# Appendix 4: Plantation Operation*

## 1. Planning

### 1.1 Technical Aspects

Before establishing forest plantations it is necessary to have a management plan which addresses at least the following:

- Areas to be excluded from planting and production management, including steep topography, fragile soils, protective beds along watercourses, areas for the preservation of amenity and areas for nature, species and genotype conservation.
- Layout of the road, fire protection and extraction network
- Procedures for site preparation, planting; tending, prevention of erosion, compaction and other forms of site degradation, and silvicultural treatments.
- Fire protection and fire management.
- Biological pest management and protection against pests and diseases
- Market development and utilization plan
- Land ownership: Determine legal ownership of the plantation site. Prepare a written agreement to ensure legal rights to use the land and water resources.
- Planting size: There is no clear rule about the size of the planting area. It depends mainly on the resources available and purpose of the plantation. Generally, the bigger the plantation, the lower the costs of production per unit area. Exchanging land or cooperative ventures may be considered to make the plantation more economic.
- Labour: Most of the work on tree plantations is carried out by farmers and their families during the off season of agricultural crops. If the plantation is too large, hiring local or migratory workers might be necessary. This is often the case during the land clearing and planting seasons. It is necessary to provide workers with accommodation.
- Plantation establishment schedule: To ensure the success of the operation there should be a plan for plantation establishment which depends mainly on ecological conditions. The timetable should cover the following:
  - Optimal dates for felling the trees, if the area is being reforested
  - Date for site preparation
  - Time of seed collection and sowing
  - Date of nursery establishment
  - Time of out-planting
  - Date of fertilizing, weeding and replacement of failed seedlings.
- Communities should be actively involved in the planning and establishment of plantations in order to motivate them to continued co-operation and eventually increase their income and quality of life. Think about provision of all kinds of forest products to the local communities and recognition of rights.

### 1.2 Cost

Setting up a plantation, even a small one, is expensive. Some costs, such as purchasing land, are not necessary for farmers who have established tenure or user rights. Other expenses are difficult to avoid. Key costs are likely to include: purchasing planting material, purchasing or renting land, hiring supplemental labourers, building roads,

*(*): Some elements in this section was extracted and modified from Forestry / Fuelwood Research and Development Project.1994.*

erecting fences, planting, maintenance, and transportation.

With good planning costs can be reduced. Ask yourself:

- Will the site be cleared with local labour and hand tools or contracted to persons with heavy machinery?
- How much fencing will be required? What type of material will be used for the fences and what will they cost? etc.

# 2. Site Selection

## 2.1 Accessibility of Site

To reduce the high cost of road construction, it is best to select a site where there will be as little need as possible for building roads. Transportation is also expensive. The plantation site should be:

- close to main roads and access roads
- close to sources of supplies and inputs
- close to villages
- close to markets where tree crops will be taken.

## 2.2 Terrain

Terrain refers to slope steepness, ground configuration, rockiness, elevation and exposure to sunlight. Slope is the most important element to consider. A site where slopes are steep will tend to have shallow soil and be highly susceptible to erosion. In areas where annual rainfall is higher than 2,000 mm and slopes are steep, terracing and other measures may be necessary. This depends on the value and management requirements of the species being planted and the cost of labour in the area.

## 2.3 Soil

### *2.3.1 Soil Type*

This is the most important property. Deep colluvial and alluvial soil are ideal for planting. Colluvial soil is a type of transported soil that is often found on the lower slopes of gentle hills. Alluvial consists of matter deposited by water; it tends to be composed largely of clay and silt. Soils found in mid slope are also suitable for planting. In areas where there is a hard pan or dense layer of gravel close to the surface, it is difficult for roots of many species to grow downward, making planting for commercial purposes impractical. However, for the purpose of soil conservation (erosion control) shrubs or grass should be introduced to the area.

### *2.3.2 Texture and Permeability*

The most suitable soils for tree plantations are soils with an intermediate loam texture that is crumbly. Sandy soils, very clayey soils, and soils with poor aeration or a high water table are less suitable for plantation. Soils with poor structure or permeability can sometimes be improved, for example, by installing drains to lower the water table.

### *2.3.3 Fertility*

Loamy sands and loams are not usually very fertile. Fertilizers might have to be applied.

Areas previously used for agricultural crops might not have enough nutrients. Areas with excessive litter might also have temporarily inadequate supplies of nutrients. In high rainfall areas, soils are also likely to be low in nutrients, particularly if they are sandy. In sandy soils, it is important to apply organic matter to increase fertility and improve the soil structure.

### *2.3.4 Acidity*

Neutral soils are generally good for plantations. Moderately acidic and alkaline soils are also suitable for tree planting as long as species are selected that can adapt to these conditions.

## 3. Climate

Two aspects of climate must be considered in site selection: amount and distribution of rainfall and minimum and maximum temperatures. These two factors determine the suitability of particular species.

Detailed information on temperature ranges and rainfall patterns are available through the Department of Meteorology or the local stations.

## 4. Site Preparation

The objectives of site preparation are: (i) to clear the site of existing vegetation by felling of trees and cutting of shrubs, herbs, etc. (ii) to facilitate planting and establishment, (iii) to reduce weed growth, (iv) to reduce soil erosion by creating physical barriers to surface runoff, (v) to conserve soil moisture as much as possible in dry areas, (vi) to encourage root development, (vii) to work the soil and make it most receptive for promoting germination and growth of seedlings,(viii) to remove all surface and sub-surface obstructions to plant growth and (ix) to improve drainage conditions in wet areas.

The degree of site preparation depends mainly on: (i) species to be planted, (ii) existing vegetation, (iii) site conditions, (iv) expenditure/budget, and other factors. Steep slopes, possibility of soil erosion, etc. require careful consideration about soil working and preparation of the site. Site preparation usually consists of the following operations:

### 4.1 Cutting of Trees and Shrubs

It is usually necessary to clear the sites of existing vegetation. Very few shade demander species require overhead and lateral light competition. Complete clearing of the site is needed in case of several light demander species. Where it is not desirable or it is too costly to clear the site completely of existing trees and bushes, strip and patch clearing may be adopted. The width of cleared strip should be preferably 1.5m. If trees are scattered and bushes are not dense, cutting may not be necessary.

Clearing in strip: In open grasslands, it might not be necessary to remove vegetation unless it is covered by dense weeds such as *Imperata cylindrica*. Clearing all grass might be undesirable if planting is going to be on steep slopes susceptible to erosion. In grasslands where the grass is more than one meter high, the vegetation can be cleared in strips. The taller the grass, the wider the strip that is cleared. This method is useful where natural regeneration has failed.

Clearing in patches: This method can be used in grasslands or forest areas. It involves burning patches of vegetation where the trees are to be planted.

### 4.2 Removal of Stumps

Removal of stumps is necessary where the site is to be prepared mechanically or there is danger of passing root-rot or stem rot infections to the new crop. Removal of stumps includes digging of roots and excavation of stumps. Removal of stumps may be quite costly and therefore, it is not always done. However, if the old stumps are suffering with diseases like root rot and stem rot then their removal is necessary to avoid infection of the new crop. Mechanical site preparation is more expensive than manual site preparation and less suitable for small plantations.

### 4.3 Disposal of Debris

Debris left after clearing bushes should be properly disposed of. People are allowed to remove such debris either free of cost or at a very nominal fee. But if a certain amount of debris remains, it is advisable to dispose of it by burning because: it is a fire hazard, it adversely affects soil working, it has a harmful effect on seedlings and regeneration, it may cast heavy shade and create mechanical obstruction, and it can be a source of heart rot and root rot in the future crop.

## 5. Planting Method

### 5.1 Staking

The planting spots are marked by stakes of bamboo or other locally available material. If planting spots can be marked using a rope or spacing could be maintained with help of some other method, staking may not be essential.

### 5.2 Digging the Hole

Holes should be dug at least one week before planting in order that sunlight can decompose the organic elements in the holes and kill viruses or other diseases.

It is good to dig a large hole to enable the seedling to root deeper and to absorb more nutrients. The holes should be at least 30 square cm, with a depth of 20-30 cm. Put the upper soil in a mound separate to the lower soil and loosen the soil at the bottom of the hole. When planting fill the hole with the upper soil first.

### 5.3 Planting

- Remove plastic bags at time of planting by slashing each bag up one side with a sharp blade, taking care not to damage root ball inside. Gently peel away the plastic bag. Try to keep the medium around the root ball intact.
- Insert roots into soil up to the root collar. In arid areas, plant as deep as possible so that only a small part of the shoot is above ground. This will help ensure that roots reach most soil and reduce water loss by evaporation.
- Take care to avoid breaking, bending, crushing, or damaging roots.
- Compact soil around the roots.
- Make a small furrow around the base of the mound to maximize water retention on dry sites.

## 5.4 Planting Position and Pattern

Planting should generally be in straight lines to facilitate maintenance. In hilly areas plant trees along the contours for better soil conservation. It is important that rows be aligned and that proper spacing be allowed between trees.

The three principle planting patterns are:

- Square planting, in which the space between the trees in each row is the same as the space between the rows.
- Rectangular planting, which tends to be used in areas where some vegetative cover is retained for soil protection.
- Contour planting, which is modified from rectangular planting to fit the contour.

## 5.5 Spacing

Economic and market considerations are important in determining initial plant spacing. Close spacing is more expensive because more plants are needed. Wide spacing tends to under-use the available land.

Spacing depends on the tree species and the types of tree products that will be harvested. For example:

- Fuelwood: 1-2 m. The goal is maximizing yields in short rotations. This spacing is best suited to small- and medium-size timber.
- Pulpwood: 2-3 m. The goal is maximizing yield in 5-15 year rotation harvesting. This spacing also allows for pruning branches with a diameter of 1-4 cm for fuelwood.
- Sawn timber and veneer: 2.5-5 m. The goal is to produce high value logs that are at least 30 cm in diameter.

Biological factors of species determine spacing:

- For fast growing species, competition starts early so wider spacing is more favourable.
- Trees that branch at wide angles from the trunk require more space between trees for normal growth.
- In high rainfall areas, where weeds grow quickly, initial spacing should be closer than in areas where weeds are slower to compete with seedlings.
- Sites that become water-logged inhibit normal tree growth. In that case, trees can be planted more closely.

## 5.6 Timing

The best time for planting is the start of the rainy season which varies a little among different ecological zones (early May-early June).

Planting on cloudy rather than sunny or windy days.

## 5.7 Replacement of Dead Seedlings

- Reserve about 20% of the most healthy and vigorous seedlings as replacement stock. The number of seedlings for replacement (N) can be calculated by the formula: N= percentage of dead seedlings x total seedlings planted.
- Replacement might be necessary twice. The first replacement takes place after one month of planting. The second replacement will take place in the next planting season.

- Generally, in large-scale plantations, seedlings are replaced only if their survival rate is less than 70 %.

## 5.8 Direct Seeding

Direct seeding in the field is less expensive than planting nursery stock. Consider direct seeding of a species when seed of that species has a consistent rate of germination; seedlings grow fast enough that they will not be threatened by competing vegetation; and seed is abundant and cheap. Direct seeding is possible with such species as *Cassia* spp., *Dalbergia* spp., *Gmelina* spp., some leguminous trees such as *Leucaena* spp., and most *Acacia* spp.

Sowing in lines: This method is convenient on clean, cultivated sites or those that have been cultivated in lines or strips. The seed is sown by hand or by using a dibble stick for making holes 2-5 cm deep and planting 2-3 seeds per hole depending on species. The spacing between and within lines is determined by species, growth rate, and tending methods.

Spot sowing: Seeds are sown in relatively small, cultivated patches spaced at regular intervals that correspond to desired spacing. Two or three seeds are sown in each spot.

Mound sowing: This method is recommended on moist sites with poorly drained soil. Excavate the soil from pits and deposit it in a series of small, flat-topped mounds. Seed is sown at the top of the mound.

## 5.9 Planting on Difficult Sites

Some sites that present special difficulties for plantation establishment are: sites subject to low rainfall or constant high winds; sites without enough top soil or soil with high mineral toxicity; sites badly damaged by over grazing or burning. From a purely economic development perspective, the planter is unlikely to make money on very difficult sites.

Three possible ways to overcome difficult sites conditions are:

- Use of a species and provenance known to grow under the site conditions. Selecting the right species is especially important.
- Modify the site to improve surface stability, moisture level, soil nutrient, or other problems.
- Erect fencing or take other measures to protect trees from possible damage by grazing animals.