrage and planting	2	853	0	853
2	Complete weeding and prunning	2	853	0	853
3	Soil working and manuring	2	853	0	853
4	Cost of fertilizer and insecticide	0	0	500	500
5	Fireline tracing and inspection path	1	426	0	426
6	Soil conservation measures	8	3411	0	3411
7	Watch & Ward (Whole year)	8	3411	0	3411
8	Contingency and Unforeseen Expenditures	0	0	150	150
	Sub Total	**23**	**9807**	**650**	**10457**
3RD YEAR					
1	Complete weeding and prunning	1	426	0	426
2	Soil working and manuring	1	426	0	426
3	Fireline tracing and inspection path	1	426	0	426
4	Watch & Ward (Whole year)	8	3411	0	3411
5	Contingency and Unforeseen Expenditures	0	0	0	0
	Sub Total	**11**	**4690**	**0**	**4690**
4TH YEAR					
1	Fireline tracing and inspection path	1	426	0	426
2	Prunning, Watch & Ward	2	853	0	853
	Sub Total	**3**	**1279**	**0**	**1279**

Sl. No.	Item of work	Person Days	Labour Cost (Rs.)	Material Cost (Rs.)	Total Cost (Rs.)
ABSTRACT					
1	0th year	17	7249	2000	9248.8
2	1st year	67	28569	1800	30369
3	2nd year	23	9807	650	10457
4	3rd year	11	4690	0	4690
5	4th year	3	1279	0	1279
Total		**121**	**51594**	**4450**	**56044**

ANNEXURE - III / 2

PER HECTARE COST NORM FOR AIDED NATURAL REGENERATION (ANR) 400 PLANTS / HA / WAGE RATE Rs. 426.40 / DAY

Sl. No.	Item of work	Person Days	Labour Cost (Rs.)	Material Cost (Rs.)	Total Cost (Rs.)
0TH YEAR					
1	Survey, demarcation and pillar posting, GPS Reading with mapping	2	852.8	0	852.8
2	Site preparation	2	852.8	0	852.8
3	Silvicultural Operation including clearance of weed, climber cutting, high stump cutting, singling of shoots	5	2132	0	2132
4	Raising Nursery @ 440 seedling / ha. (including 10% cauality replacement) and wach & ward (part-1)	16	6822.4	3000	9822.4
5	Contingency and Unforeseen Expenditures	1	0	500	500
	Sub Total	**26**	**10660**	**3500**	**14160**
1ST YEAR					
1	Maintenance of Nursery (Balance)	8	3411	0	3411
2	Pitting 30 cm cube size	14	5970	0	5970
3	Carriage and planting including causality replacement	9	3838	0	3838
4	Complete weeding, soil working, manuring	11	4690	0	4690
5	Cost of Vermi compost and insecticide for plantation	6	2558	2000	4558
6	Cost of Chemical fertilizer	2	853	1000	1853
7	Fireline tracing and inspection path	3	1279	0	1279
8	Silvicultural operation involving clearance of weeds, cutting of climbers, singling of shoots etc.,	15	6396	0	6396

Sl. No.	Item of work	Person Days	Labour Cost (Rs.)	Material Cost (Rs.)	Total Cost (Rs.)
9	Soil conservation measures	20	8528	0	8528
10	Watch & Ward	8	3411	0	3411
11	Contingency and Unforeseen Expenditures	2		300	300
	Sub Total	**98**	**40934**	**3300**	**44234**
2ND YEAR					
1	Casuality Replacement including cost of seeding, carrage and planting	4	1706	0	1706
2	Complete weeding and prunning	4	1706	0	1706
3	Soil working and manuring	4	1706	0	1706
4	Cost of fertilizer and insecticide	2	853	1000	1853
5	Fireline tracing and inspection path	1	426	0	426
6	Soil conservation measures	8	3411	0	3411
7	Watch & Ward (Whole year)	8	3411	0	3411
8	Contingency and Unforeseen Expenditures	1	0	150	150
	Sub Total	**32**	**13218**	**1150**	**14368**
3RD YEAR					
1	Complete weeding and prunning	2	853	0	853
2	Soil working	2	853	0	853
3	Fireline tracing and inspection path	1	426	0	426
4	Watch & Ward (Whole year)	8	3411	0	3411
	Sub Total	**13**	**5543**	**0**	**5543**
4TH YEAR					
1	Fireline tracing and inspection path	1	426	0	426
2	Prunning, Watch & Ward	2	853	0	853
	Sub Total	**3**	**1279**	**0**	**1279**

ABSTRACT					
Year		No. of Person Days	Cost of Labour	Cost of Material	Total Cost (Rs)
1	0th year	26	10660	3500	14160
2	1st year	98	40934	3300	44234
3	2nd year	32	13218	1150	14368
4	3rd year	13	5543	0	5543
5	4th year	3	1279	0	1279
Total		**172**	**71635**	**7950**	**79585**

ANNEXURE - III / 3

PER HECTARE COST NORM FOR AIDED NATURAL REGENERATION (ANR) 600 PLANTS / HA / WAGE RATE Rs. 426.40 / DAY

Sl. No.	Item of work	Person Days	Labour Cost (Rs.)	Material Cost (Rs.)	Total Cost (Rs.)
0TH YEAR					
1	Survey, demarcation and pillar posting, GPS Reading with mapping	2	853	0	853
2	Site preparation	2	853	0	853
3	Silvicultural Operation including clearance of weed, climber cutting, high stump cutting, singling of shoots	5	2132	0	2132
4	Raising Nursery @ 660 seedling / ha. (including 10% cauality replacement) and wach & ward (part-1)	24	10234	4500	14734
5	Contingency and Unforeseen Expenditures	1		500	500
	Sub Total	**34**	**14071**	**5000**	**19071**
1ST YEAR					
1	Maintenance of Nursery (Balance)	12	5117	0	5117
2	Pitting 30 cm cube size	21	8954	0	8954
3	Carriage and planting including causality replacement	13.5	5756	0	5756
4	Complete weeding, soil working, manuring	16.5	7036	0	7036
5	Cost of Vermi compost and insecticide for plantation	9	3838	3000	6838
6	Cost of Chemical fertilizer		0	1500	1500
7	Fireline tracing and inspection path	3	1279	0	1279
8	Silvicultural operation involving clearance of weeds, cutting of climbers, singling of shoots etc.,	15	6396	0	6396

Sl. No.	Item of work	Person Days	Labour Cost (Rs.)	Material Cost (Rs.)	Total Cost (Rs.)
9	Soil conservation measures	20	8528	0	8528
10	Watch & Ward	8	3411	0	3411
11	Contingency and Unforeseen Expenditures	2	0	300	300
	Sub Total	**120**	**50315.2**	**4800**	**55115.2**
2ND YEAR					
1	Casuality Replacement including cost of seeding, carrage and planting	6	2558	0	2558
2	Complete weeding and prunning	6	2558	0	2558
3	Soil working and manuring	6	2558	0	2558
4	Cost of fertilizer and insecticide	3	1279	150	1429
5	Fireline tracing and inspection path	1	426	0	426
6	Soil conservation measures	8	3411	0	3411
7	Watch & Ward (Whole year)	8	3411	0	3411
8	Contingency and Unforeseen Expenditures	1	0	150	150
	Sub Total	**39**	**16203**	**300**	**16503**
3RD YEAR					
1	Complete weeding and prunning	3	1279	0	1279
2	Soil working	3	1279	0	1279
3	Fireline tracing and inspection path	1	426	0	426
4	Watch & Ward (Whole year)	8	3411	0	3411
	Sub Total	**15**	**6396**	**0**	**6396**
4TH YEAR					
1	Fireline tracing and inspection path	1	426	0	426
2	Prunning, Watch & Ward	2	853	0	853
	Sub Total	**3**	**1279**	**0**	**1279**

ABSTRACT					
Year		No. of Person Days	Cost of labour	Material	Total Cost (Rs)
1	0th year	34	14071	5000	19071
2	1st year	120	50315	4800	55115
3	2nd year	39	16203	300	16503
4	3rd year	15	6396	0	6396
5	4th year	3	1279	0	1279
Total		**211**	**88265**	**10100**	**98365**

ANNEXURE - III / 4

PER HECTARE COST NORM FOR AIDED NATURAL REGENERATION (ANR) 800 PLANTS / HA / WAGE RATE Rs. 426.40 / DAY

Sl. No.	Item of work	Person Days	Labour Cost (Rs.)	Material Cost (Rs.)	Total Cost (Rs.)
0TH YEAR					
1	Survey, demarcation and pillar posting, GPS Reading with mapping	2	853	0	853
2	Site preparation	2	853	0	853
3	Silvicultural Operation including clearance of weed, climber cutting, high stump cutting, singling of shoots	5	2132	0	2132
4	Raising Nursery @ 880 seedling / ha. (including 10% cauality replacement) and wach & ward (part-1)	32	13645	6000	19645
5	Contingency and Unforeseen Expenditures	1	0	500	500
	Sub Total	**42**	**17482**	**6500**	**23982**
1ST YEAR					
1	Maintenance of Nursery (Balance)	16	6822	0	6822
2	Pitting 30 cm cube size	28	11939	0	11939
3	Carriage and planting including causality replacement	18	7675	0	7675
4	Complete weeding, soil working, manuring	22	9381	0	9381
5	Cost of Vermi compost and insecticide for plantation	12	5117	4000	9117
6	Cost of Chemical fertilizer	4	1706	2000	3706
7	Fireline tracing and inspection path	3	1279	0	1279
8	Silvicultural operation involving clearance of weeds, cutting of climbers, singling of shoots etc.,	15	6396	0	6396

Sl. No.	Item of work	Person Days	Labour Cost (Rs.)	Material Cost (Rs.)	Total Cost (Rs.)
9	Soil conservation measures	20	8528	0	8528
10	Watch & Ward	8	3411	0	3411
11	Contingency and Unforeseen Expenditures	2	0	300	300
	Sub Total	**148**	**62254**	**6300**	**68554**
2ND YEAR					
1	Casuality Replacement including cost of seeding, carrage and planting	8	3411	0	3411
2	Complete weeding and prunning	8	3411	0	3411
3	Soil working and manuring	8	3411	0	3411
4	Cost of fertilizer and insecticide	4	1706	2000	3706
5	Fireline tracing and inspection path	1	426	0	426
6	Soil conservation measures	8	3411	0	3411
7	Watch & Ward (Whole year)	8	3411	0	3411
8	Contingency and Unforeseen Expenditures	1	426	150	576
	Sub Total	**46**	**19614**	**2150**	**21764**
3RD YEAR					
1	Complete weeding and prunning	4	1706	0	1706
2	Soil working	4	1706	0	1706
3	Fireline tracing and inspection path	1	426	0	426
4	Watch & Ward (Whole year)	8	3411	0	3411
	Sub Total	**17**	**7249**	**0**	**7249**
4TH YEAR					
1	Fireline tracing and inspection path	1	426	0	426
2	Prunning, Watch & Ward	2	853	0	853
	Sub Total	**3**	**1279**	**0**	**1279**

ABSTRACT					
Year		No. of Person Days	Cost of labour	Material	Total Cost (Rs)
1	0th year	42	17482	6500	23982
2	1st year	148	62254	6300	68554
3	2nd year	46	19614	2150	21764
4	3rd year	17	7249	0	7249
5	4th year	3	1279	0	1279
Total		**256**	**107879**	**14950**	**122829**

ANNEXURE - IV/1

COST NORM FOR URBAN PLANTATION FOR 1000 SAPLINGS
(TALL SEEDLING PLANTATION OF 8 MONTHS OLD)

Avenue Plantation " 4m X 4m Block Plantation : 2.5m X 2.5m

Labour Rate Rs. 426.40/- per manday

Sl. No.	Item of work	Unit	Qty	Rate (in Rs.)	Amount (in Rs.)
PREPARATORY OPERATION (OTH YEAR)					
1	Cost of sapling (8 months old including 10% causality)	No.	1000	20	20000
2	Alignment & stacking at 4M spacing including clearance sites in avenue & 2.5 m X 2.5m in case of block	MD	20	426.4	8528
3	Excavation of pits - 45 cm X 45 cm X 45 cm in hard soil with vertical cut edges to make an uniform cube & heaping the excavated soil out side the pits	MD	52	426.4	22172.8
4	Refilling of pits with excavated soil after breaking the clouds completely	MD	8	426.4	3411.2
5	Carriage and transport of saplings from Nursery site to plantation site over an average lead of 10 kms	No.	1100	10	11000
6	(a) Cost of FYM 0.25 CFT per plant	CFT	250	14	3500
	(b) Cost of Bio-fertilizer 250 gm per plant	Kg	250	20	5000
	(c) Cost of NPK 50 gm per plant in two doses	Kg	50	20	1000
	(d) Cost of Chloropyriphos 10 gm per plant	Kg	10	60	600
7	Planting of sapling after carefully removing from sacks including mixing of FYM, Bio-fertilizer, Clorophyphos & Scooping the soil to required depth & pressing the soil around the plants	MD	32	426.4	13644.8
8	Cost of Manures 100 Gm per plant (Urea)	Kg	100	10	1000
9	1st weeding around the plant to a radius of 30 cm, application of Urea 50 gm/plant in holes.	MD	28	426.4	11939.2
10	2nd weeding around the plant to a radious of 50 cms.	MD	20	426.4	8528

Sl. No.	Item of work	Unit	Qty	Rate (in Rs.)	Amount (in Rs.)
11	Soil working around 0.5 Mt radious of the plant & application of Urea 50 gm per plant, mulching with available materials	MD	32	426.4	13644.8
12	Watering for 3 month, 10 days per month from January to March, including cost of water, labour & transportation through tractor / tanker	No.	1000	30	30000
13	Watch & Ward for 7 months from September to march 270 days	MD	210	426.4	89544
14	Contingency expenditure	No.	1000	0.4	400
	Total				**243913**
2ND YEAR MAINTENANCE OF PLANTATION					
1	Cost of sapling - 8 months old for casuality replacment	No.	100	20	2000
2	Carriage and transport of saplings from Nursery site to plantation site over an average lead of 10 kms	No.	100	10	1000
3	Replacement of casuality after reopening the pits & planting of sapling 100 nos.	MD	4	426.4	1705.6
4	(a) Cost of DAP & CDM including transportation to be applied to 100 plants 250 gm per plant of 8 months old seedlings	Kg	25	16	400
	(b) Cost of urea 100 gm per plant	Kg	100	10	1000
	(c) Cost of NPK 50 gm per plant for 1000 plants	Kg	50	20	1000
	(d) Cost of chloropyriphos dust 10 gm per plant for 100 plants	Kg	1	60	60
5	1st weeding around this plant to a radius of 30 cm application of urea 50 gm & NPK 25 gm per plant	MD	24	426.4	10233.6
6	2nd weeding around around the plant to radius of 0.5 MT.	MD	16	426.4	6822.4
7	Soil working around 0.5 Mt radious & application of Ura C5 gm & NPK 25 gm per plant. Saucer of mousture conservation & muching.	MD	20	426.4	8528

Sl. No.	Item of work	Unit	Qty	Rate (in Rs.)	Amount (in Rs.)
8	Watering for eight months four days per month including cost of water, labour & transportation through tractor / tankers. (April to Aug & Jan. to March)	No.	1000	32	32000
9	Watch & ward for 12 month from April to March (365 Days)	MD	365	426.4	155636
10	Contingency expenditure	No.	1000	0.4	400
	Total				**220786**
ABSTRACT					
1	Ist year Operation				243913
2	2nd year Operation				220786
Total					**464698**

ANNEXURE - IV/2

COST NORM FOR URBAN PLANTATION FOR 1000 SAPLINGS
(TALL SEEDLINGS PLANTATION OF 1 YEAR 8 MONTHS OLD)

Avenue Plantation " 4m X 4m Block Plantation : 2.5m X 2.5m

Labour Rate Rs. 426.40/- per manday

Sl. No.	Item of work	Unit	Qty	Rate (in Rs.)	Amount (in Rs.)
IST YEAR OPERATION					
1	Cost of sapling (1 year 8 months old including 10% causality)	No.	1000	30	30000
2	Alignment & stacking at 4M spacing including clearance sites in avenue & 2.5 m X 2.5m in case of block	MD	20	426.4	8528
3	Excavation of pits - 75 cm X 75 cm X 75 cm in hard soil with vertical cut edges to make an uniform cube & heaping the excavated soil out side the pits	MD	240	426.4	102336
4	Refilling of pits with excavated soil after breaking the clouds completely	MD	32	426.4	13644.8
5	Carriage and transport of saplings from Nursery site to plantation site over an average lead of 10 kms	No.	1100	10	11000
6	(a) Cost of FYM 0.75 CFT per plant	CFT	750	14	10500
	(b) Cost of Bio-fertilizer 750 gm per plant	Kg	750	20	15000
	(c) Cost of NPK 50 gm per plant in two doses	Kg	150	20	3000
	(d) Cost of Chloropyphos 30 gm per plant	Kg	30	60	1800
7	Planting of sapling after carefully removing from sacks including mixing of FYM, Bio-fertilizer, Clorophyphos & Scooping the soil to required depth & pressing the soil around the plants	MD	64	426.4	27289.6
8	Cost of Manures 200 Gm per plant (Urea)	Kg	200	10	2000
9	1st weeding around the plant to a radius of 30 cm, application of Urea 100 gm/plant in holes.	MD	28	426.4	11939.2
10	2nd weeding around the plant to a radious of 50 cms.	MD	20	426.4	8528

Sl. No.	Item of work	Unit	Qty	Rate (in Rs.)	Amount (in Rs.)
11	Soil working around 0.5 Mt radious of the plant & application of Urea 100 gm per plant, mulching with available materials	MD	32	426.4	13644.8
12	Watering for 3 month, 10 days per month from January to March, including cost of water, labour & transportation through tractor / tanker	No.	1000	30	30000
13	Watch & Ward for 7 months from September to march 270 days	MD	210	426.4	89544
14	Contingency expenditure	No.	1000	0.4	400
	Total				**379154**
2ND YEAR MAINTENANCE					
1	Cost of sapling - 1 Yr & 8 months oild for casuality replacment	No.	100	30	3000
2	Carriage and transport of saplings from Nursery site to plantation site over an average lead of 10 kms	No.	100	10	1000
3	Replacement of casuality after reopening the pits & planting of sapling 100 nos.	MD	12	426.4	5116.8
4	(a) Cost of DAP & CDM including transportation to be applied to 100 plants 750 gm per plant of 8 months old seedlings	Kg	75	16	1200
	(b) Cost of urea 200 gm per plant	Kg	200	10	2000
	(c) Cost of NPK 150 gm per plant for 1000 plants	Kg	150	20	3000
	(d) Cost of chloropyriphos dust 20 gm per plant for 100 plants	Kg	2	60	120
5	1st weeding around this plant to a radius of 30 cm application of urea 100 gm & NPK 75 gm per plant	MD	24	426.4	10233.6
6	2nd weeding around around the plant to radius of 0.5 MT.	MD	16	426.4	6822.4
7	Soil working around 0.5 Mt radious & application of Ura C100 gm & NPK 75 gm per plant. Saucer of moisture conservation & mulching.	MD	20	426.4	8528

Sl. No.	Item of work	Unit	Qty	Rate (in Rs.)	Amount (in Rs.)
8	Watering for eight months four days per month including cost of water, labour & transportation through tractor / tankers. (April to Aug & Jan. to March)	No.	1000	32	32000
9	Watch & ward for 12 month from Oct to March (365 Days)	MD	365	426.4	155636
10	Contingency expenditure	No.	1000	0.4	400
	Total				**229057**
3RD YEAR MAINTENANCE					
1	Weeding & Prunning	MD	20	426.4	8528
2	Watch & Ward for 12 month from April to March 365 Days	MD	365	426.4	155636
	Total				**164164**

ABSTRACT FOR PLANTAITON OF 1000 SAPLINGS

Sl. No.	**Year of Operation**	**Cost per plant**	**Total Amount (Rs.)**
1	1st year Planting	379.00	379154.4
2	2nd year Maintenance	229.00	229056.8
3	3rd year Maintenace	164.00	164164
Total		**772.00**	**772375.2**

ANNEXURE - V

COST NORM FOR RAISING OF AVENUE PLANTATION
(250 PLANTS PER RKM, SPACING OF 4 METERS BETWEEN PLANT TO PLANT)

Sl. No.	Item of work	Mandays	Labour Cost @ Rs.426.4/-	Material Cost in Rs.	Total Cost in Rs.
A. PREPARATION OF NURSERY					
1	Cost of 8 (eight) Months old seedlings with cost of transporation to site of planting (Cost of 250 potted seedlings and 10% Casuality replacement)	10	4264	520	4784
2	Cost of Transportation to site of planting	4	1706	0	1706
	Total	**14**	**5970**	**520**	**6490**
B. 0TH YEAR ADVANCE WORK					
1	Survey, demarcation, site prepartion, alignment & Stacking	4.5	1919	100	2019
2	Digging of pits (45 cm X 45 cm X 45 cm)	21	8954	0	8954
3	CDM (125 cft @ 0.5 cft per pit)		0	2000	2000
4	Contingency		0	125	125
	Total	**25.5**	**10873.2**	**2225**	**13098**
C. 1ST YEAR CREATION					
1	Filling up of CDM in pits	1	426	0	426
2	Planting of seedlings with short carriages including CR & application of basal dose 50 gm & pesiticides 5 gms per pit	5	2132	0	2132
3	1st Weeding within 45 cm radius	7.5	3198	0	3198
4	Intensive soil working 15 cm deep & 50 cm radius around the plant with application of 2nd dose fertilizer 50 gm per plant	5	2132	0	2132
5	Provision of soil & water conservation measures by providing circular trench in flat land & half moon trench in slope area.	2.5	1066	0	1066
6	Cost of fertilizer NPK/DAP & pesticides		0	500	500
7	2nd Weeding wihtin 50 cm radius	5	2132		2132

Sl. No.	Item of work	Mandays	Labour Cost @ Rs.426.4/-	Material Cost in Rs.	Total Cost in Rs.
8	Watering 1st Jan to 31st March	50	21320	100	21420
9	Watch & Ward per RKM	60	25584	0	25584
10	Contingency		0	100	100
	Total	**136**	**57990.4**	**700**	**58690**
D. 2ND YEAR MAINTENANCE					
1	10% Casuality replcement including cost of seedlings 25 Nos	2.5	1066	325	1391
2	Weeding, Woil working and application of fertilizer (50 gm.plant)	15	6396	200	6596
3	Watering 1st April to 15th Sep & 1st Jan to 31st March	100	42640	200	42840
4	Watch & Ward per RKM	91	38802		38802
5	Contingency		0	100	100
	Total 2nd year	**208.5**	**88904.4**	**825**	**89729**
E. 3RD YEAR MAINTENANCE					
1	Maintenance of plants including shrub cutting, weeding & soil working	10	4264	0	4264
2	Watch & Ward per RKM	91	38802	0	38802
	Total 3rd year	**101**	**43066.4**	**0**	**43066**
F. 4TH YEAR MAINTENANCE					
1	Maintenance of plants including shrub cutting and weeding	0	0	0	0
2	Watch & Ward per RKM	91	38802	0	38802
	Total 4th year	**91**	**38802.4**	**0**	**38802**
ABSTRACT					
A	Cost of nursery	14	5970	520	6490
B	0th year (except nursery	25.5	10873.2	2225	13098.2
C	1st year (except nursery)	136	57990.4	700	58690.4

Sl. No.	Item of work	Mandays	Labour Cost @ Rs.426.4/-	Material Cost in Rs.	Total Cost in Rs.
D	2nd year Maintenance	208.5	88904.4	825	89729.4
E	3rd year Maintenance	101	43066.4	0	43066.4
F	4th year Maintenance	91	38802	0	38802
	Total	**576**	**245606.4**	**4270**	**249876**

Cost per plant : Rs.999.50/-

Gabion Cost : Rs.500/- per plant extra