

# **Plantation Manual**

*Haryana Community Forestry Project*  
*Haryana Forest Department*

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## PREFACE

The Haryana Community Forestry Project is embarking on a very ambitious programme of raising tree plantations on 27,380 ha. in the next seven years. These plantations are to be raised under six models spelled out in the Overall Work Plan. Main objectives of this exercise are:

- Arid and semi-arid areas affected by sand dunes and wind erosion are rehabilitated and are productive again.
- Panchayat, shamlat and institutional land are rehabilitated and are productive again.
- Wastelands within villages are converted into community tree groves for amenity purposes.
- Multi-species agroforestry cropping patterns are established on marginal and small farms.
- Poplar plantations are established on prime agricultural land, and
- Households establish improved homestead plots and/or kitchen gardens.

Currently most of these lands are under non-sustainable use, resulting in environmental degradation and decline in quality of life of the disadvantaged groups in village communities, particularly women. The arid/ semi-arid climate marked by low rainfall (as low as 400 mm p.a. in the southwest) quickens the process of degradation. The increasing demand on natural resources by industries and a burgeoning urban population and 'development' continues the historical and political processes that set in motion the non-sustainable use of resources in the first place.

The chief problems that earlier confronted the programme on Social Forestry on Panchayat land relate to the very poor quality of land, water logging, alkalinity at some places, sand dunes and drought at other places. Considering these factors it became necessary to have a comprehensive plantation manual to guide the staff in their field work. The aim is to raise plantations that will really grow and provide desired benefits to the community.

Work pertaining to raising of a plantation has 3 distinct parts, viz. (i) production of seedlings for planting, (ii) planting of seedlings in field, and (iii) taking care of the young and tender plants in the field. As regards item (i), a nursery manual has already been written by Mr. R.N. Kaul. This plantation manual deals with the other two aspects and the two manuals can be treated as complementary to each other.

The plantation manual has 9 chapters, covering project background in chapter 1 and choice of species in chapter 2. In fact, chapter 2 is more or less a verbatim reproduction of chapter 3 of the nursery manual except for a small addition.

Chapters 3 - 7 cover field activities related to plantation work. In fact these field activities can be divided into distinct jobs, such as site preparation, fence erection (plantation protection), planting, after care and crop protection from pests and biotic factors. Each of these jobs has been dealt with in a separate chapter. Further, these jobs are done in a definite sequence; so chapters have also been arranged in the same sequence.

Chapter 8 deals with plantation journal and job calendar. The plantation journal gives details about the plantation site and surroundings and also details of different works that are carried out there. In the long run it will give the history of the plantation at its maturity and will be a very valuable guide for future programming. The job calendar, on the other hand, gives programme of works to be carried out and is a sort of engagement diary of staff in charge of the planting work.

Chapter 9, the last one, is no less important. In plantation work there are quite a number of jobs that need to be done at different times. Very often there is a substantial labour force engaged. Chapter 9 guides staff as to the manner in which different jobs have to be supervised. Without proper supervision there are bound to be snags which may have adverse effect on a plantation's progress.

The manual ends with an appendix, giving silvicultural characteristics of the species that are likely to be planted at one place or other.

The manual has been developed to cater to the needs of project staff, right from Forest Guards to Range Officers, who will be directly responsible for different jobs related to raising of plantations. This project tries to take care of the deficiencies in our earlier efforts, e.g. irrigation for four times has been provided during the first year to avoid adverse effects of drought; similarly manuring and fertilizer application provided should help plants put in poor sites. Readers, it is hoped, will ensure success of their plantations and help Haryana move to better and sustainable use of its land resources.

#### ACKNOWLEDGEMENTS

This manual is based on my learning at Indian Forest College, Dehradun and my experience of working in the field for >30 years. Besides, I had the opportunity of reading a large number of publications on the subject. When at Indian Forest College many items appeared trivial, though our teachers (M/S Y.M.L. Sharma, S.A. Shah, A.B. Rudra, A.L. Rao, P.G. Sathe, Jaswant Singh, B.K. Bakshi, and G.S. Lamba - I express my reverence for them) laboured hard to emphasize the importance of these items. It was only in the field that I realized that neglecting these trivial items sometimes spells disaster for plantations.

While preparing the draft of this manual, I borrowed a whole chapter almost verbatim (Choice of Species) from the Nursery Manual by Mr. R.N. Kaul; I have also reproduced a substantial portion on Silvical characteristics of species from the same manual. I do feel extremely grateful to Mr. R.N. Kaul.

I am particularly thankful to Mr. S.K. Dhar, C.C.F. & Project Director, HCFP, with whom I had several discussions during the preparation of this manual. I wish to thank Mr. K.S. Chauhan, C.F. and also Mr. Rajbir Singh, D.F.O. HQ, who were very helpful to me in removing many of my doubts about the working in Haryana. My most sincere thanks are due to Mr. Göran Jonsson, our Team Leader, who helped me a lot in the preparation of this document when I (a novice with computers) was trying to type mss. Editing and formatting on computer was totally done by him.

PANCHKULA

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Madan Gopal

## LIST OF ACRONYMS

BHC	Benzene hexachloride
CCF	Chief Conservator of Forests
CF	Conservator of Forests
DFO	Divisional Forest Officer
FD	Forest Department
HCFP	Haryana Community Forestry Project
MSS	Manuscript
OWP	Overall Work Plan
PD	Project Director
TA	Technical Assistance

# CHAPTER 1

## BACKGROUND

### 1.1 Introduction

This manual is written for a wide array of (i) staff of the Haryana Community Forestry Project and (ii) farmers and villagers who would be engaged in raising numerous plantations in project areas as envisaged in the OWP. It is meant to be a practical guide to them while they work in field. This can also serve as a reference each time there is a problem or a question about the plantations.

### 1.2 Agro-ecological Zones and their Problem Features

The HCFP covers three main agro-ecological zones. Table 1 describes the area and categories of people living thereon. Each of these zones has its own peculiar problems of utilization and potentialities for use. These zones are:

- (i) Shivalik Hills are steep and comprise friable sandstone and conglomerates in the northeast. The hill slopes represent a severely eroded landscape resulting in 'Cho' formation in the adjoining plains, mainly due to misuse of vegetation through excessive grazing and indiscriminate exploitation of woody biomass.
- (ii) The Central Plain, where large areas have been affected by soil erosion, water logging, soil salinity and lowering of ground water table as a result of cultivation on marginal lands and increase in irrigated cropping.
- (iii) The Desert, comprising numerous low stabilized and shifting sand dunes in the south west, is characterized by overgrazing and recurrent droughts; the consequence is degradation of vegetation resources, soil erosion and inducement of livestock migration.

**Table 1**  
**Agro-Ecological Zones Covering Different Project Districts**

Agro-Ecological Zones	Districts	Category of people
i. Shivalik Hills	Panchkula, NE Yamunanagar	<i>Gujar</i> – cattle herders, marginal and small farmers.
ii. Plains: Normal lands	Kurukshetra; East Hisar; East Bhiwani; Jatusana; comprising North Rewari; NE Mahendragarh (Kanina and Nahar)	Farmers, landless and poor.
iii. Desert:		
a) Stabilised sand dunes	a) Parts of Hisar; Bhiwani; Mahendragarh; Rewari and Sirsa	a) Cattle herders, small, marginal and big farmers, landless and poor.
b) Shifting sand dunes	b) Parts of Bhiwani, Hisar, Mahendragarh and Sirsa	b) Cattle herders, small and marginal farmers, landless and poor.

For each of the three agro-ecological zones, the factors and processes generally responsible for serious acceleration of the rate of degradation witnessed in recent times are summarized in Table 2 below.

**Table 2**  
**Factors and Processes Responsible for Land Degradation in Agro-Ecological Zones of Haryana**

Factors	Processes	Consequences
i. Microclimatic changes	Accentuation of aridity; recurrent drought.	Dust storms, soil erosion; Decrease of crop yields; degradation of vegetation; livestock migration.
ii. Increase in human population	Cultivation of marginal lands.  Increase in irrigated cropping.  Exploitation of woody biomass.	Decline in crop production; soil erosion; loss of soil fertility.  Water logging; increase of soil salinity; over exploitation of ground water.  Degradation of forests; suppression of natural vegetation; diminution of wildlife.
iii. Increase in livestock population	Overgrazing.	Degradation of vegetation resources; diminishing livestock production; livestock migration.

It is, therefore, apparent that rapid desertification in Haryana is seriously undermining the productive resource base and endangering vital life support systems. Sustainability of agriculture and ecosystem protection has, therefore, taken a centre stage in the development strategy of the state.

### **1.3 Project Background**

The project aims at reversing the process of degradation by restoring vegetation cover. It also aims to focus on needs of the community for fuel, fodder, fruit, timber and other minor uses on a sustainable basis. The project will keep in view that the species are suitable to the site and meet the diverse needs of the people as identified during participatory assessment and microplanning stages. The degraded wastelands, village common lands, farm boundaries, homestead surroundings, institutional lands, river banks and other areas unsuited to agriculture will be targeted for improvement by raising tree plantations.

Since the area under tree cover in the state is very low (it is around 8% of the total area), the project is also encouraging farmers to shift to tree crops in preference to agriculture, at least whenever tree crops are found to be profitable. The component pertaining to poplar is one such example; planting of superior clones of eucalyptus is another.

The Overall Work Plan (OWP) of HCFP also recognizes raising of tree plantations, within the interrelated framework of land, water, trees, crops and livestock, as one of the main activities to generate sustained income and livelihood for target communities and to improve environment. HCFP plans to cover a total area of 27,380 ha. under planting over a period of seven years. The tree planting activity is spread over 300 villages in 43 community development blocks of 10 districts.

It is foreseen that plantation activities would be carried out through 6 models, viz.

- **Model I:** Establishment of village woodlots on 7,400 ha. of Panchayat lands, village common lands (jointly owned by several villagers), institutional lands and river banks.

- **Model II:** Fixation of 9,300 ha. of shifting sand dunes on common or private lands.
- **Model III:** Planting of mixed species, mainly around boundaries of farmlands but also in blocks on marginal and sub-marginal lands, to an extent of 5,300 ha.
- **Model IV:** Provision of poplar seedlings to farmers for block planting on 5,000 ha. of prime farm land.
- **Model V:** Establishment of tree groves (19 tall seedlings on 0.08 ha. of each tree grove) over 200 ha.
- **Model VI:** Establishment of kitchen gardens/ homestead plots on 36,000 sites covering 180 ha.

Each area taken up for planting will be surveyed, demarcated and mapped to help the villagers as well as the monitoring and evaluation teams in assessing the condition of assets.

## CHAPTER 2

### CHOICE OF SPECIES

#### 2.1 Background

The HCFP envisages achieving plantation targets set out in the OWP through six plantation models (see Section 1.2), with the objective of providing fodder, firewood, fruits and small timber to village communities and high value commercial tree species to farmers. Even though the choice of species would depend upon the community, the ultimate choice of species and their provenance (seed source) will, however, be governed by its capacity to make greatest use of the site (habitat), in terms of utility, density and rate of growth.

#### 2.2 Criteria

While selecting species for each of the plantation models, the chosen species as far as possible should fulfil the following criteria:

- Species compatibility to site, viz. adaptability to cold, heat and drought conditions of the site.
- Produce acceptable growth and yield.
- Remain healthy throughout the rotation.
- Easy to propagate and establish - preferably a good coppicer.
- Ability to withstand repeated lopping and pruning to yield fodder and firewood.
- Capacities to tolerate browsing or species easy to protect against stray livestock.
- Indigenous species or species which proved successful when grown in the locality and for which local people have a preference.
- Market demand.

### 2.3 Recommended Species

Keeping in view the above criteria and in order to meet the needs of different user groups, different species for the six plantation models (see section 1.3) for each project division have been selected and are presented in Table 3. The silvical characteristics of the forest tree species suggested are discussed under Appendix 1.

In the case of fruit trees, generally demand is for grafted mangoes, litchi (china, *Sita*, *Gulab* varieties etc.), citrus (viz. *kino*, sweet lemon, lemon lime), *aonla* (*kanchan* variety ND5 and ND7 selections), guava, *bel*, (Mirzapuri, *kagzi*, *Gonda*, Faizabad oblong, Faizabad round and *Narendra bel* - 5 varieties), *ber* (see under species *Zizyphus mauritiana* - Appendix 1) and papaya (honeydew variety). Planting material of improved varieties of *aonla* and guava can be obtained from the Department of Horticulture, Acharya Narendradev University of Agriculture Technology, Faizabad U.P. The Director, Central Arid Zone Research Institute, Jodhpur (Rajasthan) and Haryana Agriculture University, Hisar would be able to supply seedling stock of *bel* and budded varieties of *ber*. For seedling of other fruit species Government Horticulture Research Station, Saharanpur and/or Directorate of Horticulture, Haryana, Panchkula should be contacted.

Table 3  
Possibility Implementation Of Different Models And Corresponding Species In Project Districts

Plantation Models (Species)	Districts				
	Panchitula <	Ambata <	Yamanagar <	KURUKSHETRA <	Sirsa >
Village Woodlots (Species)	Eucalyptus spp., A. nilotica, A. catechu, D. sissoo, M. indica, E. officinalis, P. guajava	Eucalyptus spp., A. nilotica, A. catechu, D. sissoo, M. indica, E. officinalis, P. guajava	Eucalyptus spp., A. nilotica, A. catechu, D. sissoo, M. indica, E. officinalis, P. guajava	Eucalyptus spp., D. sissoo, A. nilotica, D. sissoo, M. indica, E. officinalis, P. guajava	A. nilotica, A. tortilis, A. excelsa, P. cineraria, T. unculata, Eucalyptus spp. (I)
Sand Dune Fixation (Species)	NP	NP	NP	NP	SW< A. tortilis, A. excelsa, F. albida, R. communis Z. jujube, T. unculata.
Tree Grove (Species)	Y A. indica, F. religiosa, F. bengalensis, D. sissoo, P. pinnata	A. indica, F. religiosa, F. bengalensis, D. sissoo, P. pinnata	Y A. indica, F. religiosa, F. bengalensis, D. sissoo, P. pinnata	Y A. indica, F. religiosa, F. bengalensis, D. sissoo, P. pinnata	Y A. indica, F. religiosa, F. bengalensis, D. sissoo, P. pinnata
Mixed species on Farms (Farm forestry) (Species)	Eucalyptus spp., Poplar (G 48, S 7, C15, C1.8 & 20 clones), A. chinensis	Eucalyptus spp., Poplar (G 48, S 7, C15, C1.8 & 20 clones), A. chinensis	Eucalyptus spp., Poplar (G 48, S 7, C15, C1.8 & 20 clones), A. chinensis	Eucalyptus spp., Poplar (G 48, S 7, C15, C1.8 & 20 clones), A. chinensis, T. grandis	>(I)
Poplar Plantations	> Poplar (G 48, S 7, C15, Udaï, L34, Kranti, C1.8 & 20 clones)	> Poplar (G 48, S 7, C15, Udaï, L34, Kranti, C1.8 & 20 clones)	> Poplar (G 48, S 7, C15, Udaï, L34, Kranti, C1.8 & 20 clones)	>(I) Poplar (G 48, S 7, C15, Udaï, L34, Kranti, C1.8 & 20 clones)	>(I) Poplar (G 48, S 7, C15, Udaï, L34, Kranti, C1.8 & 20 clones)

>=greater scope, <=less scope, (I)= under irrigation  
NE=Northeast, SW= Southwest, NP = Not possible

Table 3 (Continued)  
Possibility of Implementation Of Different Models And Corresponding Species In The Project Districts

Plantation Models (Species)	Districts / Blocks					
	Fathebad	Hissar	Siwani	Loharu	Bhiwani	Jatusana
Village Woodlots (Species)	NE> A. nilotica, A. tortilis, A. excelsa, P. cineraria, Eucalyptus spp. (I)	NE> A. nilotica, A. tortilis, A. nilotica, A. tortilis, A. excelsa, P. cineraria, Eucalyptus spp. (I)	> A. tortilis, A. excelsa, A. nilotica, Z. mauritiana, T. undulata.	> A. tortilis, A. excelsa, A. nilotica, Z. mauritiana, T. undulata.	> A. tortilis, A. excelsa, A. nilotica, Z. mauritiana, T. undulata.	A. tortilis, A. excelsa, A. nilotica, Z. mauritiana, T. undulata.
Sand Dune Fixation (Species)	SW< A. tortilis, A. excelsa, F. albida, R. communis, Z. jujuba, T. undulata.	SW< A. tortilis, A. excelsa, F. albida, R. communis, Z. jujuba, T. undulata.	> A. tortilis, A. excelsa, F. albida, R. communis, Z. jujuba, T. undulata.	> A. tortilis, A. excelsa, F. albida, R. communis, Z. jujuba, T. undulata.	> A. tortilis, A. excelsa, F. albida, R. communis, Z. jujuba, T. undulata.	A. excelsa, H. integrifolia, T. undulata.
Tree Grove (Species)	Y A. indica, F. religiosa, F. bengalensis, D. sissoo, P. pinnata	Y A. indica, F. religiosa, F. bengalensis, D. sissoo, P. pinnata	Y A. indica, F. religiosa, F. bengalensis, D. sissoo, P. pinnata	Y A. indica, F. religiosa, F. bengalensis, D. sissoo, P. pinnata	Y Z. jujuba F. bengalensis, D. sissoo, P. pinnata	Y A. indica, F. religiosa, F. bengalensis, D. sissoo, P. pinnata
Mixed species on Farms (Farm forestry) (Species)	>(I) Eucalyptus spp., Poplar (G 48, S7, C15, Udai, L34, Kranti, S7, C1, 8 & 20 clones), D. sissoo.	>(I) Eucalyptus spp., Poplar (G 48, S7, C15, Udai, L34, Kranti, S7, C1, 8 & 20 clones), D. sissoo.	<< D. sissoo (I), A. excelsa, P. cineraria, A. indica, T. undulata.	<< D. sissoo (I), A. excelsa, P. cineraria, A. indica, T. undulata.	<<(I) D. sissoo (I), A. excelsa, P. cineraria, A. indica, T. undulata.	<<(I) D. sissoo (I), A. excelsa, P. cineraria, A. indica, Z. mauritiana,
Poplar Plantations (Species)	>(I) Poplar (G 48, S7, C15, Udai, L34, Kranti, S7, C1, 8 & 20 clones).	NP	NP	NP	NP	NP

>=greater scope, <=less scope, >>=limited scope, Y=possible, NP= no possibility, (I) = under irrigation  
NE=Northeast, SW= Southwest, Y= possible.

During the past two - three decades there have been significant changes in water regime in Haryana. In some districts, subterranean water has been pumped out in large quantities for irrigation, resulting in sinking water table. On some other sites, canals have been constructed and water brought from outside for irrigation; this has resulted in rise of water table in areas adjoining the canals, so much so that some sand dunes have actually become waterlogged. In view of the above, some modifications in lists of recommended species have become necessary. These are as under:

Species recommended for sand dunes:

Sl. No.	Category of area	Additional recommended species
1.	Sand dunes where conditions are less arid now on account of rising water table.	<i>Acacia catechu</i> , <i>Acacia nilotica</i> , <i>Dalbergia sissoo</i>
2.	Sand dune where irrigation is easy to provide.	<i>Dalbergia sissoo</i> and <i>Acacia catechu</i> , <i>Albizzia lebbek</i>
3.	Erstwhile sand dunes, now water logged areas.	<i>Albizzia lebbek</i> , <i>Pongamia pinnata</i>

## CHAPTER 3

### SITE PREPARATION

#### 3.1 Site Map

The area that has to be planted should be decided about and acquired a year in advance of planting. First of all a site map is procured. It should indicate its location in reference to its surrounding features beside its boundaries and inner features and extent of area enclosed.

#### 3.2 Plan Map

This map is now prepared on a somewhat larger scale to indicate things mentioned below. Depending upon extent of area chain survey should perhaps suffice. Following are the items indicated on the map:

- ( a ) Exact boundary of area.
- ( b ) Total area in hectares.
- ( c ) Type of land.
- ( d ) Slope.
- ( e ) Choice of species to be planted.
- ( f ) Spacing to be adopted.
- ( g ) Total number of plants.
- ( h ) Irrigation facilities available, if any.
- ( i ) Arrangement for irrigation if needed.
- ( j ) Drainage.
- ( k ) Chemical analysis of soil and also of water.

The map has also to indicate area that needs special soil and water conservation measures, e.g. check dams, ponds etc. and their exact location. Once the map gets prepared, site preparation has to be taken up. If it is a larger area, there is a possibility that its different parts have different characteristics needing different treatments.

As an example a map of an imaginary site is shown on next page.



	Neem & sisso, 4m x 2.5m	1.2 ha	1,200 pits (45 x 45 x 45 cm)
	Sloping area , Khair 4m x 2.5m	2.0 ha	2,000 pits (45 x 45 x 45 cm)
	Eucalyptus, 4m x 2.5m	3.0 ha	3,000 pits (45 x 45 x 45 cm)
	Kikar. 4m x 2.5m	8.0 ha	8,000 pits (45 x 45 x 45 cm)
	Fruits, mango & guava, 6m x 6m	1.5 ha	415 pits (60 x 60 x 60 cm)

 Village drain

N.B. Appended to this map have also to be information regarding soil, water, drainage, and topography as required under para 3.2 of the manual.

## VILLAGE WOODLOT

FIG. 1 — PLAN MAP

### **3.3 Preparation of Estimates**

Once this map is prepared it is time to take steps to prepare site as per plan. This will begin with preparation of estimates for plantation work and submitting the same to competent authority for sanction.

### **3.4 Site Preparation**

#### **3.4.1 Objectives of Site Preparation**

- i. To cause maximum percolation of rain water into the land for maintenance of soil moisture.
- ii. To ensure maximum use of rain water for plant growth by preventing its rapid run-off.
- iii. To control soil erosion.
- iv. To loosen soil to make it easier for roots to grow and penetrate deeper.
- v. To allow proper availability of air to roots for their health.

#### **3.4.2 Soil Preparation**

To prepare land for planting, different measures have to be adopted for different kinds of sites. Some examples are:

- a. Plough is used on plain sites.
- b. Pits are dug at sites with hard soil, which have not been ploughed for many years.
- c. Low lying sites may have to be filled with soil brought from other places.
- d. Interrupted trenches along the contours may be preferred on sloping land.
- e. At alkaline sites, normally salts get deposited in layers in the top. These layers will need to be scraped and pits for planting need to be dug deep to reach lower depths.
- f. Besides, to make best use of water and also to prevent soil erosion, check dams and crescent shaped mounds may be needed at some places.
- g. Last but not the least — *Soil working is started in November and finished latest by early May.*

### 3.4.3 Tools and Other Goods Needed

Following is the list of tools that may be needed for above said works:

- i. Spade
- ii. Pick axe
- iii. Crow bar
- iv. Axe
- v. Basket
- vi. A few 2 - 3 m long sticks
- vii. Wooden pegs
- viii. A couple of ropes of about 20 - 30 m length
- ix. Measuring tape (30 m)
- x. Lime
- xi. Two water cans with rose head
- xii. Saws
- xiii. A few tins for carrying water
- xiv. *Khukri*, sickle

Following are the items that may be needed during planting exercise:

- i. F.Y.M
- ii. Oil cakes of *neem*, *mahuwa* etc.
- iii. B.H.C. or Aldrine powder of known strength
- iv. Aldrine (liquid) for termite control
- v. Urea
- vi. Super phosphate

### 3.4.4 Soil Working under Different Plantation Models

Site preparation begins with work of clearance of wild growth of shrubs and herbs, and debris may need disposal by burning. Ash from this may be scattered on the site as it happens to be rich in potassium. *Clearing and burning of shrubs or any kind of vegetation will not be done on sand dunes or hill sites. Permission of DFO must be sought if, for any reason, the supervisor feels its necessity.*

General principles for soil working are listed under para 3.4.2 above; however, each spot needs special attention and treatment depending on its special features. Paragraphs below indicate types of soil working to be adopted under different plantation models being pursued by HCFP.

#### **A. Model I**

*This model envisages planting of Panchayat lands, village common lands, institutional lands and river banks.*

Obviously these lands are not fit for cultivation. Mostly they are undulating or sloping, comprising rocky debris or stony porous grounds, somewhat shallow or just sand dunes. At some places they may be flat, but these areas have been open to grazing and soil has been compacted over the years.

Further, almost all the villages that are agreeing to part with their land for woodlot planting want this programme to yield some regular income to enable them to maintain their woodlots and also to continue with this programme after the project has withdrawn. To meet this contingency it is contemplated that 10 % of the area under each woodlot is devoted to fruit production.

Keeping these points in view, soil working under Model I will be as under:

- (A) For flat, mildly sloping or undulating areas:
  - (i) Pits are to be dug for planting after proper alignment. Proper spacing and alignment of pits ensures proper distribution of light, water and nutrients among plants.
  - (ii) Ropes, sticks and wooden pegs are used to align pits to be dug.
  - (iii) Best patch to the extent of 10 % of woodlot area will be selected for planting fruit trees. Pits of size 60 cm x 60 cm x 60 cm will be provided for fruit trees and these pits will be spaced at 6 m x 6 m.
  - (iv) In rest of the area pits of size 45 cm x 45 cm x 45 cm will be dug at spacing of 4.0 m x 2.5 m. In other words, pits will be dug in rows and

spaced 2.5 m apart in the row; rows will be 4.0 m apart. Further rows will be aligned in E-W direction. Thus there will be 1,000 pits per hectare.

- (v) Soil dug out of a pit is heaped by the side of the pit and it is allowed to be weathered for a period of not less than 15 days. Pebbles and stones, if found in dug out soil, should be separated.
  - (vi) In May,  $\frac{1}{2}$  basket of FYM,  $\frac{1}{2}$  basket of oil cakes and 15 - 20 gm of Aldrine or BHC powder should be mixed thoroughly in the soil of each pit. This job should be completed before 31<sup>st</sup> May.
- (B) For steeply sloping lands, prescription is as under:

Sloping lands:

Surface run off of rainwater on slopes is fast and it carries top soil also with it affecting the fertility adversely. To prevent degradation, such lands need to be covered with vegetation at the earliest. Depending on slope of site, suitable soil conservation measures may have to be adopted.

For sites with mild slopes (i.e. upto 3%), ridges along the contours at proper intervals can help decelerate the speed of surface run off. Ridges may be 20 - 35 cm high, depending upon rainfall intensity.

For sites with steep slopes, say >5%, contour lines should be precisely determined with help of a contour frame (see Figure 2).

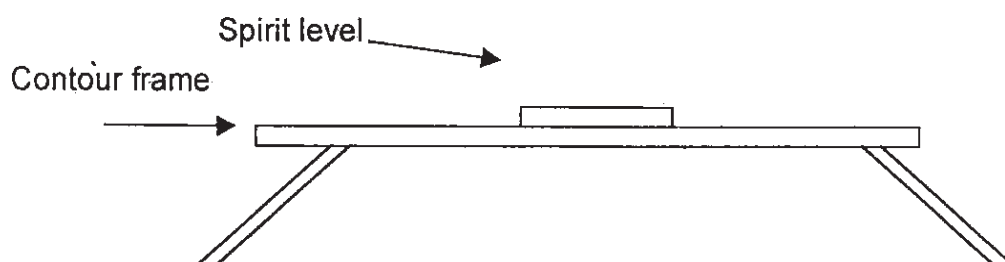


Fig. 2. Contour frame

Make the bench stand with legs at two ocularly selected points and put the spirit level in the middle of bench. If the bubble stays in middle, points under two legs are on the same contour.

Soil working on sloping lands will be as under:

- (i) Pits of size 45 cm x 45 cm x 45 cm will be dug along contour lines. Pits in line will be 2.5 m apart. Lines will be 4.0 m apart.
- (ii) Adjoining each pit a trench of size 1.5 m long (along contour) 45 cm wide and 30 cm deep will be dug.
- (iii) Dug out soil will be heaped in form of a ridge on upper side of the trench.
- (iv) Pits and trenches in adjoining lines will be staggered with respect to each other as shown in Figure 3 below.

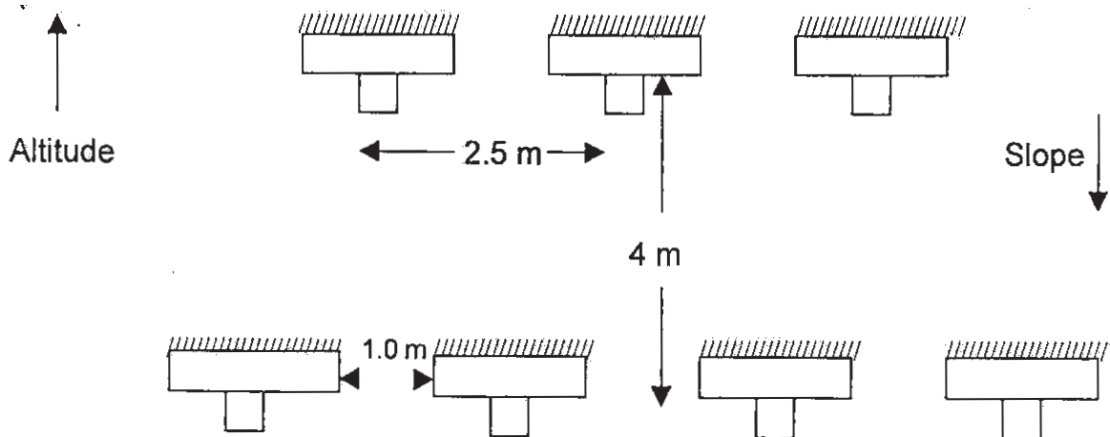
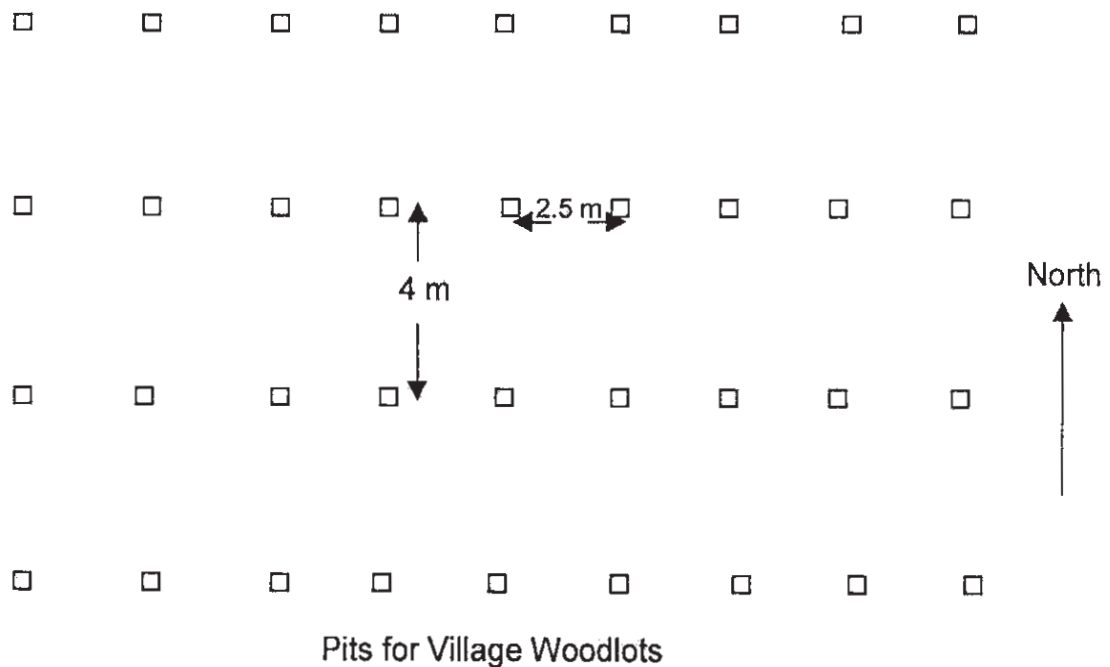


Fig. 3. Pit, trench & dug out soil on sloping sites under Village Woodlots

Reference - Para 3.4.4 - Model I

## **B. Model II**

### *Fixation of Shifting sand dunes*

Here the soil comprises sand that was blown from some other place and deposited here. There is no vegetation to hold it back. Since it is not certain that sand available at any time will stay or will be blown over to some other place, it is advisable to carry out soil work only at the time of planting. Pattern of soil working here is as under:

Pits of size 45 cm x 45 cm x 45 cm will be dug at spacing of 4.0 m x 2.5 m; this spacing is to be used for fuelwood species. Some good patches will be devoted to raising of fruit trees and spacing here will be 6.0 m x 6.0 m. Area under fruit species will not exceed 10 % of land being planted at any place. The area will also have cattle proof trench all around plantation area. The dug out soil will be piled up on the inside of the trench and castor seeds will be sown on the ridge so formed. The trench will have its section in the form of a trapezium, with bottom 90 cm wide, top 120 cm wide and depth equal to 100 cm.

## **C. Model III**

*Planting trees of mixed species mainly around boundaries of farm lands, but also in blocks on marginal and sub- marginal lands.* Here site is mostly flat, with some exceptions where it may have mild slope. The soil, however, is poor, shallow and devoid of nutrients.

Planting here is to be done in pits. Size of pits prescribed is 45 cm x 45 cm x 45 cm. Spacing between plants here will be 2 m if planting is done on boundaries only. In case it is block planting, spacing will be 4.0 m x 2.5 m.

## **C. Model IV**

*Block planting of poplars on prime farmlands.* This planting is being done on best land available in the state. The area should be ploughed with a tractor. The owner should be asked to have augur holes of 20 cm diameter and 120 cm depth at spacing of 4 m x 5 m for poplar planting. He is also advised to provide a

basketful of FYM and another basketful of *neem* or *mahua* oil cakes, to be mixed with dug out soil before its refilling at the time of planting.

#### **D. Model V**

*Establishment of tree groves (19 tall seedlings on 0.08 ha. of each grove).* These groves are to be developed near a habitation for use by the whole community. It is a small area and will be flat. Here only large seedlings (2-year-old seedlings grown in plastic woven bags) are to be planted. Pits of 60 cm x 60 cm x 60 cm will be dug. Quantity of FYM and oil cakes to be mixed with soil will be double of what is being used in (45 cm) cube pits. Alignment of pits will be in rows as under:

Pits in rows will be 7 m apart. Each row will be 6 m apart from adjoining rows and plants in adjoining rows will be staggered as shown in Figure 4 on next page.

#### **F. Model VI**

*Establishment of kitchen gardens.*

These are small plots of about 500 square metres in area each. Owners will grow vegetables. The area has to be ploughed or dug with a spade for making beds for vegetable plants. Five fruit trees will also be planted. Suitable points for putting fruit trees will be selected by the owner. Pits to receive fruit plants should be at least 60 cm x 60 cm x 60 cm in size. Besides, each pit should receive a basketful of FYM and another basketful of oil cake beside usual NPK fertilizer later on.

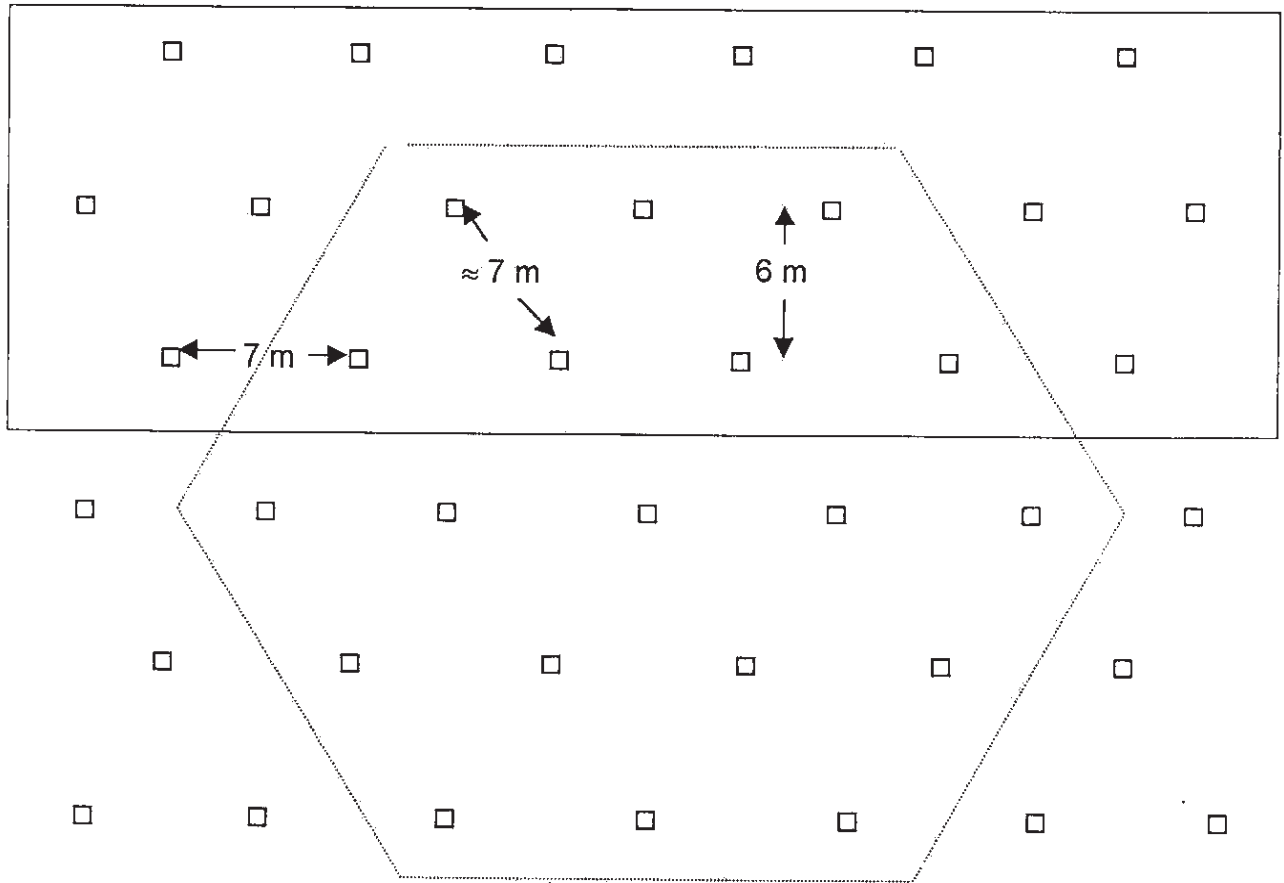


Fig. 4. Pit Alignment under Tree Grove, Model V

Reference Para 3.4.4

#### SITE PREPARATION

- (1) Get map of plantation site prepared at least a year in advance of planting time. Plan works to be carried out there and show the same on the map.
- (2) Wild shrubs etc. are to be cleared and burnt, except on sand dunes and steep hills.
- (3) Considering type of soil land, take up soil working.

## CHAPTER 4

### PLANTATION PROTECTION

#### 4.1 General

While soil working is being done, action has also to be taken to ensure that the plantation, when raised, does not get damaged by any external factors. Usually the plantation needs protection from livestock and human beings. Cows, buffaloes, camels, goats and sheep can graze on plants, nibble growing tips or eat away the whole plant. They can also trample and kill seedlings. Humans may also damage unintentionally while moving along plants or may deliberately cut the plants. To prevent such damage, the plantation area needs to be provided with proper fence. Fencing is of two kinds, viz.:

(A) LIVE FENCES, and;

(B) OTHER FENCES, such as Barbed wire fence (with bamboo or wooden posts) and stone wall.

#### 4.2 Live Fences

Here plants that have thorns and/or are not palatable for animals are grown along the boundary. Live fence is usually cheaper to erect than barbed wire fencing or a stone wall. Repair charges are also less. Some of these fences may provide some income instead. Following are the species that are usually used for fencing:

- (i) *Ricinus* - Castor
- (ii) *Acacia nilotica* - Kikar
- (iii) *Prosopis juliflora* - Mesquite
- (iv) *Euphorbia Royleana* - Thuhar
- (v) *Agave americana* - Ketki
- (vi) *Ipomea fernia* - Ulti sulti bel
- (vii) *Jatropha* - Ratanjot

*Kikar, Prosopis, Euphorbia* and *Agave* are thorny and therefore more effective.

#### **4.2.1 Castor**

A trench 100 cm deep, with a trapezium section having a width of 120 cm at ground level and 90 cm width at bottom, is dug along the boundary and dug out soil is piled on the inner side, forming a ridge. Seeds of castor are sown on the outer side of the ridge. The trench is usually interrupted at an interval of about 10 m, where an about 10 cm thick portion is left un-dug (there is no interruption in ridge formed of dug out soil). Plants raised in polyethylene bags are also used, along with seeds. With time, plants growing closely on the ridge form an impenetrable fence. Castor plants in due course start producing seeds which are oily and have commercial value.

The trench is dug in the period March - May. Seed is sown in June.

#### **4.2.2 Kikar and Mesquite**

*Kikar* and mesquite are raised in the same manner as castor. These are thorny trees but these do not yield oil; however, cutting of these trees at some predetermined height provides some fuelwood.

#### **4.2.3 Thuhar**

It is practical only in areas where *Euphorbia* plants are already growing in plenty. Plants having 2 - 3 branches and 1 - 1.5 m tall are cut and brought to site. From cut point a milky liquid oozes and gets dry by the time plants are brought to site. Before planting another cut about 5 - 10 cm from bottom is given and milky liquid starts oozing again. It is in wet condition that plant should be planted, about 15 - 20 cm deep in a hole made with a crowbar. Planting is done in April - May and roots develop a few days after planting. Since plants are already 1.0 - 1.5 m tall, the fence starts functioning before the area gets planted.

#### **4.2.4 Ketki**

*Agave americana* plants are taken from nursery and are planted on the outer side of a ridge made of soil dumped on the edge of the trench. Plants are put 1.0 m apart.

#### 4.2.5 Ulti-sulti bel

*Ipomea* is raised by putting 15 - 20 cm long branches of thumb thickness on the ridge, at a spacing of 20 cm along the line.

#### 4.2.6 Ratanjot

It is also raised in the same way as *Ipomea*. Its seeds are oily and the oil is used in making of soap.

### 4.3 Other Fences

#### 4.3.1 Barbed Wire Fence

About 150 cm long bamboo or wooden post is coated with coal tar upto 35 cm of its length from the lower end. It is put in a 30 cm deep pit and made to stand upright, the coal tar end being buried in the pit. Coal tar prevents termite attacks. Bamboo posts like this are put along the boundary at a spacing of about 2.5 m. Barbed wire is stapled in 4 straight strands and another 2 strands in cross form, as shown in Figure 5.

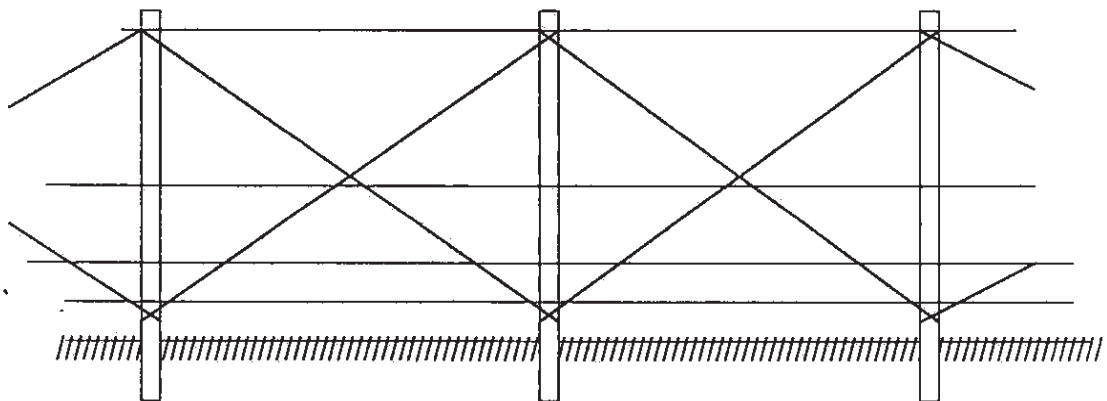


Fig. 5. Barbed wire fencing

#### 4.3.2 Stonewall

In case stones are available cheaply and in the vicinity of the plantation site, this alternative can be used. A stone wall is built all round the plantation area by arranging the stones in a wall, which is 1.20 m high and 75 - 90 cm wide.

## CHAPTER 5

### PLANTING

#### 5.1 General

After onset of the monsoon, soon after a first good rainfall in July, healthy plants (normally meaning 60 - 100 cm tall) should be taken to the site and planted without delay. Planting should preferably be done on some cloudy day. In case some delay occurs, plants should be kept in shade under a tree till these get planted. In case any of the plants appear to be withering, their daily watering, both in the morning and also in the evening, will need to be arranged.

In good rainfall areas, soil around plants should be a little higher than the surrounding area, so that water may not collect around the plant. In case of low rainfall areas, soil around plants may be kept a little below the ground level, so that some water gets collected around the plants to help plants during dry spells.

Planting, as already said above, is started on some cloudy day. In Haryana, the standard method of raising plantations is:

To raise plants in polybags in nurseries and transplant these in the field at proper time. In field pits are dug in advance to receive these transplants as prescribed in Chapter 3. (Details of procedure adopted for polybag planting are given in para 5.2.)

At places, however, planting is supplemented by sowing seed directly on ridge formed by piled up soil; trenches are also dug along with pits (see para 3.4.4 model I - sloping lands - pages 15 & 16).

- N.B. (i) Sowing seed directly is also resorted to while raising plants for live fences - see paras 4.2.1 and 4.2.2
- (ii) There are two other methods of raising plantations, viz planting of stumps and planting of branch cuttings. These methods are suitable for moister localities and are not in use in Haryana.

- (iii) Water on surface at some water-logged sites evaporates in the summer. Planting on such sites should be done immediately after the water disappears. Of course, soil working here will be done immediately before planting, and formation of a mound a little higher than ground surface will be helpful to plant being put in there. This planting has to be treated as an exception.

## 5.2 Planting Polybag Plants

Procedure for polybag plants is as under:

- Arrange well developed plants in polybags and keep one plant by side of each pit.
- Have dug out soil well mixed with FYM and insecticide, fill it in the pit upto the depth equal to the height of the polybag.
- Cut the polybag with a sharp blade so as to cleanly remove polythene without disturbing soil or roots of the plant.
- Place the plant along with its soil in the pit so that the plant collar is at ground level. Fill balance soil in the pit around the plant. This process should not disturb the original ball of earth around the plant. It should, however, get completely buried in soil now being put in the pit.
- Provide irrigation to plants if there is a dry spell immediately after planting. Regarding irrigation, please see para 6.2.
- If planting has been done properly, roots of the plants will start growing into the ground and the plant will start developing.

## 5.3 Direct Sowing of Seeds

Many species are raised by sowing their seeds directly in the field, on ridges made of dug out soil, pits or just broadcast all over. Most of the seeds do not need any pre-treatment. However, many of the small seeds are made into pellets.

For example, *kikar* and *khair* are often sown on ridges, putting seeds about 10 cm apart while ridgelines are kept 3 m apart. Small seeds of grasses are mixed with soil and cow dung and made into pellets, which are dried and stored. Sowing is done with the onset of monsoons and pelleting prevents seed from being

carried away with run-off of rain water. Pellets are also made by mixing seeds with some chemical nutrients and some sort of glue - this is a commercial activity now.

Following are 2 ways of raising forest crops in Haryana, viz.

1. Transplanting of polybag plants in field
2. Direct sowing of seeds

## CHAPTER 6

### AFTER CARE OF PLANTS

#### 6.1 General

After planting of seedlings, their aftercare comprising of activities like weeding, soil working, hoeing around plants, fertilizer application etc. is very important for their growth/ survival, especially because these crops are grown under rain fed conditions only. Activities during the first 3 years are to be as below:

#### 6.2 First Year

##### 6.2.1 Weeding and Hoeing

- (i) Two weeks after planting, there should be total removal of grasses and weeds around the plant at least within 50 cm radial distance. Also soil needs to be loosened upto 10 - 15 cm depth in this circular patch. In case of casualties the same are to be beaten up. This job has to be done latest by first week of August.

In the second week of August, make a small circular trench of 4 cm depth and an equal width, having a radius of about 20 cm around each plant. Sprinkle super phosphate @ 20 grams/ plant in this trench and cover it with soil. Successive rains or irrigation are expected to provide enough water that percolates down, dissolves fertilizer and takes it to the plant.

- (ii) Again during the first fortnight of September, second weeding and hoeing are to be done in the area around the plant, at least within 50 cm radial distance. Also soil in this area needs to be loosened upto the depth of 10 - 15 cm. Casualties are to be replaced by new plants. The second weeding needs to be completed before 20<sup>th</sup> September.
- (iii) 3<sup>rd</sup> weeding and hoeing need to be done in October, preferably in 2<sup>nd</sup> and 3<sup>rd</sup> week. When rains have stopped and plants are growing under clear sun. Soil should now be heaped around the plant to ensure soil moisture

around the plant for a longer period and also to provide some protection against the winds

- (iv) 4<sup>th</sup> weeding and hoeing is being prescribed to be carried out in 1<sup>st</sup> fortnight of March.

### **6.2.2 Termite Control**

'Heptachlor' 2% solution is applied in October - November to plants where termite attack is feared. Repeat the treatment if termites appear again.

### **6.2.3 Irrigation**

Haryana does not get regular rains in the monsoon period. During certain years rains are late in coming, or first showers come in time to be followed by a dry spell for several weeks. This has often had very adverse effect on the survival of plantations. Irrigation is being provided four times during first year of the plantations to offset the adverse effects of irregular rains/ drought. First irrigation should be provided immediately after planting. Second irrigation will be provided in 3<sup>rd</sup> week of August or earlier if there is continuous break in rains for >3 weeks after the 1<sup>st</sup> irrigation. Third irrigation is to be provided in second fortnight of September unless there is a need for this earlier. Fourth irrigation is reserved for second fortnight of February or a little later.

One irrigation means 15 litres of water per plant and this quantity will be provided in a circular *thaonla* around each plant of about 60 cm radius. This standard is meant for plants put in at 4.0 m x 2.5 m spacing. In case of fruit plants, which are put at 6.0 m x 6.0 m, irrigation will be provided in the same fashion as for other plants, except that quantity of water will be 25 litres per plant (instead of 15 litres).

## **6.3 Second Year**

### **6.3.1 Replacement of Casualties**

- (i) Soil working to beat up casualties should be taken up in May and completed in the same month.
- (ii) Casualties are replaced in July or latest by first week of August.

### **6.3.2 Weeding and Hoeing**

- (i) First weeding and hoeing is to be done in August. Climbers, if any, should be cut and removed. Casualties if any should also be replaced.
- (ii) Second weeding and hoeing is suggested in October. Some loose soil should be heaped around the plant. Branches in lower 1/3<sup>rd</sup> of the stem may be pruned if plants have grown beyond 3 m in height.

### **6.3.3 Irrigation**

Irrigation of plants put in for replacement of casualties is to be provided immediately after planting. For older plants irrigation has to be provided if rains have failed and there is drought. A break in monsoons continuously for 4 weeks will be considered sufficient reason for providing irrigation. Second irrigation may again be provided if there is another break for same duration. In case there is no need for second irrigation in August/September it may be saved for next February/March.

## **6.4 Third Year**

### **6.4.1 Weeding and Hoeing**

Weeding and hoeing are to be done in September. Heap the soil around plants as was done in previous years. Climbers, if any, are to be cut.

### **6.4.2 Irrigation**

One irrigation can be used in 3<sup>rd</sup> year if monsoons are deficient.

## **6.5 Protection**

Protection from grazing needs to be provided right from the time of planting for at least full 3 years, if not possible for 5 years.

## **6.6 Pruning**

Pruning is normally prescribed after plants have attained a height of 5 - 6 m. Branches are pruned upto 1/3<sup>rd</sup> of the plant height for a clean bole. In case a fork appears at a low level, the best branch may be retained, pruning the poorer one. Only sharp blades are to be used so that bark does not split away from wood at any cut point.

## CHAPTER 7

### CROP PROTECTION FROM PESTS & BIOTIC FACTORS

#### 7.1 General

During the first two years when plants are tender they need protection from various pests and various biotic factors. Attention in this respect is vital for success of this venture. Below some information on various menaces is given.

#### 7.2 Termite Menace

Many areas in general, and saline and sandy areas in particular, tend to have severe problem from termites. Termites start to appear after moisture in soil starts decreasing in November. Following is the treatment suggested for termite control:

Heptachlor is used to control termites. Directions for its use are given on pack or given by dealer. These directions should be followed.

#### 7.3 Caterpillars

Different caterpillars appear on the scene during the growing season and start nibbling tender leaves and buds. To control their menace, spray thiodine solution on affected plants and around these. Spray of thiodine controls most of the insect pests moving on plants. Thiodine solution is made as under: Dissolve 30 ml of Thiodine (*Endosulphan*) 30 EC in 15 litres of water. This is the solution ready for spray.

#### 7.4 Fire Protection

Fire damage can be very severe and needs to be prevented. Grass in plantation areas starts drying in October - November and soon becomes inflammable. Carelessly thrown cigarette/ *bidi* burning stubs can start a fire. Following measures need to be adopted:

- An about 2.5 m wide strip around the plantation area should be cleared of all inflammable material.
- Have a fire line of 1 - 2 m width laid out and cleared of all inflammable material in the plantation area, in form of rows and columns at a spacing of 50 -100 m apart.
- Allow grass in the plantation area to be cut and carried away by villagers for their cattle or other use.

### **7.5 Climbers**

In initial stages when plants are still small and the area gets lot of sunlight, climbers start coming up in plantations. These climbers can strangulate the plants or may allow many insect pests to move from plant to plant. So cut each climber at two places and remove cut material, dumping it in a pit in an isolated corner or disposing it off in any other way, whenever weeding is done in the plantations.

### **7.6 Cattle Damage**

The cattle population is increasing in rural areas since dairy farming is also being promoted by the Government under different development schemes. People are accustomed to graze cattle on common/ community lands and there are grazing grounds in rural areas. Land available with people for growing fodder crops is very limited, considering the size of the cattle population. Following steps are suggested:

- Plan for alternative arrangement for cattle grazing.
- There are lots of grasses and other palatable plants that grow during the rainy season. Excess of these should be harvested and made into silage to be used as fodder during lean periods.
- Lots of grasses grow even in plantation areas. Encourage these to be cut and carried away for cattle feed.
- Last but not the least: Whenever plantations are to be raised in or near any village, it is advisable to involve villagers in plantation programmes. People need to be educated about the necessity of afforestation. Call a meeting to discuss problems with affected people.

## **CHAPTER 8**

### **PLANTATION JOURNAL & JOB CALENDAR**

Previous chapters have described field works to be carried out for raising a plantation. This chapter deals with keeping a record of these activities.

#### **8.1 Plantation Journal**

It takes quite a few years to establish a forest plantation and see it to its maturity. Initially a lot of expenditure is incurred and also quite an effort invested, but later on some income also starts pouring in. Recording all this in a register and maintaining it as a permanent record may help in future also. The date when a job is started and the date when it is completed, along with expenditure incurred – all has to be recorded in this register – and this register is called a plantation journal. Further, if the crop happens to suffer from any disease or if it suffers some damage from pests or there is some other calamity, that also gets recorded. Measures adopted to remedy the situation are also mentioned in the journal. All this information may act as a guide for dealing with any future problems.

#### **8.2 Job Calendar**

Different activities related to raising and maintenance of plantations are performed at certain pre-determined times of the year - besides, for many activities some advance preparations are needed. All this is indicated in the calendar. The worker has simply to see the calendar, chalk out his daily programme and execute his work in time. This ensures successful completion of the job. Thus the job calendar helps in streamlining the performance of daily routines and completion of different jobs satisfactorily and in time.

### **8.3 BASIC INFORMATION & FIRST YEAR'S WORKS**

In the plantation journal there are forms which need to be filled in as the work progresses. This keeps the work in-charge on his toes and ensures satisfactory performance of his job. Information recorded in these forms is somewhat as under:

#### **8.3.1 Primary Information**

1. Name of plantation site
2. Village
3. *Tehsil* and district
4. Site survey no./ *khasra* no.
5. Total area

N.B. Please attach site map as per revenue record.

#### **8.3.2 Site Specific Information**

1. (i) Soil type  
(ii) Soil depth
2. Description of existing vegetation at the time the area becomes available for planting. Indicate species/ trees standing on site
- 7 Information about ownership
- 8 Information about land transfer
- 9 Soil analysis report
- 10 Climate
  - (a) Temperature
  - (b) Rainfall
- 11 Irrigation facilities
- 12 Analysis of water available
- 13 Tree species suited to above site & climate

#### **8.3.3 Specific Information about Village**

1. Village name
2. Total population
3. Total no. of families

4. Area of total arable land
5. Waste land - total area as per revenue records and reference no.
6. Details about Panchayat grazing ground
7. Cattle population
8. Other particulars

Record here sources from which villagers procure their needs of timber, fuel wood, fodder, fruits, vegetables and give comments about their scarcity etc.

### 8.3.4 Information about Plantation Site

1. Area of plantation site
2. Year when work started
3. Details of plantation plans: Include map indications, details of work planned
4. Irrigation facilities - information about facilities if available
5. Details of Plantation Work envisaged

	Spacing	Area of plantation	No. of seedlings to be planted	Add 20 % of seedling no. for casualty replacement	Total No of seedlings required

### 6. Details of Soil Work

Date when work started	Date when work was completed	No. of pits dug	Size of pits

### 7. Soil/ Water Conservation Works

Check dams		Ponds		
No of check dams	Size of check dams	No of ponds	Pond area	Pond's capacity

Any other information about these measures.

## 8. Fencing

Type of fence	Length	Date when work started	Date when fence was completed
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### 9. Further information about Soil Work:

- (i) (a) Quantity of FYM mixed per pit
- (b) Total quantity used
- (ii) (a) Termite control adopted: Y/N?
- (b) Name pesticide used
- (c) Quantity of pesticide used.

### 8.3.5 Source of Planting Stock

Under this form the following information is recorded in the journal:

- 1. Name of nursery
- 2. Distance from plantation site
- 3. Details of plants needed for planting

Species	No. of plants	Average Height	Health	Remarks
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- 10. Date of start of planting
- 11. Date of completion of [planting
- 12. Any information about alternate area for grazing

## 8.4 Maintenance

### 8.4.1 First Year's Works

- 1. Dates of:

Weeding	Hoeing	Fertilizer application (indicate date and quantity used)	Replacement of casualties (indicate dates and no. of plants replaced.)	Remarks

- 2. Details of second weeding etc. (Similar as under item 1 above)
- 3. Indicate details of use of pesticides if any.

#### 8.4.2 Second Year's Activities

1. Details of first weeding, hoeing, fertilizer application, climber cutting, casualty replacement etc.
2. Details of second weeding etc.
3. Details of use of pesticides if any.

#### 8.4.3 Third Year's Activities

1. Details of weeding, hoeing, climber cutting etc.
2. Steps taken for protection of plants.

#### 8.4.4 Irrigation Details

No. of irrigations and dates thereof provided in 1<sup>st</sup> year.

No. of irrigations and dates thereof provided in 2<sup>nd</sup> year.

No. of irrigations and dates thereof provided in 3<sup>rd</sup> year.

#### 8.5.1 Details of Survivals after 3 Years

Sl. No.	Species	Spacing	No. of plants	Average height
1	2	3	4	5

Average DBH	Health	Remarks
6	7	8

#### 8.5.2 Details of Produce Obtained from Plantation Area after Establishment

Year	Name of produce	Details	Quantity	Remarks
1	2	3	4	5

Above form should include grasses, flowers, fruits, timber, fuelwood, gum etc.

#### 8.5.3 Details of Trees fit for Cutting

Sl. No.	Species	No. of trees	Average height	Average DBH	Remarks
1	2	3	4	5	6

#### 8.5.4 Crop Obtained at Maturity

Year	Species	Quantity	Remarks
1	2	3	4

#### 8.5.5 Manner of Disposal of Crop

1. Was it auctioned? If not, how was it sold?
2. Purchaser's name
3. Was any produce given to villagers and at what cost?  
Was any concession given to villagers, if yes, how much?
- 9 How were fodder, grass, fruits etc. disposed off?

#### 8.6 Financial Aspects

##### 8.6.1 Details of Income Received from Plantations

Year	Produce	Purchaser's name	Quantity	Price	Amount	Remarks
1	2	3	4	5	6	7

##### 8.6.2 Details of Expenditure on Plantations

###### Expenditure on Purchase of Materials/Tools etc.

S. No.	Date	Item purchased	Quantity	Rate	Total cost	Remarks
1	2	3	4	5	6	7

##### 8.6.3 Details of Expenditure on Labour

S. No.	Dates from – to	Type of work	No. of labourers	Man days	Labour rate	Total cost
1	2	3	4	5	6	7

##### 8.6.4 Expenditure on Protection

S. No.	Year	Details of work	Rate	Total Expenditure	Remarks
1	2	3	4	5	6

### 8.6.5 Expenditure on Extraction

Sl. No./ Date	Produce details	Rate	Total expenditure	Remarks
1	2	3	4	5

### 8.7.1 Details of Assistance (if any) Received from Outside Agency

Job for which assistance was received	Rate	Total amount	Cash received	Goods received (give details)	Remarks
1	2	3	4	5	6

### 8.7.2 Remarks of Inspecting Officers

Sl. No.	Name of Officer, Designation & address	Date	Activity seen and instructions issued	Implementation details
1	2	3	4	5

## 8.8 JOB CALENDAR

Month & year	Works to be done in first fortnight	Works to be done / completed in second fortnight
	FOR AREAS TO BE PLANTED NEXT YEAR	
March		To prepare map of area to be planted next year, indicating therein the boundary and main features.
July		Indicate in map low lying areas where water stagnates, also locate spots where check dams, ponds etc. need be constructed.
September	Demarcate areas with choice of species to be planted and decide about type of fence to be put. Submit estimates to divisional office.	
November	Start soil working, pit digging as per need of species.	
December – March	Align and start construction of trenches; continue pit digging.	
March – April	Start work on fence erection/ construction.	Take up planting in waterlogged areas where water has disappeared due to summer heat.
May	Complete soil working, fence erection etc.	
<b>FIRST YEAR OF PLANTING</b>		
June- July 1 <sup>st</sup> fortnight	Start planting work after onset of monsoon on some cloudy day. Complete planting by July 15. First irrigation to be done if there are no rains within 2 days of planting.	
August	Take up first weeding, hoeing, beating up and fertilizer application.	Provide 2 <sup>nd</sup> irrigation.
September	2 <sup>nd</sup> weeding & hoeing; replace casualties.	Provide 3 <sup>rd</sup> irrigation.

Month & year	Works to be done in first fortnight	Works to be done / completed in second fortnight
October	3 <sup>rd</sup> weeding, hoeing, climber cutting and piling up of soil around stems.	
November	Inspect fences and ensure proper protection.	Look for termites and take steps to administer suitable pesticide if necessary. If no termites are seen, record it accordingly.
December	Inspect fence again.	
January	Look for termites, take action if termites are seen.	Record your observations and action taken.
February – April	Protect plantations and plants. See that fence is in proper shape. 4 <sup>th</sup> weeding & hoeing to be carried out in March.	Provide 4 <sup>th</sup> irrigation.
May	Dig new pits if casualties are found.	
<b>SECOND YEAR</b>		
June – July 1 <sup>st</sup> fortnight	Beating up of casualties. Inspection of fence and repairs if needed. This is a critical time as rains often fail and newly put plants need closer attention. See that irrigation is provided to all the plants if there is break in rains. Ensure that quantity of water is not less than expected, i.e. 15 litres to a plant.	
July	Protection.	
August - September	First weeding, hoeing, fertilizer application and climber cutting Protection. Second irrigation may be provided a month after the first, but only if there is a dry spell of not less than a week. Replace casualties if any.	
October	2 <sup>nd</sup> weeding, hoeing, climber cutting, loosen soil and pile it up around stems.	
November – May	Protection.	
<b>THIRD YEAR</b>		
July-September	One watering is provided in estimate during 3 <sup>rd</sup> year; provide it at a critical time. Provide one irrigation if required.	
October	Weeding, hoeing, climber cutting, loosen soil and pile it up around stems.	Protection. Take up pruning if necessary.
October – May next year	PROTECTION	

## CHAPTER 9

### SUPERVISION OF PLANTATION WORK

#### 9.1 General

Work relating to raising of a plantation comprises planning for it, preparing site map according to plan, procuring seedlings from nursery, transporting these to site, planting these at their assigned place, viz. pits/ trenches etc., carrying out works pertaining to their after-care, protecting these from pests, diseases and other biotic factors. Besides, it also includes arranging and organizing a labour force to do the job properly and keep records of various activities involved. Success of plantation demands that each and every job is done properly and timely. To ensure all this it is necessary that an experienced and conscientious official is present at the place of activity to guide and supervise the numerous workers engaged there.

This chapter tells of the works that the supervisor has to pay attention to. There are certain instructions that have to be followed; also there are certain questions, and answers to these have to be had to ensure that everything is proceeding satisfactorily.

#### 9.2 Site Preparation

- Is location map available?
- Is plan map also available? Does this map show the number of pits to be dug and also their size? What are the different species and number of plants thereof that will be planted? Has every item of work been indicated on this map?
- Have different items (tools, implements and other goods as indicated under para 3.4.3) been procured?
- As regards pit digging, is the same being done after proper alignment? What is the size of pits provided in estimate? The supervisor should see that workers know how to do it.

- When spacing between plants is in rectangular form, e.g. 2 m x 3 m or 2 m x 4 m (and not 2 m x 2 m which is in square form), it has to be ensured that the longer side of the rectangle is in north-south direction. Is it being done?
- In case the land is sloping, is terracing pattern being adopted?
- Have check dams/ ponds been rightly located?

### **9.3 Plantation Safety**

- Has it been decided as to what type of fence will be made?
- In case it is live fence, have steps been taken to have it in position in time?
- What is the species being used for live fence?
- Has planting material been arranged?
- Is any trench a part of the fence? If so, is the size of the trench dug as per that provided in estimate?
- In case it is barbed wire fence, has the wire been purchased?
- Ensure that fence posts, if of bamboo or some wood, are properly treated with tar for prevention of termite attack and also that these posts get fixed firmly in the ground.

### **9.4 Planting**

- Has arrangement been made to transport planting material from nursery to plantation site in time?
- Is shade available at the planting site for stacking of plants/ seedlings if delay in planting occurs? What about availability of water that may be needed for sprinkling on stacked seedlings?
- Planting of seedlings in their assigned positions is the most important item of the plantation job. The supervisor should try to be present throughout the period when this job is being done. Labourers do need guidance/ supervision on different aspects. Planting of polybag plants without removal of polybags is not a very rare occurrence. Such mishaps occur only if there is laxity in supervision.

### **9.5 After-care of Plantations**

- Three weedings/ hoeings etc. have been prescribed in the first year. These operations are important for survival of plants and need to be carried out tenderly. It will be helpful if the supervisor demonstrates to workers the methods involved in carrying out different operations.
- Is climber cutting being done?

### **9.6 Protection from Pests & Biotic Factors**

- In these operations, pesticides that are used are essentially poisonous and need to be handled carefully. The supervisor should acquaint himself of precautions that are needed to be taken and also instruct workers to observe the same carefully. These instructions are always provided on packages containing these pesticides.
- Have proper precautions been taken to prevent fire damage?
- What is the condition of the fence? Have any cattle ever been seen inside the plantation area - has any dung been found on the ground? If yes, then find out how it happened. Take corrective measures.

### **9.7 Plantation Journal & Job Calendar**

- Every piece of work that has started and has been completed should get recorded in the plantation journal. To ensure this, it will help if proper forms are made and incorporated in the journal. Expenditure incurred on different items of work has also to be entered in the journal.
- As regards the job calendar, it should be the second nature of the supervisor to consult it frequently. This keeps him alert towards his duties. It also helps him to tackle problems in time to prevent mishandling of work in his charge. In raising of plantations, the role of the supervisor is the most important and it will always go to his credit if his plantation develops in a healthy way.

## **9.8 Responsibility**

Reading this chapter may give an impression that supervisor is the only person responsible for establishing and looking after a plantation. It is not so. Range Officer and superiors are equally involved in the venture. Every work that is completed has to be paid for. Rang Officer has to inspect and certify about satisfactory completion of the work. Instructions given in this chapter should also be noted by him and followed. DFO has to pass the voucher and authorize its payment. He too has to keep a watch on the work.

## SILVICAL CHARACTERISTICS OF RECOMMENDED SPECIES

For proper planning of plantation programme it is necessary to have an understanding of important silvical characteristics of the species recommended for different plantation models outlined in the OWP of the HCFP.

The important silvical characteristics of 20 species are discussed below.

### 1. *Acacia catechu*

Common name	Khair.
Uses	Wood yield catechu (Katha).
Seed collection	December – March.
No. of seeds/kg	40,000.
Seed viability	8 - 10 months. One year stored under dry, cold and airtight condition.
Germination percent	60 - 40%.
Pretreatment of seed	Soak in cold water for 24 hours.
Nursery technique	Raised by direct sowing or by stump planting. Germination in 8 - 30 days and plantable size seedlings are ready in 3 - 4 months. Transplants exhibit high mortality due to damage caused to long tap root suckers. Vegetative propagation through coppice and cuttings. Growing in 100 - 150 cc root-trainer is recommended. Seedlings show high tendency of branching from the base. Hence, planting when seedlings are 15 - 20 cm tall is preferred.
Site requirements	<i>Climate:</i> Grows in tropical areas under direct sunlight; it does not tolerate shade. Rainfall in its natural habitat varies from 500 mm to 2500 mm.  <i>Soil:</i> Occurs on variety of soils though it thrives best on sandy soils available along river banks. It also grows on gravel at the foot of hills and also on murrum.

*Spacing:* Bag plants are usually planted at spacing of 4 m x 2.5 m. When raised by direct sowing, seeds are sown 10 cm apart in lines 3 m apart.

*Pests:* Rodents do a lot of damage to young seedlings; it also suffers from certain insects. To control rodents rat poison is mixed in soil, while against insects use of thiodine 30 E.C. is recommended. When old, Ganoderma lucidum causes serious root rot. Sites having this fungus should be avoided.

## 2. *Acacia nilotica ssp. Indica (syn. Acacia arabica)*

Common name	Keekar, Babul.
Uses	Excellent firewood and gives good quality charcoal, calorific value is 4,950 cal/kg. Widely used for making agricultural implements and cartwheels. Bark is rich source of tannin (12% tannin content).
Seed collection	April – June.
No. of seeds/kg	7,000 – 11,000.
Seed viability	More than two years.
Germination percent	88%.
Pretreatment of seed	Seed coat is very hard. Seeds are dipped in boiling water for one minute and soaked in water for 24 hours. Pods fed to sheep and goat and scarified seeds (in their droppings) are collected from their pen.
Nursery technique	Direct seeding is the easiest and most common method for raising babul plantation. In February to March one or two treated seeds are dibbled in polybags filled with potting mixture (soil and compost in 2:1 proportion). Germination starts one to two weeks after sowing and is completed in a month's time. Germination is epigeal. In the case of root-trainers pre-germinated seeds are sown. After germination 2 - 3 watering/week are given, excessive watering to be avoided. Regular weeding is done for 2 - 3 months and excess seedlings are removed leaving one seedling in each container. The seedlings attain a height growth of 30 to 49 cm with a woody rood collar in six months time, which is the correct stage for planting out. It is frost tender and should, therefore, be protected during winter. Site quality I can support 1196 trees at five years to produce maximum volume.
Site requirements	Soil does well on alluvium but comes up on a variety of soils from poor skeletal to black cotton soils.  <i>Climate:</i> It is happy in hot climate with summer temperatures almost reaching 50° C. It has a long tap root that goes deep in soil in search of water. The species can grow in dry areas having rainfall 100 mm to 1200 mm. Young seedlings suffer from frost.  <i>Spacing:</i> Recommended is 4 m x 2.5 m in 45 cm x 45 cm x 45 cm pits.

Other characteristics

Fixes nitrogen. Poor coppicer. In average areas it is expected to produce about 400 quintals of fire wood after 6 years. Trees at age of 10 years may also produce about 250 gms. of gum. For timber production rotation has to be >20 years. It dies early when raised in areas having *kankar* pan.

### 3. *Acacia tortilis*

Common name	It was introduced from Elat, Israel in 1963 in Jodhpur and is called Israeli babul.
Uses	Good firewood (4,400 kcal/kg), lopped for fodder (4 – 6 kg dry leaves and 10 - 12 kg pods/tree/year). Crude protein and digestibility coefficient reported to be 18% and 46.2% respectively. Its gum has medicinal properties.
Seed collection	November – February.
No. of seeds/kg	12,000.
Seed viability	1 – 2 years.
Germination percent	40-60%.
Pretreatment of seed	Soaked in concentrated Sulphuric acid for 40 minutes and immediately thoroughly washed in running water. Can also be dipped in boiling water just removed from the boil and allowed to soak in the cooling water. Pods fed to sheep and goats, and scarified seed collected from their droppings.
Nursery technique	In February – March two or three seeds are sown 1-1.5 cm deep in polybags filled with potting mixture (sand, clay and FYM mixed in equal proportion). Germinate in 60 days. Surplus seedlings are pricked out to empty polybags. By early July seedlings are 25 - 30 cm at planting.
Site requirements	<p><i>Soil:</i> It grows on soft dry, porous gravelly or sandy soils. Shuns areas where water stagnates. Is used in fixing of sand dunes.</p> <p><i>Climate:</i> It tolerates extreme dry climate with maximum temperatures reaching 50° C. Needs direct sun light for its growth. Rainfall in its habitat varies from 100 mm to 1000 mm. Young plants suffer from frosts.</p> <p><i>Spacing:</i> Adopted for this species is 2.5 m x 4 m. It coppices well and at time of harvesting stump with 15 cm height is left for coppice to come for next rotation.</p> <p>It yields about 40 tonnes of wood per ha. at age of 10 years, if it is growing well.</p>
Other characteristics	Compared to indigenous arid zone tree species its growth rate is four to five times more. In the Indira Gandhi Canal Project, Rajasthan its MAI was recorded as 6m <sup>3</sup> /ha. An excellent species for refractory sites, including shifting sand dunes.

#### 4. *Aegle marmelos*

Common name	Bel.
Uses	Fruit has great medicinal value; leaves are good fodder; bark yield tannin (11.58%); timber used for agricultural implements.
Seed collection	April – May.
No. of seeds/kg	5,300.
Seed viability	30 – 180 days.
Germination percent	56%.
Pretreatment of seed	After separating seed from pulp seeds are soaked in water for 24 hours.
Nursery technique	Fresh seeds @ two seeds sown per polybag in June or July covered with soil and irrigated. Germination starts in about a week's time and takes about a month to complete. One or two-year-old seedlings are out planted by which time they are 15 – 30 cm high. Desirable to propagate by gootee or in arching from the selected trees. Plants start fruiting within 4 -5 years.
Site requirements	<p><i>Soil:</i> Attains best growth in well drained soils with sufficient moisture. It does occur on gravelly and poor soils but growth is also poor. It is a good coppicer.</p> <p><i>Climate:</i> It is frost and drought hardy. Grows in hot climate with rainfall varying from 500 mm to 1500 mm.</p> <p><i>Spacing</i> suggested for this species is 4 m x 4 m.</p>

## 5. *Ailanthus excelsa*

Common name	Ullu Neem, Maharukh, Ardu.
Uses	Good camel fodder (a farmer can get as much as Rs. 300 – 350 from leaf fodder/tree/year). It yields 5 - 7 quintals of green fodder twice a year. Leaf fodder can be dried and store. It is rich in calcium and crude protein. Timber is used in match and sports goods industries.
Seed collection	May – June.
No. of seeds/kg	9,500.
Seed viability	Poor (one to six months). Seeds must be used the same year.
Germination percent	70 - 90%.
Pretreatment of seed	Not necessary.
Nursery technique	Seeds are dried in the sun and the seeds are separated from fruits. Seeds being small, they are usually mixed with sand before sowing. In December – January seeds are sown in polybags filled with potting mixture (soil, sand and FYM mixed in 3:2:1 proportion). Germinate in 8 - 10 days and germination is completed in about 40 - 45 days. Can also be propagated by root shoot cuttings 2 - 3 cm in diameter, which are prepared from one-year-old seedlings. A spray of urea boosts seedling growth. Avoid over irrigation it causes seedling mortality due to damping-off. Regular weeding and hoeing are more important than frequent watering. In January, February and April weeding and hoeing is necessary and has been found beneficial for seedling growth. At the end of one month seedling attains a height of about 22 cm.
Other characteristics	Thrives best on porous sandy loam soil and avoids clayey soils with poor drainage and waterlogged areas. The rainfall range is wide. However, it avoids heavy rainfall area. It is strong light demander, fast growing and good coppicer. When mature the tree is large, 18 - 25 m high with a straight trunk of 60 - 80 cm diameter. Susceptible to defoliator attack, which can be controlled by spraying 0.2% Endosulphan solution.

## 6. *Albizzia lebbek*

Common name	Siris.
Description	Generally grows upto 20 – 30 m in height; has a good round crown when grown up. Its roots spread along surface of the ground and is not strongly anchored. Strong winds do fell it at places.
Seed collection	June – July.
No. of seeds/kg	8,000 – 12,000.
Germination	60 - 90%.
Pretreatment of seed	Soak in cold water for 24 hours.
Nursery technique	Sow directly in polybags in February/March or in beds in September/October and transplant in polybags when plants are 6 - 10 cm high. Plants are put in field in July with onset of monsoons.
Site requirements	<p><i>Soil:</i> Grows on variety of soils; likes well drained site; tolerates alkalinity upto a point say pH 9.0; can grow in deserts.</p> <p><i>Climate:</i> Grows in hot climate with temperature varying from 5 - 45° C. Tolerates drought; rainfall in habitat varies from 500 mm to 2000 mm.</p>
General characteristics	Species coppices; is fairly fast grown; is cut at rotation of 10 years or more. When mature it has heartwood that is fairly strong and is used in variety of things including furniture.

### 7. *Anthocephalus chinensis* (syn. *A. kadamba*)

Common name	Kadamb.
Uses	Veneering, ceiling boards, packing cases, canoes, etc.
Seed collection	January – February and August – October.
No. of seeds/kg	10,00,000.
Seed viability	About one year (moderate and long lived).
Germination percent	90% and above (of freshly extracted seeds).
Pretreatment of seed	Not required.
Nursery technique	<p>Sowing should be done thinly in February to have the right size of seedlings at the planting time. Soil medium and watering with fine spray is good for germination. Germination takes place in about three weeks. Seeds being very minute are mixed with sand before sowing. Sowing is done from March-May @ 130 gm seed/m<sup>2</sup>. Young seedlings are sensitive to both drought and excessive moisture, watering should, therefore, be done with a fine rose and as per seedlings need. Pricking out should be done when the seedlings are five cm in height. The species can be grown in root-trainers as well. In Haryana, like Poplars, this species can grow on light soils with irrigation.</p>
Other characteristics	<p>A tree of moist warm region. Prefers deep well drained moist alluvium. Fast growing, for first 6-8 years height-growth averages 3.05 m/year. Growth is slower up to 20 years and thereafter it tapers off. It is sensitive to frost and is severely browsed.</p> <p>It starts flowering at age of 6 - 8 years. Flowers are eagerly eaten by monkeys and langurs, who climb to its top and in the process break leading shoots. This seriously affects its growth.</p>

## 8. *Azadirachta indica*

Common name	Neem.
Uses	Leaves provide excellent fodder and are used for extraction of azadirachtin, used as insect-repellent. Fruits used for extracting neem oil or morgosa oil used in soap, disinfectant drugs and as a lubricant. Seed cake is excellent manure. Bark contains tannin. Wood is used for furniture, carts, axles, yokes, packing cases, ship and boat building, etc. In arid regions wood is used as firewood.
Seed collection	June – August.
No. of seeds/kg	3,300 - 4,400.
Seed viability	15 - 30 days.
Germination percent	Stored seeds: 15%, and Fresh seeds: 85 – 90%.
Pretreatment of seed	De-pulping and soaking the seed in cold water for 24 hours.
Nursery technique	<p>Can easily be raised by direct seeding. In June-July seeds in nursery beds are dibbled 2.5 cm deep at a distance of 2.5 cm in lines and lightly covered with sand and the beds are sparingly watered. Germination occurs in 1 - 2 weeks. Seedlings are pricked out at 15 cm<sup>2</sup> when about two-month-old. Weeding and hoeing are beneficial. In frosty localities seedling are to be protected by erecting overhead screens closed to ground.</p> <p>When seedlings are 7 - 10 cm tall with taproot 15 cm long, these are out planted with ball of earth around the roots. In dry areas, two-year-old seedlings (at least 45 cm in height) are planted to enable them to tide over prolonged drought period. Alternatively, two seeds can be sown in polybags. Polybag-raised seedlings do well in difficult sites. It can be regenerated by dropping one or two seeds in clump of bushes (such as Euphorbia, Capparis, etc.). These bushes provide favourable conditions for growth, particularly protection against browsing.</p>
Site requirements	<i>Climate:</i> It usually grows in dry areas with rainfall ranging from 450 mm to 1200 mm. It can tolerate temperatures upto 45° C. It needs sunlight for its growth, though in seedling stage it needs protection from hot sun.

*Soil:* It grows on variety of soils e.g. dry, gravelly, sandy, deep or clayey. It has roots very capable of going very deep into ground in search of water and nutrients. It however avoids water-logged conditions.

*Spacing* adopted usually is 5 m x5 m.

Other characteristics

Fruit, when ripe, are yellow in colour and fall from trees in June - July. Healthy fruits can be collected from ground. Fruits are depulped and then dried. Seeds are short lived and viability is lost in 2 - 3 weeks. Fresh seeds however show about 90 - 95% viability.

Tree starts fruiting at about 5 years. A ten-year tree will yield about 10 kg of fruit and a mature tree can yield about 50 - 100 kg. Besides, a mature tree will also yield about 400 kg of leaves. On good soils crop will yield about 4 - 10 cum. of wood per annum of its age.

## 9. *Dalbergia sissoo*

Common name	Sissoo, Shisham.
Uses	Finest timber used for doors and windows to cabinet making and carving. It is good for turnery. Lops and tops used a firewood and leaves as fodder.
Seed collection	November – March.
No. of seeds/kg	50,000.
Seed viability	At least one year.
Germination percent	90%.
Pretreatment of seed	Pods are broken in segments each containing a seed. No seed treatment is required.
Nursery technique	It is regenerated either by direct seeding in the field or by root suckers. In nurseries seedlings are raised in regular beds flush with ground or slightly sunken in relatively dry area. Soil is thoroughly worked and pod segments containing seed are sown either in February – March or in July - September. Beds are irrigated either manually or by flooding at an interval of 3 - 4 days. Over flooding should be avoided. For production of tall transplants (3 m or more) sowing in irrigated nurseries is done in February. The stock is first transplanted when 10 - 15 cm tall in about 4 months, 15 cm <sup>2</sup> spacing. A second transplanting is done 4 - 6 months later when plants are about a m high, at 25 cm <sup>2</sup> . Stump or root-shoot cuttings are also used for raising plantations. Thicker stumps give healthier and bigger plants. In dry areas container plants are raised for out planting.
Site requirements	<p><i>Soil:</i> Prefers well-drained sandy alluvial soil and avoids stiff clayey as well as saline soils overlying hard calcareous pan.</p> <p><i>Climate:</i> Hot climate suits it. Can survive extreme temperatures of 50° C and also 0° C. It occurs in areas having rainfall in range of 750 mm to 4500 mm. Areas with lesser rainfall cause stems to become crooked.</p> <p><i>Spacing</i> adopted for this species is usually 4 m x 2.5 m in pits of 45 cm x 45 cm x 45 cm. Species can also be raised from root-shoot cuttings (stumps). Technique is similar to that adopted for teak.</p>
Other characteristics	Yield at about 15 years will be about 40 tonnes of firewood and at about 20 years about 100 cum. of timber can be had. A rotation of about 30 or more years is recommended if timber is to be produced.

## 10. *E. tereticornis*

Common name	Eucalyptus hybrid.
Uses	Leaves: essential oil, Wood: pulp, core veneer, Firewood and charcoal.
Seed collection	May.
No. of seeds/kg	80,000 (minute in size).
Seed viability	10 years (seed stored at room temperature with relative humidity between 20 - 16%).
Germination percent	High.
Pretreatment of seed	Not required.
Nursery technique	<p>To obtain even distribution seeds are mixed with fine sand. The seeds are sown either in shallow earthen trays having a few holes or in raised nursery beds. In both the cases the germination medium is a mix of sand and compost in equal proportion. The seeds are sown in February - March. After sowing the trays are kept in a bowl filled with water and as soon as the topsoil becomes moist the tray is removed and kept under shade, the procedure is repeated as soon as the topsoil becomes dry. A fine rose can should be used to water the beds. Trays can and shaded by a thatch screen 30 - 50 cm above the bed.</p> <p>Germination commences in about a week and is completed in about 2 - 3 weeks. When the seedlings show second pair of leaves above the cotyledons, the seedlings are transplanted into polybags filled with a mixture of sand and compost in 1:1 proportion. To protect the seedlings against termites the potting mixture is drenched with a solution of Chlorophyriphos in water. After over watering the polybags are kept in sunken bed and are shifted occasionally to check the roots growing into the bed. Alternatively the nursery bed can be lined with stone; this will obviate shifting and reduce frequency of root pruning and watering. Nowadays genetically superior phenotypes of Eucalyptus are propagated by cuttings in a mist chamber. Seedlings are also being raised by direct seeding in root trainers.</p>

## Site requirements

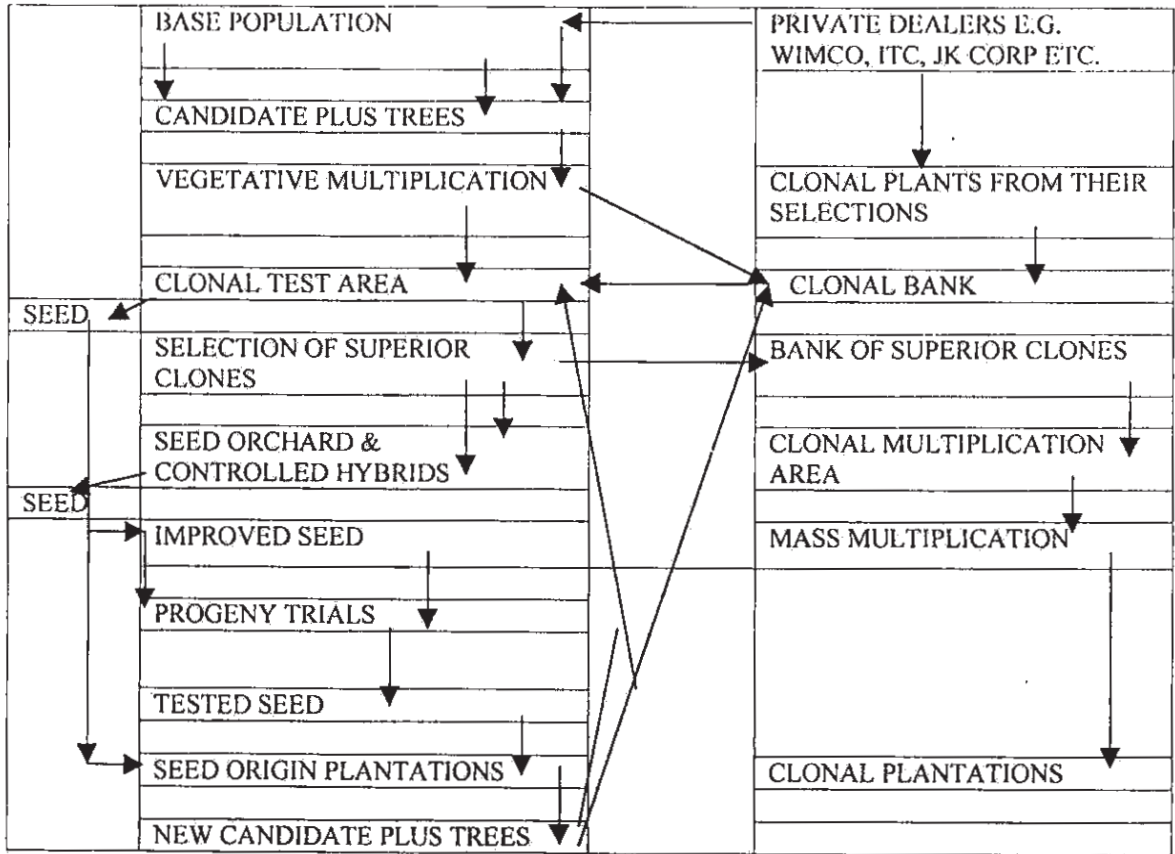
*Soil:* It needs a well drained site. Soil with pH varying from 6.5 to 8.0 is the best. It grows on gravelly, poor and shallow soils also, but growth is equally poor. It shuns water-logged conditions.

*Climate:* Normal hot climate where extreme temperatures reach 0°C and about 45°C suits it. Rainfall in the range of 750 mm to 1500 mm is quite good. If irrigation facilities are available it helps its growth a lot if it is provided in spring season when day temperatures are around 30-35°C and sun light is also plenty.

*Growth characteristics:* Crop raised with seedlings shows lot of variation from stem to stem. These seedlings are planted with spacing of 4 m x 2.5 m. Now clonal plants with their known origin from selected plus trees are available and their rate of growth is higher; so these need more space to grow. Yield from these plantations is very much higher. So more nutrients are needed. It is therefore recommended that pit size should be 60 cm x 60 cm x 60 cm. Besides, quantity of FYM, oil cakes and other chemical nutrients is also doubled. Site for clonal plants should also be best possible available.

The HCF Project is currently anxious to set up facilities for production of one million clonal plants annually. Once this gets done, the Project will be looking beyond this. For that moment, a flow chart on next page shows a suggested 'Tree Improvement Programme for *Eucalyptus tereticornis*' through route of Clonal Plants.

TREE IMPROVEMENT PROGRAMME FOR  
EUCALYPTUS TERETICORNIS  
THROUGH CLONAL PLANT ROUTE



## 11. *Ficus bengalensis*

Common name	Bargad.
Uses	Shade, small twigs and branches for elephant fodder.
Seed collection	April – May.
No. of seeds/kg	Very small.
Seed viability	Not available.
Germination percent	Not available.
Pretreatment of seed	Not available.
Nursery technique	Propagated by cuttings, which root easily. The seeds are very small, and are, therefore, mixed with fine sand at the time of sowing. The seeds are sown in trays filled with sand mixed with some compost and powdered charcoal. After the seeds are very lightly covered with soil watering is done with a fine rose. Seeds germinate in about a week's time. When seedlings are 5 cm tall they are transplanted out in the nursery beds at a spacing of 30 cm <sup>2</sup> . While transplanting care should be taken not to damage roots. Watering and weeding are carried out as per the need.
Site requirement	<p><i>Soil:</i> Grows on well drained soils.</p> <p><i>Climate:</i> It is a large evergreen tree that occurs in moist deciduous areas. It is much planted in villages and avenues throughout the country. Rainfall in areas of its occurrence varies from 1000 mm to 3000 mm and more. Throws down aerial roots from branches which are mostly horizontal and also act as feeders.</p> <p><i>Wood:</i> Its wood is gray and fairly hard; it is durable in water. Its leaves and twigs are a favourite fodder for cattle and elephants. Fruit is eaten at time of scarcity and is greedily eaten by birds and monkeys. It is an epiphytic tree and it is often seen growing on trees where its seed gets lodged through birds. It allows no species to grow under it because of shade.</p> <p><i>Spacing:</i> No spacing is being suggested for this species, simply because it is not planted pure. Normally it is planted as a central tree in a grove and here it can be placed about 6 - 8 m away from its neighbour. When planted as avenue tree it may again be planted at 6 - 8 m apart.</p>

## 12. *Ficus religiosa*

Common name	Pipal.
Uses	Shade and ornamental tree; its leaf-fodder is widely used for feeding elephant, sheep and goat.
Seed collection	April – May.
No. of seeds/kg	Very small.
Seed viability	Not available.
Germination percent	Not available.
Pretreatment of seed	Not necessary.
Nursery technique	For planting, the stock can be raised either by raising seedlings in the nursery or from rooted branch cuttings. Cuttings from branch 2 m in length and over 5 cm in diameter are planted during the monsoon. Cuttings dipped in rooting hormones (like Indol Butyric Acid) root in the months of March and September. For raising saplings in the nursery, the best method to sow the seeds in germination trays filled with a mixture of sand and compost. Sowing is normally carried out in March - April. The seeds are spread on the surface and lightly covered with soil.
Site requirement	<p><i>Climate and soil:</i> It will grow anywhere in dry as well as mist areas. In dry areas it needs some water body around. It is an epiphyte and does a lot of damage to its hosts. It is often seen growing on walls and abandoned buildings. It sends its roots through their crevices causing cracks therein.</p> <p><i>Spacing</i> suggested for this species is 6 - 8 m when planted as avenue tree. When it is planted in a grove same distance may be retained between <i>Ficus</i> and neighbouring plant.</p>
Other characteristics	<p>Its wood is grayish white and its leaves and branches are good elephant fodder.</p> <p>The species is good for a grove and also avenues and can easily be raised through branch cuttings.</p>

### 13. *Holoptella integrofolia*

Common name	Desi papri, Chirol.
Uses	Leaf and fruit eaten by cattle, excellent firewood (5,258 kcal/kg), Wood used for veneering, packing cases, shoe-heels, bobbins, matchboxes, etc.
Seed collection	April – June.
No. of seeds/kg	27,000.
Seed viability	Up to six months.
Germination percent	60%.
Pretreatment of seed	Soaking in cold water for 24 hours.
Nursery technique	The seeds are sown in April-May or September-October either in nursery beds or in polybags and the plants are ready for planting out by the beginning of the next year. They attain a height of 40-50 cm. Avoid excessive watering during germination and to juvenile seedlings as it causes seedling mortality due to damping-off. Weeding and hoeing improves seedling growth. Stumps can also be planted.
Site requirements	Comes up on a variety of soils ranging from rocky debris, stony porous grounds to deep porous soil. Requires good drainage. Moderate coppicer. It is browsed.  <i>Climate:</i> Occurs in dry deciduous areas having rain fall in range of about 600 mm to 1500 mm and temperatures reaching over 45° C in summer. It is not a frost hardy species.
Other characteristics	Wood is moderately hard and is used for buildings carts and carving. Seeds are oily.

#### 14. *Melia azedarach*

Common name	Bakain.
Uses	Planted as avenue tree. Wood used as firewood and oil is extracted from its seed, which is suitable for lightening.
Seed collection	September – October.
No. of seeds/kg	Not available.
Seed viability	Not available.
Germination percent	85 – 90%.
Pretreatment of seed	Light cracking the seed coat.
Nursery technique	Easily propagated from seeds, cuttings, stump sprouts and root suckers. Seed sown in February.
Site requirement	<i>Soil:</i> Needs good drainage Soil may be sandy or even rocky debris or stony porous.  <i>Climate:</i> Grows in hot climate with temperatures reaching beyond 45° C. Rainfall varies from 350 mm to 1500 mm.  <i>Spacing</i> adopted for this species is 4 m x 2.5 m.
Other characteristics	It is strong light demander and fast growing. It grows very fast and also coppices extremely well. Leaves are lopped for fodder and its wood is used for a variety of purposes in rural areas.  Its life is short and it needs to be replaced every 20 years or so.

### 15. *Phyllanthus officinalis* (syn. *Embilica officinalis*)

Common name	Aonla, Amla.
Uses	Leaves: fodder, Fruit: valuable source of vitamin C and used for making pickle and preservatives, Bark: used for tanning and dyeing, Wood : firewood (5,200 kcal/kg) and excellent quality charcoal.
Seed collection	November – January.
No. of seeds/kg	6,500 - 8,000 (small seeds).
Seed viability	6 months.
Germination percent	40%.
Pretreatment of seed	Hot water (80° C for five minutes).
Nursery technique	In March - April seeds are sown in polybags and the seedlings are ready for planting out in July when they are about 15cm tall.
Site requirements	<p><i>Soil:</i> It grows on a variety of soils; gravelly and dry soils suit is most. Wants good drainage but tolerates alkaline soils upto 8.5 pH.</p> <p><i>Climate:</i> Favours dry hot climate temperatures reaching almost 50° C in summer and rainfall ranging from 600 mm to 1250 mm. It is sensitive to frost and drought. Higher humidity favours luxuriant growth.</p> <p><i>Spacing:</i> When species is raised for fruits, it is planted with spacing of 5 m x 5 m.</p>
Other characteristics	Cultivated varieties like Kanchan, ND 5 and ND 7 are heavy bearers with big size fruits. Planting stock of these varieties can be obtained from the Horticulture Department, Acharya Narendra Dev. University of Agriculture Technology, Fyzabad.

## 16. *Pongamia pinnata*

Common name	Papri.
Seed collection	September – October.
No. of seeds/kg	800 - 1,000.
Pretreatment of seed	Soak in water for 24 hours.
Nursery technique	Seeds are sown in beds in October - November and plants are transferred to polybags in February. Planting in field is done in July.
Site requirements	<i>Soil:</i> Grows on a variety of soils - gravelly, sandy/ normal/ alkaline/ barren; even tolerates water logging.  <i>Climate:</i> Grows in hot climates, temperature reaching 50° C in area having rainfall of 500 mm to 2500 mm.
General Characteristics	Wood is good for sports items, bobbins etc. Leaf is used as fodder. Seeds are oily; oil can be used for soap making; plants start seeding in 5 years.

## 17. *Prosopis cineraria* (syn. *P.spicigera*)

Common name	Jand, Khejri, Sami, Sangri (Kandi is the trade name).
Uses	Leaves: fodder (on an average complete lopping of a full grown tree yields 59 kg green forage; crude protein of leaves range from 13.90 - 15.29), Bark: medicinal purposes, Fruits: used as vegetable, Branches: fencing material, Wood: firewood (5,000 kcal/kg) and house building, agriculture implements, boat frames, etc.
Seed collection	June – August.
No. of seeds/kg	2,700.
Seed viability	Not available.
Germination percent	40-60%.
Pretreatment of seed	Soaked in cold water for 24 hours.
Nursery technique	<p>Sowing is done in April - June. However, October sown seedlings are available, in about 9 months, for monsoon planting. Two seeds are sown 1 cm deep in a polybag filled with potting mixture (loam and compost in 2:1 proportion). Watering is done regularly. Avoid over watering. Germination starts in about four days after sowing and is completed in about two week's time. If both the seeds germinate, one of the two seedlings is clipped. To avoid roots striking the soil of the nursery beds the polybags are frequently shifted and the roots are pruned. After pruning, seedlings are watered. Alternatively a thick polythene sheet is spread under the polybags, or in the case of permanent nursery beds are paved with stone. Weeding from time to time helps in production of healthy seedlings.</p> <p>In about one month seedlings attain a height growth of 5 - 6 cm and at the end of one year seedlings attain plantable size. Even under irrigated condition initial seedling growth is slow. Normally no fertiliser is given; a small dose of urea may boost seedling growth.</p>
Site requirement	<p><i>Soil:</i> Grows on variety of soils, ranging from sandy to rocky debris to stony porous grounds with adequate moisture available in lower layers; grows on alkaline soils also (with pH &gt;9.0).</p> <p><i>Climate:</i> Strong light demander, drought resistant, susceptible to severe frost, prefers deep sandy loam soils quite happy in hot climates, survives temperatures</p>

varying from 0° C to 50° C; and rainfall from 100 mm to 900 mm.

*Spacing* adopted is normally 4 m x 2.5 m. Crop is usually harvested at rotation >10 years. Trees are usually cut 10 - 15 cm above ground for coppice to come up.

Other characteristics

Growth rate in pole stage is relatively faster than that in seedling and sapling stages as during the earlier stages a strong root system develops and thereafter shoot growth is accelerated. It takes about 15 - 17 years to attain an average height growth of 2 m - 2.30 m in dry areas. When young it coppices well and freely reproduces root suckers. Does not tolerate flooding.

**18. *Tecomella undulata***

Common name	Roheda, Marwar teak.
Uses	Building construction, furniture.
Seed collection	May – July.
No. of seeds/kg	75,500.
Seed viability	Poor.
Germination percent	0 - 30 (a large proportion of seeds per fruit are infertile).
Pretreatment of seed	Not required.
Nursery technique	Three to four seeds are sown in each polybag in June. It takes from 4 - 13 days to germinate. One-year-old seedlings are out planted.
Other characteristics	It is fire and drought hardy. High susceptibility to gerbil attack.

## 19. *Tectona grandis*

Common name	Teak, Sagon.
Uses	Furniture, doors and windows, ship building, carving, etc.
Seed collection	November – January.
No. of seeds/kg	1,200 – 3,000.
Seed viability	Several years.
Germination percent	10 - 60%.
Pretreatment of seed	Frequent soaking and drying for a week. The other method comprises heat treatment of one-year-old stored seed in 80° C for 48 hours, followed by soaking in water for 6 hours.
Nursery technique	Pre-treated (alternate soaking and drying) seeds germinate in about two months. Usually planted through stumps. Pre-germinated seeds are pricked out in polybags or nursery beds.

In the case of teak seedling production in root-trainers (RT) three main problems are identified, viz.

(i) Low germination, stretching out over time. This does not fit with RT technology, which essentially needs a good evenness of the crop. The solution to this problem is to either use pre-sprouted seeds or prick out 2 - 4 leafed stage;

(ii) Due to big leaf size, seedling when growing seems to require relatively big space. This will mean that if RTs are used, then unit cost for production of teak seedling will be high. Generally, the spacing in RT nursery is more important than the pot/cell volume. A general rule is that RT seedlings should be grown in such a way that the lower leaves are not pruned. The solution is:

(a) either to grow teak in single-pots/cells supported by a wire grid where spacing can be varied over time; or

(b) use mould with bigger pots/cells that automatically provide wide spacing; or

(c) grow seedlings in 150 cc pots/cells for a short time. From cost point of view 'c' alternative would be preferred;

(iii) Teak being predominantly a taproot species, it is perceived that the depth of pots/cell in root-trainer block is inadequate. A general experience from RT growing of taproot species is that deeper pots/cells are not needed in a self-pruning system. In 150 cc pots/cells, the taproot, as all other roots, develops well and forks out into 3 - 5 roots. When planted, any or several of these will develop into taproots. Self-pruning creates good and dense root systems that facilitate and improve plant establishment in field. Generally, the initial establishment of the seedling and subsequent growth of the roots is very fast after planting.

In view of the above the best approach would be to take up pilot production of teak seedlings in 150 cc pots/cells to test the technical and economic feasibility of RT technology before large investments are made.

Site requirement

*Soil:* Needs well drained soil, prefers sandy and light soils. Avoids heavy clayey black soils.

*Climate:* A species from moist deciduous areas, with temperatures varying from 15° C to 48° C and rainfall varying from 750 mm to over 3000 mm. It is a frost tender species and needs protection from cold when young.

*Spacing* adopted is 4 m x 2.5 m. Pits of 45 cm x 45 cm x 45 cm are used for transplants and crow bar holes are used for stump planting.

Other characteristics

It is good coppicer in young age. Difficult-to-root species. However, juvenile coppice shoots cuttings root. Leaf defoliator and skelatiniser are the major insect pests.

## 20. *Ziziphus mauritiana*

Common name	Ber.
Uses	Leaf: excellent fodder; Pruned branches: fencing material; Fruits: rich source of vitamin C; Wood: firewood (4878 kcal/kg) and charcoal; Bark: yields tannin (4 - 9 %).
Seed collection	October – March.
No. of seeds/kg	1240 - 1760.
Seed viability	30 months.
Germination percent	31 – 95%.
Pretreatment of seed	By carefully splitting the hard shell covering the seed.
Nursery technique	The seeds are directly sown in polybags 2cm deep in April-May. Seed germination takes 16-97 days, whereas kernal germinates in 7-8 days. Fruit varieties are propagated by budding scion of improved variety on seedling stocks.
Site requirement	<p><i>Soil:</i> Grows on variety of soils. Shows best growth on deep sandy loam; tolerates moderately saline soils.</p> <p><i>Climate:</i> Quite happy in hot climates, having temperature varying from 0° C to 50° C. It is a frost hardy and strong light demander. Rainfall in its natural habitat varies from 150 mm to &gt;2000 mm.</p>
Other characteristics	<p><i>Fruit:</i> This species is planted solely for its fruits. A number of cultivars have been developed and there is variation time of fruit ripening from cultivar to cultivar. Some information is given below:</p> <p>Cultivars 'Gola' and 'Seb' ripen in February, while 'kaithali' and 'baramasi' ripen in second fortnight of February and March. Cultivar 'Uran' ripens in late March and April.</p> <p>To maximize fruit yield, ber plant needs to be nurtured. Plant has to be properly pruned and treated to specific chemicals. There are chemicals that can produce more flower buds per unit length of a branch, then there are chemicals that help flowers to stay on the tree and not falloff prematurely. Certain chemicals help increase fruit size, and others help fruit to ripen properly. Then there is a fruit fly that would eat into fruit, if not properly dealt with. For all this information, reader is advised to get in touch with Horticulture people.</p>