

Plantation Forestry

e-manual



College of Forestry

**Banda University of Agriculture & Technology, Banda
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E- PRACTICAL MANUAL

Plantation Forestry

SA 3209 (2+1)

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Published by

**Department of Silviculture and Agroforestry
College of Forestry
Banda University of Agriculture & Technology
Banda-210001 (Uttar Pradesh)**

E-Practical Manual on Forestry

Year 2024

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Publication number: BUAT/M/2024/49



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Practical Syllabus

Study the tools and materials for plantation establishment- Visit small and large plantations- study their management and functioning- Exposure to plantation project preparation- economic evaluation and feasibility studies of plantation projects. Study of planting operations- study of tending techniques- Planting methods and techniques of different types of plantations including energy plantations, canal bank plantations - pulp wood plantations- study of Forest Development Corporation plantations-road side plantations plantation planning- Plantation journal- Choice of species for plantations-economic considerations in plantation- Study of govt vs. pvt. plantations.



Exercise

1

Aim: To study the tools and materials for plantation establishment

The Collector of Malabar Mr. Conolly, planted teak (*Tectona grandis* L.f) for the first time in Nilambur, Malapuram district of Kerala, in 1842, laying the foundation for plantation forestry in India. In Asia, this may perhaps be the first plantation. A forest crop that has been intentionally raised through planting or sowing is known as a forest plantation. Broadly forest plantation can be divided into three management phases: seed collection and handling, nursery raising and plantation establishment & management.

Plantation tools and materials:

To carry out various tasks, such as site preparation, soil working, tree planting, and maintenance operations, various tools, equipment, and materials are required at various stages of process. Therefore, different tools and materials are needed to complete a planting exercise.

Table: 1. Tools and materials used for establishing plantation

Sr.no	Operation	Tool	Use (s)
1.	Site preparation	Tractor mounted with backhoe loader	Levelling of the site in-case of large scale plantation
		Root plough	Uprooting the stumps & roots
		Survey equipment	Lay out of plantation design
		Tractor mounted auger	Pit making
		Wooden/ cement / iron pole	Fencing the plantation site
2.	Soil working	Rakes	Cleaning of felling debris
		Billhook	Cutting of bushes or small plants
		Pick axe	Manually uprooting of stumps & roots Digging of hard & compact soil
		Spade	Pit making, cutting of grasses, weeding



Sr.no	Operation	Tool	Use (s)
		Crow bar	Pit making
		Shovel	Pit making, turning over soil Mixing FYM
		Digging Hoe	Loosening soil, weeding
3.	Planting	Shovel	Filling of Pit with soil & FYM
		Spades	Filling of Pit with soil & FYM
4.	Maintenance operations	Secateurs	Removing the lower, dead or forked branches of less thickness
		Pruning saw	Pruning of thick branches in established plantation
		Khurpi	Loosing of soil & weeding
		Rose cane	Irrigation purpose
		Tractor with water tank	Irrigation purpose
		Spray pump	Application of Pesticide & insecticide

Field Exercise:

1. Identify the implement/tool and write its use in establishing a plantation.

Sr. No	Implement/tool	Name	Use
1			
2			



3			
4			
5			
6			
7			



Sr. No	Implement/tool	Name	Use
8			
9			
10			
11			



Exercise

2

Aim: To visit small and large plantations and study their management and functioning

The term "Forest Plantations" refers to forest stands established by planting/seeding the area for afforestation or reforestation. They are either of introduced or indigenous tree species with minimum area of 0.5 ha; tree crown cover of at least 10 percent of the land cover and total height of mature trees above 5 meter (Forest Resource Assessment Report 2020).

Scale of Plantations: depending upon the area, cost and intensity of management plantation can be classified into:

1. **Small-scale plantations** are referred to as trees raised under farm forestry, social forestry, agro-forestry and integrated forestry practices on small area.
2. **Large-scale plantations** are referred to those that are grown on a sizable plot of land for commercial purposes and to satisfy a significant demand for wood or lumber by organisations, industries, or government bodies other than farmers.

Characteristics and advantages and disadvantages of small scale and large scale plantations have been summarized in the table 2 and 3 as below:

Table 2. Characteristics of small scale and large scale plantations

Characteristics	Small scale	Large scale
Ownership	Farmers, shelf help groups, individual land holders	Government agencies/Private firms/large farmers
Objective	Own requirement	Commercial
Species diversity	Diversifies more number of species	Monoculture
Type of species	Fast growing/Slow growing/mixture of both	Fast growing
Management	Non-intensive	Intensive
Cost of establishment	Small	High
Profitability	Small	High



Table 3. Advantages and disadvantages of small and large scale plantations

	Small scale	Large scale
Advantages	<ul style="list-style-type: none"> • Easy to establish and manage • Establishment and management cost is low • Harvesting is easy and less time consuming • Less labour intensive 	<ul style="list-style-type: none"> • Highly profitable in monetary terms • Can fulfil large scale demand for wood • Production is very high • Hybrid varieties are utilized • Helps to ameliorates environment • Multiple products are produced
Disadvantages	<ul style="list-style-type: none"> • Less profitable in monetary terms • Difficult to meet large scale demand of wood • Production is low 	<ul style="list-style-type: none"> • Comparatively difficult to manage and establish • Establishment and management cost is high • Harvesting is difficult and time consuming • Monoculture are liable for insect & pest attack • It does not provide multiple products

Factors affecting scale of plantation:

1. Landholding size: The size of land of the owner effect the scale of plantation as small landholders opt for small scale plantations and large land holders for large scale plantations.

2. Objective: Commercial purpose plantations are always large scale than those which are established to fulfill local demands of wood and tree based products. For sustained supply of raw material, industries plan for a large scale plantation.

3. Budget: Large scale plantations are intensively managed that require high budget as compared to small scale plantation.

4. Facilities available: If the transport facilities, harvesting facilities, easy of quality planting materials and labour availability, then large scale plantations are raised otherwise small scale are preferred.



5. Demand for wood and wood based products: if demand is high for wood and tree based products then large scale plantations are usually raised.

Large scale plantation has been initiated by the Department of Environment, Forests and Climate Change, Government of Uttar Pradesh with 5.72 crore saplings planted in 2017–18, 11.77 crore in 2018-19, 22.60 crore in 2019-20 and 25.87 crore in 2020–21. While 30.53 crore saplings in 2021-22 and 35.49 crore plants were planted in 2022-23. (Hindustan Times July 11, 2023)

Field Exercise:

1. To visit plantation site to know about its management practices

- a) Name of the visiting sites:
- b) Ownership:
- c) Address:
- d) Date of visit:
- e) Area (ha):
- f) Estimated cost establishment:
- g) Scale of plantation:
- h) General information:

Sr. No	Study area	Species planted		Spacing	Total No. of Plants	Age of plantation
		Scientific Name	Common Name			
1.						
2.						
3.						

- i) Detail about the cultural & tending operation:



Exercise

3

Aim: To know about the different planting operations in plantation forestry

A variety of forest types are included in forest plantations, but they all share the characteristic that most trees in the area were planted and/or seeded (sown). Planting trees involves various operations from preparing site, planting, maintenance, controlling insect-pest and protecting from domestic and wild animals. Each operation is crucial for establishing and managing forest plantations effectively. The main object of tree planting is to (successfully) establish a uniform and healthy tree crop. The goal of afforestation or reforestation is often achieved by different planting operations as discussed in table 4.

Table 4. Detail of different planting operations:

Sr.no	Operation	Characteristics
1.	Site preparation & Land development	Objectives of site preparation <ul style="list-style-type: none"> - Vegetation clearance i.e. clearing of site of exiting competing vegetation - Create conditions that will enable the soil to catch and absorb as much rainfall as possible. - Surface runoff reduction and increase the moisture in the soil. - Provide good rooting conditions - Removal of surface & subsurface obstruction in plant growth - Create conditions to minimize danger from fire and pests is minimized
2.	Soil working	<ul style="list-style-type: none"> - Reduce the bulk density of the soil - Deep ploughing - Improving soil drainage and aeration - Increasing downward penetration of juvenile roots - Digging of pits as per requirement of target species, edaphic and climatic condition of the locality - Trench making in water stress site - Application of small doses of fertilizer or FYM in each pit
3.	Sowing/Planting	<ul style="list-style-type: none"> - Direct sowing or aerial sowing or planting out - Planting pattern - Staking i.e. marking of planting spot with help of



Sr.no	Operation	Characteristics
		stick or bamboo or locally available material - Planting distance (spacing) - Planting material (entire planting/stump planting) - Planting season
4.	Protection & maintenance plantation area	- Fencing of plantation site - Watering during dry season - Beating up i.e. casualty replacement - Singling and pruning - Used of herbicide and insecticide - Avoid entry of domestic animal until the seedlings are established

Field Exercise:

1. Discuss the importance of different planting operations as mentioned below.

i. Site preparation & Land development:

- a. Area
- b. Land development operation
- c. Time required for land development

ii. Soil working:

- a. Pit size & shape
- b. Trench
- c. Any other information

iii. Planting:

- a. Planting pattern
- b. Planting distance (spacing)
- c. Target species
- d. Planting material (entire planting/stump planting)
- e. Planting season

iv. Plantation protection measures:

- a. Beating up operation:
- b. Fencing
- c. Insect-pest management



Exercise

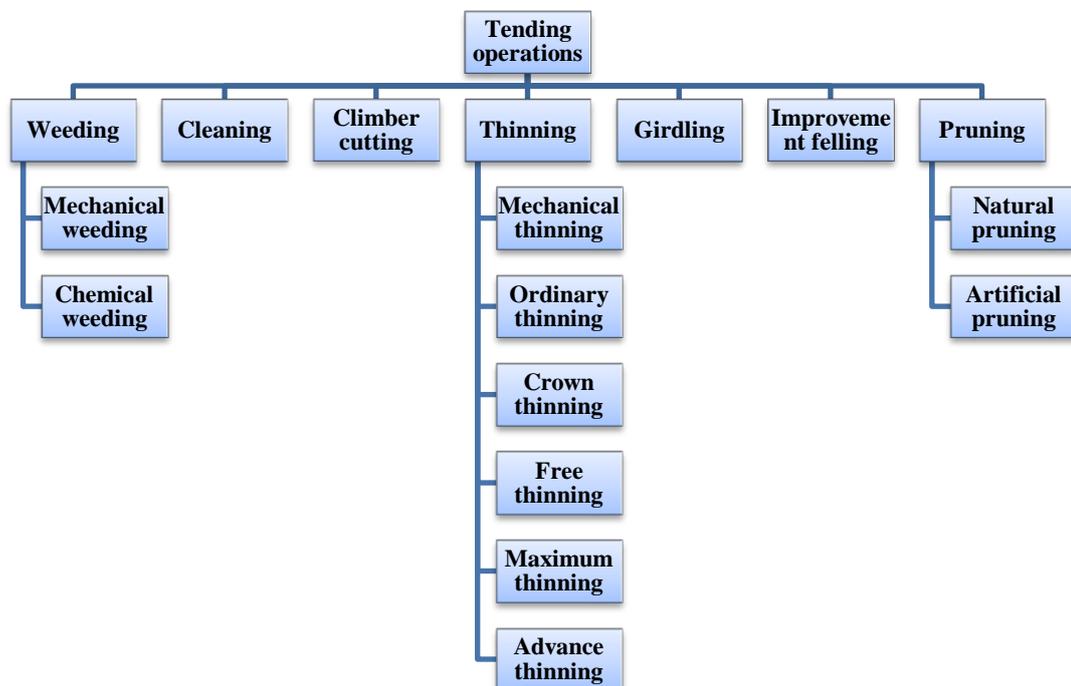
4

Aim: To know about different tending techniques used for establishing a plantation

Tending techniques are essential for ensuring the healthy growth and development of a plantation. These operations are important silvicultural tools for manipulating the growth of plantation trees for obtaining more volume of quality timber. They are generally carried out for the benefits of forests crop at any stage of its life between seedling and mature stages. These techniques focus on maintaining and improving the conditions of young plantations by controlling competing vegetation, protecting from pests and diseases, and optimizing growth conditions.

Objectives of tending operation:

- To improve the hygienic condition of forest by removal of injured, broken, weak, diseased, or infected plants
- To provide more growing space for the retained trees
- To reduce the competition for light, moisture, nutrients and space



Flow chart of different tending operation



- a) **Weeding:** A tending operation done at seedling stage in nursery or in a forest crop, which involves the removal or cutting back of all unwanted plants.

Objectives:

- To reduce root competition
- To reduce transpiration water loss
- To facilitate cultural operations
- To improve light condition for the main crop

Weeding is a common practice that must be done before weeds start suppressing the seedling crops. It should be carried out when the weeds have tender roots and shoots, otherwise, it becomes difficult to uproot. In plantation, weeding is done during and after the monsoon. Although number of weeding depends upon the intensity of weed growth and the rate of growth of seedlings of the favored species. Generally three weeding are usually done in first year, two in second year and one in the third year. In case of fast growing tree species require weeding for one or two years.

- b) **Cleaning:** It is a tending operation carried out during the sapling stage which involves removal of inferior growth including individuals of favoured species.

Objectives:

- To improve light conditions
- To reduce root competition
- To reduce transpiration water loss

Cleaning is done when the crops reach at sapling stage. At sapling stage, plants compete with each other to reach the top in order to get more light for photosynthesis. The best time for cleaning is determined by the growth season of favoured species, which is during the monsoon. It is certainly difficult to do the activities in the rainy season; hence cleaning is done before the onset of monsoon.

- c) **Climber cutting:** This operation is carried out in early stages of tree growth that involves the removal of competing vegetation, typically vines, and woody climbers from young trees in plantation forests. This operation is also known as release cutting.

Objectives:

- To improve the growth and survival of young tree by reducing competition for limited resources.



- To release the young tree from shade out or strangle by climbers.

Climber cutting involves manually or mechanically removing vines, climbers, and other competing vegetation from around individual trees or within plantation blocks. Workers may use hand tools such as pruning shears, billhook, axe or brush cutters or mowers may be used for larger-scale operations. Climber cutting is often integrated with other tending operations such as weeding, thinning, and pruning, which collectively aim to optimize the growth and quality of plantation forests. By combining these operations, forest managers can achieve synergistic effects and maximize the economic returns from their forestry investments.

d) Thinning:

Thinning is a felling operation carried out on an immature stand for the purpose of improving the growth and form of the trees that remain without permanently breaking the canopy. The thinning principles are applicable to even aged or regular crop and results in increases spacing and decreases number of trees per unit area.

Objectives:

- To distribute the growth potential uniformly
- To increase the net yield from a unit area
- To obtain earlier returns from thinned materials
- To reduce the rotation
- To produce different size timber as per requirement
- To maintain hygienic condition
- To obtain timber of desired quality and strength

Different types of thinning:

i. Mechanical thinning (Stick thinning)

A thinning in which the trees to be cut are selected by some rule of thumb, e.g., trees in alternate diagonals or rows, alternate trees in alternate rows or every second, third, etc., line or a minimum spacing gauged by a standard stick.

ii. Ordinary thinning (Low thinning/German thinning/Thinning from below)

The method of thinning that consists in the removal of inferior individuals of a forest crop, starting from the suppressed, then taking the dominated and lastly some of the dominants.



iii. Crown thinning (High thinning/French thinning/Thinning from above)

The dominating trees in a forest crop are the main targets of thinning, with the less promising trees being cut down to make room for the best individuals. The dominated and suppressed stems are retained if they are not dead, dying and diseased.

iv. Free thinning (Heck's Free Thinning/Elite Thinning/Single Stem Silviculture)

A method of thinning in which attention is concentrated on evenly spaced selected stems (called elites or alpha stems) which are retained until maturity or till the last thinning or two, thinning being directed to the removal of other stems hindering their optimum development.

v. Maximum thinning

It is the modification of Heck's free thinning developed by Gehrhardt. It is a thinning method that aims at putting as high a proportion possible of the total potential increment of the area on the retained stems. From an early stage the number of such stems limited to the minimum that can fully utilize the growing tree. It is heaviest form of free thinning so that there are no trees other than elites. As the thinning is extremely heavy, it may result in deterioration of site due to exposure, infestation of the area with shrub growth, production of knotty timber.

vi. Advance thinning (Craib's thinning)

A thinning developed by Craib and O'Conner in South Africa for wattle pine plantation. Thinning is done after the trees have been adversely affected by the competition of their neighbors. It should be done before competition actually sets in.

Thinning in irregular crops

Selection Thinning is applied to irregular crops. A method of thinning directed to obtain and/or maintain selection composition in a crop, with all diameter classes adequately represented.' It is carried out in all canopy classes removing the trees of the following characteristics:

- Dead, dying and diseased trees
- Inferior trees which restrict the development of their neighbours from all sides
- Trees which are less valuable than their neighbours



- Trees which are of no special importance as regards desirable crop mixture presented
- Trees those reached to the exploitable diameter

e) Improvement felling:

It is the removal of less valuable trees (secondary tree species) in a crop in the interest of better growth of the more valuable individuals. Usually applied to mixed uneven aged forest with the aim to improve the quality of forest by favoring the silviculturally most valuable species.

Operation to be done in improvement felling:

- Felling of dead, dying (more than 75% dead) and diseased trees
- Felling of saleable unsound and over mature trees
- Felling of unsound or badly shaped mature and immature trees
- Thinning of congested group of poles
- Cutting back of damaged seedling and saplings
- Removal of undesirable under growth
- Climber cutting

f) Girdling

It is defined as cutting through bark and outer living layer of wood in a continuous incision all-round the bole of a tree. It is generally done to kill the tree inside the forest. Girdling is usually done on trees are more than 20cm in diameter as it is easier and less expensive to fell trees smaller than this diameter.

g) Pruning

The removal of live or dead branches or multiple leaders from standing tree for the improvement of the quality of timber.

Objective

- To produce clean and knot free wood
- To maintain and care of urban trees in streets, parks and roadside plantation
- To improve the hygienic condition of stand

On the basis of agency of pruning, it is classified into:

a) Natural pruning



The natural death and fall of branches of standing trees from such causes as deficiency of light, decay snow and ice. It is also known as self-pruning.

b) Artificial pruning

The pruning done by forester without waiting for nature to do it in dense natural crops or where nature cannot do it due to artificially large spacing between stems in man-made plantations to reduce cost of formation and rotation. It is a costly operation. So, artificial pruning is carried out considering the funds or outcomes.

Pruning equipment:

Generally total pruning height is about 5.4m (18ft), thus pruning tools should be able to reach that height. The common pruning tools are:

- Hand pruning saw
- Pole Pruning Saw
- Secateurs
- Curved/ bow saw (mounted on long handle)
- Curved blade (mounted on long handle)
- Clipper
- Shears
- Small power saw (Power chain saw)
- Ladders

Field Exercise:

1. Write down weeding its objective and duration of weeding.
2. Explain why cleaning is essential in an establishment of a plantation.
3. Define Thinning and explain thinning used in light demanding species.
4. What is girdling?
5. What are the objectives of pruning and enlist the tool used in pruning?



Exercise

5

Aim: To study of Forest Development Corporation and their role in plantations

The National Commission on Agriculture recommended the establishment of Forest Development Corporation (FDC) to promote the sustainable development, management of forests and related resources and meet the raw material demand for wood-based industries. These Corporations handles timber trade, extraction and marketing of other forest produces.

Objectives

- i. Expansion and stream-lining of forestry activities
- ii. Eliminating the middleman/contractors
- iii. Create much more employment for skilled as well as unskilled hands
- iv. Expand or establish a large number of industries based on raw material from the forests
- v. Enter the export market in wood and wood products
- vi. Have a sustaining impact on employment in secondary and tertiary sectors

Forest Corporations typically undertake activities such as afforestation, reforestation and sustainable logging. In the era of conservation forestry the Forest Corporations are exclusively working to promote eco-tourism and wildlife conservation under community forestry.

Organizational Structure

FDC are registered bodies under the Companies Act, or any such similar Act, with a memorandum and articles of association of the company. The powers of managing the FDC are vested with a board of directors which are constituted by the state government. The board consists of official and non-official directors. Chairman of Forest Corporations are generally some Politicians (Forest Minister). A Forest Corporation is generally headed by a Managing Director (M.D.) usually of the rank of a PCCF. He is assisted by Directors and Deputy Directors/Managers/Divisional Managers etc. A forest depot is headed by Manager usually of a rank of Divisional Forest Officer.



Overview of state FDC

Based on the current activities, FDC can be classified into the following three broad categories:

- i. FDC dealing with replacement of allotted natural forests by industrially important wood species through plantations: The state forest departments identify and lease out the forestlands to their FDCs which is approved in the Working Plan from the regional offices of the MoEF&CC. The FDCs carries out any felling and marketing of timber and plantation activities in these allotted lands.
- ii. FDC that were created with the aim of replacing forest contractors in the harvesting and disposal of forest produce. FDCs are allotted forestland under working plan for harvesting of forest produce and as well as raising plantations in under plantation working circle. These FDCs have their sale depots where the harvested produce is transported and sold through auctions and tenders. Examples of such FDCs are Uttar Pradesh, Uttarakhand, Himachal Pradesh, Jammu and Kashmir, Punjab, Haryana and West Bengal.

Table 5. Brief Description of State Forest Development Corporation

Sr. no	State	Activity of Forest Development Corporations
1.	Andhra Pradesh	Andhra Pradesh FDC was formed in 1975 and actively involved in raising forest plantations in the leased out forest land. Species particular grown are Eucalyptus, bamboo, Red Sanders and cashew. 1994 onwards Eucalyptus clonal plantation was promoted with average survival of about 90% by end of 6 th year and with yield per ha of 70-80 MTs in high rainfall areas and 40-50 MTs in low rainfall areas. APFDC has been making profits since 1991-92. The Cumulative Profit as on 31.03.2015 is Rs. 304.7867 Cr. [http://www.apfdcl.com/]
2.	Chhattisgarh	Chhattisgarh Rajya Van Vikas Nigam Ltd. has been formed in pursuance of Notification No. F-5-2/Forest/ 2001/ dated 30th April 2001. The main activity of the Nigam is to raise commercial plantations of Teak, Bamboo and Misc. Species. In addition to this, the Nigam has also undertaken the work of rehabilitation of degraded forests, compensatory afforestation, deposit work plantation and plantation schemes of Central and State Government. Since 2001 to 2019 Nigam has raised 27235405 plants of teak, bamboo and miscellaneous species. [https://rvvn.cgstate.gov.in/]



Sr. no	State	Activity of Forest Development Corporations
3.	Gujarat	Gujarat State Forest Development Corporation Ltd.(GSFDC) founded in 1976 as a government company under the Companies Act, 1956 with Head office at Vadodara. It is engaged in collection and trade NTFPs, plantation, production and sale of furniture through the Corporations' wood institution called Vanil Udyog; production of ayurvedic products under the brand name of Dhanvantri; collection and trading of charcoal manufactured by local people and gram panchayats and promoting eco-tourism through Vanil Eco Den (Experience Nature). [https://gsfdcltd.co.in/]
4.	Haryana	Haryana Forest Development Corporation Limited founded in 1989 under the Companies Act, 1956. The main activity of the Corporation is to ensure reasonable prices to the farmers for their standing trees (<i>Eucalyptus</i> species, <i>Populus</i> species, bamboo etc.) and other forest produce and other forest produce and also to ensure the welfare of farming community and development of forest based industries. [https://hfdc.gov.in/]
5.	Himachal Pradesh	H.P. State Forest Development Corporation was established in 1974. It is primarily engaged in resin extraction, resin processing, timber harvesting and sale from Government forests in the State besides extraction of fuel-wood, pulpwood, khair and bamboo. Corporation runs Rosin and turpentine factories, timber treatment plants, wood based unit and ecotourism sites. [https://www.hpforestco.in/]
6.	Jammu & Kashmir	Jammu & Kashmir State Forest Corporation was established under the J&K State Forest Corporation Act, 1978, in 1979r. It was enamed as Jammu and Kashmir Forest Development Corporation in 2020 and registered under the Companies Act, 2013. The objectives of the Corporation are better preservation, supervision and development of forests and better exploitation of forest produce. [https://jksfc.jk.gov.in/aboutusn.html]
7.	Karnataka	Karnataka Forest Development Corporation Ltd., was founded in 1971. To raise the plantations of Eucalyptus, Rubber, Bamboo, Tropical Pines, Cashewnut, Cocoa, Tea, Coffee and other economic important species. The authorized share capital of the Corporation is Rs 2500 lakhs, the paid up capital is Rs. 931.40 lakhs. The face value of each share is Rs. 1000/- as on 2024. [https://kfdcl.karnataka.gov.in/info-1/]
8.	Kerala	Kerala Forest Department Corporation was established in the year 1975. The activities of the corporation include cultivation of tree crops such as eucalyptus, acacia, teak and cash crops like tea, cardamom and coffee to full fill the industrial demand. Due to the rich biodiversity in the state the corporation advocates eco-tourism in activities in the state. [https://kfdc.kerala.gov.in/]
9.	Madhya Pradesh	M.P. Rajya Van Vikas Nigam Limited was established in 1975 under the Companies Act, 1956. Nigam is engaged in managing 4.26 Lakh hectares forests under Sustainable Management, converting degraded forests into productive forests. The present authorised capital of the Nigam is 40.00 crores. [http://www.mpsfdc.com/Index-E.htm]



Sr. no	State	Activity of Forest Development Corporations
10.	Maharashtra	Forest Development Corporation of Maharashtra Limited (FDCM), established in 1974. FDCM has nearly five decades of experience in raising teak plantations and marketing forest produce like timber, firewood and bamboo. It also works on areas like eco-tourism (Eco-tourism policy 2008), medicinal plant cultivation and <i>in-situ</i> and <i>ex-situ</i> conservation of rare and endangered wildlife. One of India's largest Zoos, Balasaheb Thackeray Gorewada International Zoological Park is the proud creation of FDCM. It is among few public sector enterprises in India running in profit, continuously since 1988-89. [https://fdcm.nic.in/Default.aspx]
11.	Punjab	Involved in harvesting and marketing wood from forests earmarked by the Forest Department and pay royalty in turn. Corporation also assists the farmers in production and marketing of their agroforestry produce (mainly eucalyptus and poplar). The Corporation also runs saw mills and carpentry units and promotes the use of eucalyptus and poplars, and also carries out purchase of land on behalf of the state forest department for compensatory afforestation.
12.	Tamil Nadu	Tamil Nadu Forest Plantation Corporation Limited was formed in 1974 with headquarters at Trichy. The main activity of the Corporation raising Eucalyptus, Cashew, Nelli plantations every year with other species namely Casuarina and teak planted on a smaller scale. The pulpwood raised from the plantations is sold to paper mills in Tamil Nadu as well as the neighbouring states of Karnataka and Andhra Pradesh. The authorized share capital of Company is Rs.10 crores and the shares subscribed and paid up capital is Rs.5.64 crores as on date (2024). [https://www.taforcn.tn.gov.in/index.html]
13.	Tripura	Tripura Forest Development & Plantation Corporation Limited was established in the year 1976 under the Companies Act, 1956. The main objective of Corporation is to carry out business in Rubber cultivation, processing and promotion of Rubber based industries and Bamboo based industries. It also aids in rehabilitating degraded forestlands, settling of tribal shifting cultivators and generation of employment in the rural areas. It is profitable organization with authorized share capital of Rs.10.00 crores. [https://tfdpc.tripura.gov.in/]
14.	Uttar Pradesh	Uttar Pradesh Forest Corporation was established in 1974 under the Uttar Pradesh Forest Corporation Act 1974. The main activity of the Corporation is harvesting and marketing of timber, NTFP especially tendu leaf, herbs etc. and promotion of eco-tourism. The UPFDC also carries out harvesting and disposal of wood and fuelwood from plantations raised under social forestry and farm forestry. [https://upforestcorporation.co.in/]

Field exercise:

1. To visit the plantation site of Forest Development Corporations (FDC)
2. To study the role of Uttar Pradesh Forest Corporation in collection and processing of tendu leaf.



Exercise

6

Aim: Planting methods and techniques for different types of plantations and with reference to road side plantation

General Rules of Planting:

- Place the plant in pit or trench in such a way that soil is filled upto its root collar region
- Fill the pit with good soil around the roots and avoid any leaf litter or undecomposed organic matter in contact with the roots
- Soil should be firmly press around the plants with help of heel or foot pressure so the no air gap remains around the roots
- Avoid any damage to the shoot or root portion by bending, breaking or crushing
- Impervious plant containers like polybag should be completely removed before planting
- Plantation should be done soon after the onset of the rainy seasons so as to tap the maximum potential of growing season

Road side Plantation:

Planting trees along the sides of roads, canal and railway line are the examples of linear plantation. Planting of trees on roadsides is common practice in the country since ages. It has also been recognized by the Ministry of Road Transport & Highways by developing Green Highways (Plantations, Transplantation, and Beautification & Maintenance) Policy 2015.

Objective:

- i. To provide shade to the pedestrians and domestic animal against the hot sun rays and desiccating wind
- ii. To protect soil and road against the agents of erosion (wind and rain water)
- iii. To provide multiple benefits (fruits, fuel wood, fodder, flowers etc.) to the society
- iv. Trees along the roads work like traffic sign (tree lower portion are painted with white band) thus helps in road safety
- v. To protect against the air and noise pollution
- vi. To provide employment to local people



- vii. Augmenting in maintaining biodiversity
- viii. Aesthetic value

Criteria for selection of tree species

Generally for road side plantation fast growing evergreen trees are preferred that suite the ecological condition of the area. Some criteria for choice of tree species are:

- Habit should be tall evergreen or winter deciduous
- Light demanding
- Wind firm (deep tap root system)
- Fast growing species (at least in the early stage)
- Tree should be non-exacting & hardy in nature (drought resistance, fire hardy etc.)
- Attractive crown with beautiful foliage and flowers that persist for longer duration
- Preferably should not have drooping branching system

Indigenous species are favored as they are well adapted to the locality. However the choice depends upon the object of plantation.

Spacing and Alignment:

The width of the road determines how many rows should be planted along its sides. The link roads/routes and the roads passing through the towns should be planted with single row of shade trees. While along the highways and other wide roads multiple rows are planted, the first row is typically made up of ornamental/avenue or shade trees, while the subsequent rows are made up of fast growing species. The crown spread/width and crown area of the species determines the spacing. National Commission on Agriculture has recommended six row planting i.e. three rows on either side. In Uttar Pradesh pits for first row are dug at a distance of 9-10m from the center of the road in case of National Highways and at a distance 7-8m from the center for State Highways and other roads. The second and subsequent rows are planted at varying distances according to the requirement of the species. In the first row called shade line or avenue line, the pits are spaced uniformly at 7.5m for shade trees while in the remaining row planted with other trees the spacing is 3m (Fig. 1).

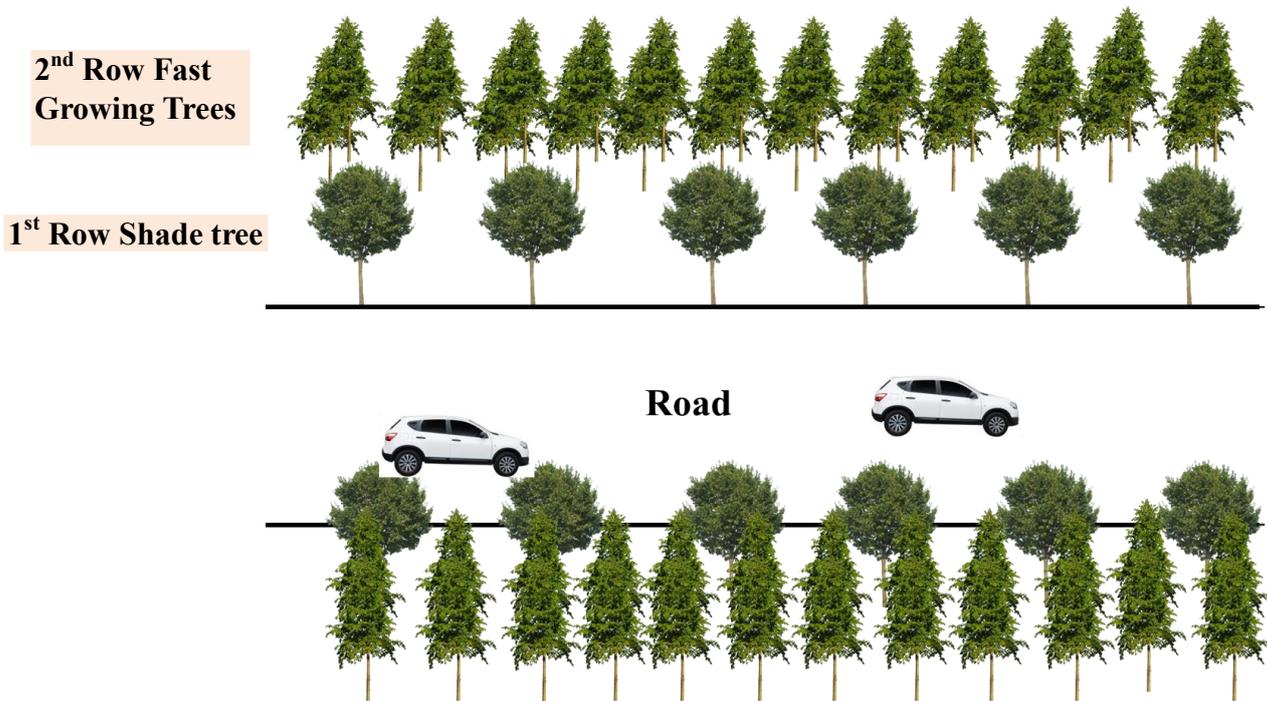


Figure: 1 Diagrammatic representation of a typical multiple road-side planting

Method of Planting

In linear plantation along the roadside, canal and railway line it is always preferred to plant tall size ($\geq 1.5\text{m}$) sturdy plant for better survival and establishment of plantation. Generally bigger size pits (45cm^3 or 60cm^3) and soil is well mixed FYM or fertilizer for proper development of the plant. Tall planting preferably two year old plant should be planted.

Protection should be carried out by fencing and common fencing used are:

- Barbed wire fencing
- Circular or rectangular brick work enclosure
- Old coaltar drums (cut & bent to increase effective height)
- Live hedge of thorny species
- Iron tree guards
- Dead fencing (cut branches of thorny trees & Bushes)



Rotation:

The best rotation suited for roadside plantation is physical rotation or silvicultural rotation for the inner/first row, while the other rows are generally managed under Rotation of Maximum Volume Production, Technical Rotation and Economic Rotation are per the objective.

Species suitable for road side planation:

Ficus infectoria, *F. glomerata*, *F religiosa*, *Tamarindus indica* (Imli), *Azadirachta indica* (Neem), *Madhuca longifolia* (Mahua), *Mangifera indica* (Mango), *Syzygium cumini* (Jamun), *Platanus orientalis* (Chinar) *Eucalyptus camaldulensis*, *Acacia nilotica*, *Delbergia sissoo*, *Casuarina eqisetifolia*, *Polyalthia longifolia*, *Millingtonia hortensis* etc.

Table 6. Activity Schedule for Road-side Plantation:

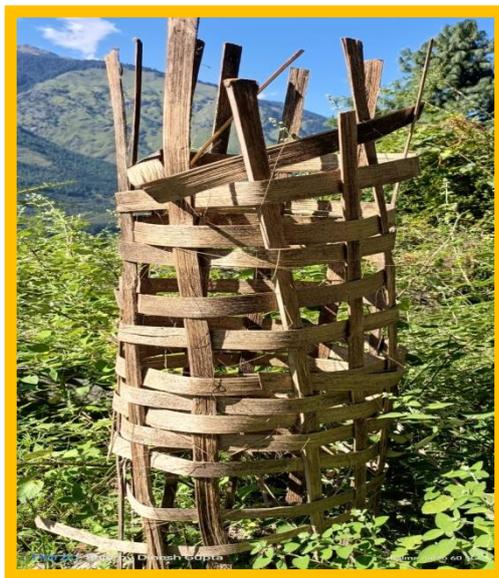
Year	Month	Activities
1 st Year	Jan- March	Surveying & cleaning plantation site
		Digging of pits
		Procurement of fencing material
	April-June	Purchase of FYM
		Fencing of plantation sit
		Mixing of FYM and soil along the dugout pits
	July- August	Transportation of plants
		Planting of saplings
		Watering
	Sep-Nov	Weeding and hoeing
		Watering as and when required
	Dec-Feb	Weeding and hoeing
Singling and staking		
2 nd Year	March	Watering once a week
	April-June	Maintenance of fencing
	July- August	Casualty replacement
		Weeding as and when required
		Maintenance by Mali
	Sep- Dec	Watering twice a month
Maintenance by Mali		
3 rd Year	Jan-March	Watering twice a month
		Pruning of lower branches
	April- August	Watering twice a month
		Casualty replacement if any
		Maintenance by Mali



Roadside Plantation of Neem



Circular Brick Tree Guard



Bamboo Tree Guard



Field Exercise:

1. To visit to a roadside plantation and to know about its management

- a) Name of sites:
- b) Date of visit:
- c) Area (ha):
- d) Type of plantation:
- e) Field work

Sr.no	Location	Tree species		Spacing	Funding agency	Plantation Period	Area (ha)
		Scientific name	Common name				

- f) Objective of road side plantation:
- g) Achievements of road side plantation to socio-economic status of local people:
- h) Management strategy used by the respected authority to managed road side plantation.



Exercise

7

Aim: Exposure to plantation project preparation- economic evaluation and feasibility studies of plantation projects

Globally, forest cover is one-third less than what it once was and global deforestation continues at 18 million hectares per year. This indiscriminate felling of trees needs to be undertaken on a large scale to reverse the ill effects of deforestation and restore the ecological balance. This can be achieved by massive afforestation and reforestation activity done inside and outside forest area. The Government emphasized on the establishment of plantation projects to control rapid depletion of forests. Emphases are generally given for planting fast-growing species that would serve as an alternative source of wood raw materials while reducing pressure on natural forests. In response to this, the project designed to support this new initiative of tree plantations.

Objectives: The main objectives of plantation project are:

1. To re-establish tree cover on under stocked and degraded forest land, thereby converting such lands to productive ones
2. To produce wood raw materials for industrial use and as alternative sources of construction and fuel wood
3. To establish a policy and institutional framework for the development of sustainable industrial plantations

Conducting an economic evaluation and feasibility study for a plantation project involves several steps. Here's a structured approach to guide you through the process:

1. Project Identification and Description

- Define the scope and objectives of the plantation project
- Identify the type of plantation (e.g., timber, fruit, oil palm, rubber)
- Determine the geographical location and the land area available
- Describe the environmental conditions (soil type, climate, water availability)

2. Market Analysis

- Analyze the demand and supply for the plantation product
- Study market trends and price projections
- Identify potential buyers and markets (local and international)



- Assess competition and market entry barriers

3. Technical Feasibility

- **Soil and Climate Suitability:** Conduct soil tests and analyze climate data to ensure suitability for the chosen crop.
- **Planting Material:** Select high-yield, disease-resistant varieties.
- **Plantation Design:** Plan the layout, spacing, and irrigation systems.
- **Labor Requirements:** Estimate the labor needed for planting, maintenance, and harvesting.

4. Economic Analysis

- **Cost Analysis:**
 - Initial investment costs (land acquisition, preparation, planting material)
 - Operational costs (labor, fertilizers, pesticides, water, maintenance)
 - Harvesting and processing costs
 - Transportation and marketing costs
- **Revenue Projections:**
 - Estimate yield per hectare
 - Project prices based on market analysis
 - Calculate expected revenue over the project lifecycle
- **Financial Metrics:**
 - Net Present Value (NPV)
 - Internal Rate of Return (IRR)
 - Payback Period
 - Benefit-Cost Ratio (BCR)

5. Risk Assessment

- Identify potential risks (climatic, pest/disease, market fluctuations).
- Develop risk mitigation strategies.
- Conduct sensitivity analysis to understand the impact of key variables on project outcomes.

6. Environmental Impact Assessment (EIA)

- Evaluate the potential environmental impacts of the plantation.
- Develop strategies to minimize negative impacts (e.g., sustainable farming practices, conservation areas).
- Ensure compliance with environmental regulations.



7. Legal and Regulatory Considerations

- Identify and comply with local, regional, and national regulations.
- Secure necessary permits and licenses.
- Understand land tenure and ownership issues.

8. Social Impact Assessment

- Assess the impact on local communities and stakeholders.
- Develop strategies for community engagement and benefit-sharing.

9. Implementation Plan

- a) Develop a detailed timeline for project activities (land preparation, planting, maintenance, harvesting)
- b) Identify key milestones and deliverables.
- c) Allocate responsibilities and resources.

10. Monitoring and Evaluation

- Develop a monitoring framework to track progress.
- Establish key performance indicators for project evaluation.
- Conduct regular reviews and adjust the project plan as needed.

A comprehensive economic evaluation and feasibility study is crucial for the successful planning and implementation of a plantation project. It helps in identifying potential challenges, understanding the financial viability, and ensuring sustainable practices.

Field Exercise:

1. To work-out the economics of a plantation project of eucalyptus with 5 years of rotation
 - a) Name of the visiting sites:
 - b) Date of visit:
 - c) Area (ha):
 - d) Proposed Project:
 - e) Total Budget (Cost)
 - f) Objective of Plantation:
 - g) Spacing:
 - h) Species Selected:
 - i) Funding Agency:



j) Detail of work:

Sr.no	Years	Work Description	Unit/No.	Quantity	Cost
1	1st Year Proposed Project	Land development	ha		
		Soil Working	ha		
		Pit Making	No.		
		Trench Making	m		
		Fencing (Pole & Wire)	m		
		FYM/Fertilizer	Kg.		
		Planting	No.		
		Watering			
		Weeding			
2	2nd Year Establishment	Hoeing & Weeding			
		Watering			
		Causality replacement	No.		
		Maintenance			
	3rd Year Maintenance	Hoeing & Weeding	ha		
		Casualty Replacement	No.		
		Firebreak clearing	m		
4	4th Year Maintenance	Weeding	ha		
		Firebreak clearing	m		
5	5th year Harvesting	Final harvesting (with conversion)	ha		
		Transport to market	km		
		Revenue from sale of produce			

k) Economic analysis (B:C):



Exercise 8

Aim: Canal-side Plantations: Planting method and techniques

In India, irrigation canals play a crucial role in supporting agriculture by providing water for crop cultivation, particularly in regions where rainfall is inadequate or unreliable. A large network of canals has been established since British times in the Indo-Gangetic plains. Strips of lands on both sides of canals are available varying from a width of 40 feet to 100 feet. These strips are generally used as inspection road, paths and borrow pits for repair of canal. Plantations that are located alongside canals are known as canal-side plantations. As per the recommendation of National Commission on Agriculture, afforestation programme along these strips to augment the production of fuel and timber has been initiated in states like Uttar Pradesh Punjab under social forestry.

Objective of canal side plantation:

- i. To stabilise the canal bank against erosion, checking of shifting sand and dust from getting into the canal courses.
- ii. Optimum utilization of wasteland resource for production of forest products for local communities.
- iii. To check waterlogging in the strips and adjoining fields by planting fast growing species having high transpiration rates.
- iv. To provide shelterbelt in the desert area

Choice of species

The soil and climate have an impact on the species selection. *Dalbergia sissoo* is the species that is raised most commonly in Uttar Pradesh, with additions of *Acacia catechu*, *Albizia*, *Ailanthus*, *Mangifera indica* and *Syzygium cumini*. On the main canals in Haryana, *Dalbergia sissoo* is planted along with a little amount of *Melia azedarach* and *Morus alba*. While *Eucalyptus* spp., *Acacia arabica*, and *Dalbergia sissoo* are planted in Rajasthan. Apart from the native species, teak has also been elevated in the south through the planting of stumps spaced five meter apart.

Planting material:

Earlier plant with ball of the earth or container plants were planted. Presently tall sturdy containerized plants with height above one meter are preferred for better survival percent.



Planting technique

In Uttar Pradesh the strip on the left bank of the canal is planted while that of the right bank is sown. This is so because the left bank has the service road and therefore transport of plants is easy. For planting, pit 60 cm × 60cm × 60cm are dug. In the first row which is on the outer edge of the road away from the canal, the pits are dug 6m apart so that the trees planted there, may serve as a shade line. The subsequent rows are 3 m apart and in these rows the pits are dug 2.1 m apart. In the water-logged places, mounds 60cm ×60cm at the top and 1.8m ×1.8m at the base and with height usually 1.2m or more, depending on the depth of water-logging are made. On the right bank, interrupted trench 60cm wide, 30cm deep with length varying from 1.5m to 3 m are made. The soil is filled back after weathering in the ridge-ditch method.

Field exercise:

1. To visit a canal plantation in your vicinity and know about the plantation technique
 - a. Name of the visiting site:
 - b. Date of visit:
 - c. Area (ha):
 - d. Type of plantation:
 - e. Ownership:
 - f. Field work:

Sr.no	Location	Tree species		Spacing	Distance from Mid of Road	Funding agency	Plantation Period/Age
		Scientific name	Common name				

- g. Objective of canal side plantation:
 - h. Management strategy:
2. Give five examples of suitable tree species for canal side plantation in Bundelkand region of Uttar Pradesh.



Exercise

9

Aim: Energy Plantations: Planting method and techniques

Planting trees just with the intention of using them as fuel is known as energy planting (EP). Since firewood is considered to be universal fuel that collects and store solar energy for subsequent release as heat energy. In energy plantations the idea is based on the fact that spacing affects the dry matter yield of some fast growing species. In contrast to conventional silvicultural techniques that employ wide spacing, such a strategy of planting at close spacing (1meter) produces more dry matter per unit area since canopy closure happens quickly at a very early stage and rotation is 3 to 5 years. Therefore the EPs are the part of short rotation forestry.

Objective of Energy plantation:

- i. To full fill the domestic and industrial demand of fuel wood
- ii. Energy plantations mitigate the effects of climate change and global warming while also reducing noise pollution and the discharge of water and air pollutants
- iii. Energy plantation such as wind breaks and shelterbelts, may serve as a soil conservation measures and protect agriculture land below
- iv. It generates employment opportunities particularly in rural areas

Criteria for selection of tree species under energy plantation

- i. Tree species should be fast growing with high photosynthetic efficiency which results into high yields
- ii. Ability to coppice and pollard well
- iii. Tree should have almost conical or cylindrical and straight stem
- iv. Good amount of heat content of wood i.e high calorific value and wood density
- v. Wood should be low in sulphur and non-polluting
- vi. Should preferably be drought hardy, non-exacting and easy to manage
- vii. Should have the ability to fix atmospheric nitrogen into the soil
- viii. Tree species should be multipurpose
- ix. Should tolerate incidences of insects, pests and diseases

Species suitable for energy plantation:

In general tree species that have dense wood, high calorific value and good combustibility are suitable for EP. Hardwood species preferably due to their good coppicing ability fix atmospheric nitrogen and yield multifarious benefits.



Eucalyptus is the most common one. Casuarina is mostly famous in the coastal areas, whereas Leucaena grown in most part of the country. Examples of the suitable tree for EP are given in the table 7.

Rotation: 3-5 years

Table 7. Species fit for energy plantations with their respective calorific value and specific gravity

Sr. No	Species	Sp. gravity	Calorific value (K cal/kg)	Sr. No	Species	Sp. gravity	Calorific value (K cal/kg)
1.	<i>Acacia auriculiformis</i>	0.60-0.78	4800-4900	24.	<i>Gmelina arborea</i>	0.42-0.64	4763-4800
2.	<i>Acacia catechu</i>	1.00	5142-5244	25.	<i>E. camaldulensis</i>	0.6	4800
3.	<i>Acacia dealbata</i>	0.70-0.85	3500-4000	26.	<i>Grevillea robusta</i>	0.57	4904-4914
4.	<i>Acacia leucophloea</i>	0.78	4899-4886	27.	<i>Michelia champaca</i>	0.45	5068
5.	<i>Acacia mearnsii</i>	0.70-0.85	3500-4000	28.	<i>Morus alba</i>	0.63	4371-4773
6.	<i>Acacia nilotica</i>	0.67-0.68	4800-4950	29.	<i>Lannea coromandelica</i>	0.55	4933
7.	<i>Aegle marmelos</i>	0.91	4495	30.	<i>Melia azedarach</i>	0.56	5043-5176
8.	<i>Albizia lebbek</i>	0.55-0.64	5163-5166	31.	<i>Mangifera indica</i>	0.58	4610
9.	<i>Albizia odoratissima</i>	0.73	5131-5266	32.	<i>Madhuca longifolia</i>	0.56	5043-5156
10.	<i>Albizia procera</i>	0.68	4870-4865	33.	<i>Leucaena leucocephala</i>	0.55-0.70	4200-4600
11.	<i>Alnus nepalensis</i>	0.32-0.37	4600	34.	<i>Holoptelia integrifolia</i>	0.63	5228
12.	<i>Anogeissus latifolia</i>	0.94	4948	35.	<i>Diospyros melanoxylon</i>	0.79-0.87	4957-5030
13.	<i>Anogeissus pendula</i>	0.94	4900	36.	<i>Hardwickia binata</i>	1.08	4891-4952
14.	<i>Anthocephalus cadamba</i>	0.94-0.53	4800	37.	<i>Diospyros montana</i>	0.70-0.80	5125
15.	<i>Artocarpus heterophyllus</i>	0.51	5318	38.	<i>Quercus leucotrichophora</i>	0.74	4633



Sr. No	Species	Sp. gravity	Calorific value (Kcal/kg)	Sr. No	Species	Sp. gravity	Calorific value (Kcal/kg)
16.	<i>Barringtonia acutangula</i>	0.58	5078	39.	<i>Schleichera oleosa</i>	0.91-1.08	4928-4950
17.	<i>Bauhinia retusa</i>	0.72	5027	40.	<i>Sesbania grandiflora</i>	0.55	4407
18.	<i>Dalbergia sissoo</i>	0.75-0.80	4908-5181	41.	<i>Shorea robusta</i>	0.68-0.82	5095-5433
19.	<i>Dodonaea viscosa</i>	1.20-1.28	5035-4939	42.	<i>Syzygium cuminii</i>	0.67-0.78	4834
20.	<i>Emblica officinalis</i>	0.70-0.80	5200	43.	<i>Tamarindus indica</i>	0.91-1.28	4909-4969
21.	<i>Eucalyptus globulus</i>	0.80-1.00	4800	44.	<i>Tamarix aphylla</i>	0.60-0.75	4835
22.	<i>E. grandis</i>	0.40-0.70	4900	45.	<i>Tectona grandis</i>	0.55-0.70	4989-5535
23.	<i>E. tereticornis</i>	0.70	4800	46.	<i>Terminalia alat</i>	0.71-0.94	5047-5373

Source: <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=14483>

Field exercise:

1. To visit an energy plantation to know about the management techniques
 - a. Name of the visiting sites:
 - b. Date of visit:
 - c. Area (ha):
 - d. Type of plantation:
 - e. Presence of prioritized tree species to the specific energy plantation sites:

S.No.	Tree Species		Rotation Period	Uses	Spacing		Other information
	Common Name	Scientific Name			Row to Row (m ²)	plant to Plant (m ²)	

- f. Achievements of energy plantation to socio-economic status of local people:
2. Give example of five suitable tree species for energy plantation in Bundelkand region of UP.



Exercise-10

Aim: Pulp and Paper plantation: Planting methods and techniques

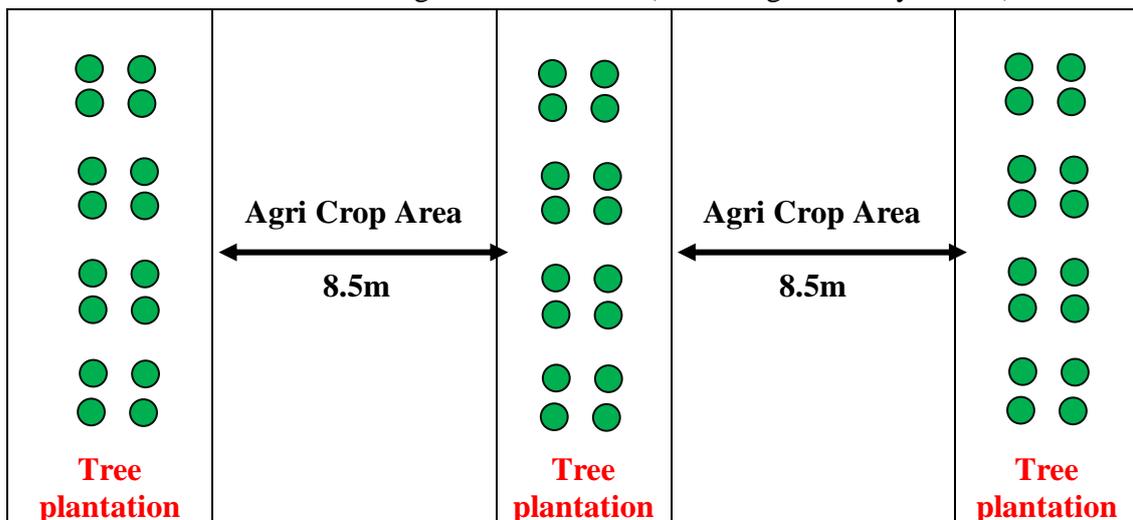
Pulp is a fibrous lignocellulose material that is made by mechanically or chemically extracting the cellulose fibers from wood. The most common raw material used to make paper and paperboard is wood. In general, there are three types of pulpwood: hardwood, softwood, and sawdust and chips from sawmills.

India is the world's 15th largest paper manufacturer, with about 900 pulp and paper mills; it is also thought to have the fastest-growing paper market. In comparison to wealthy nations, India's 2020 per capita paper usage was comparatively low at 15.63 kg, against the world average of 56.7 kg per person.

Species, Spacing and Density:

Mostly the paper mills are using mainly three different genera for as a wood raw material: *Eucalyptus* sp., *Leucaena* sp. and *Casuarina* sp. of them, *Eucalyptus* is the most common one. *Casuarina* is mostly farmed in the coastal areas whereas *Leucaena* is used all around India. Some mills are using *Populus* sp. *Acacia* sp., *Melia dubia* and bamboo due to its better qualities for paper making. Determine the appropriate spacing and planting density based on the growth characteristics of the selected species, the intended rotation cycle, and the management practices. Generally high density plantations that maximize fiber yield per unit area are preferred but may require more intensive management.

ITC has developed package of practices for planting eucalyptus under a new concept of “Paired Row Design”, where two row of eucalyptus are planted between agri crop area of 8.5m. it accommodating 2000 Trees/Ha. (Under Agroforestry Model)



Row to Row distance 2m; Tree to Tree distance 1m

**Rotations:**

The length of the rotation cycle depends on not only the growth conditions (site quality and management intensity), farmers' willingness to sell and industry demand. The rotations cycles vary between species. Eucalyptus and Leucaena have the shortest rotations with about 3-4 years whereas *Casuarina*, as well as *Acacia*, could take more than five years.

Planting Techniques:

Planting:

Utilize machinery such as tree planters or seed drills for large-scale planting operations. Mechanical planting ensures uniformity in spacing and depth, leading to better establishment and growth. Manual planting in case of smaller-scale plantations.

Post-Planting Care:

Includes the cultural and tending operation required especially during the establishment phase, to ensure adequate moisture for plant growth.

Harvesting:

Harvesting operations are taking place mostly in the winter time which begins in October and lasts until March. Harvesting during the summer time is banned by the government. The monsoon season is also low harvesting season due to the heavy rainfalls making the terrain as well as road conditions difficult to operate. Usually debarking is carried out at the site or at some temporary terminal. Mostly the transportation is made by trucks and tractors.

Important Clones:***Leucaena leucocephala:***

The Salvador type (Hawaiian giant) is tall and tree-like. The trees can grow 60 ft in height in five years. The best varieties of this type are K8 (Mexico), K28, K67 and K72. K67 is the best variety for producing large quantities of seed. K8 is widely introduced in India.

Populus deltoids:

is the only species of poplar that is planted on a significant scale in India. It constitutes the backbone of agroforestry in irrigated plains of Northern India.

Clones: G-48, Udai, W-22, W-32, W-39, A-26, S-7 C-15, S-7 C-8 are suitable for agroforestry.

Melia dubia:

Forest Research Institute (FRI) Dehradun under Indian Council of Forestry Research and Education (ICFRE) released 10 improved varieties of Malabar Neem that are having high productivity per unit area with an average of 34.57 cubic meter /hectare



/annum and excellent bole form which is a desirable characteristic for plywood industry.

Important Paper mills of India:

1. Ballarpur Industries Ltd., Jagahdri
2. Ballarpur Industries Ltd., Balharshah
3. Trident Group, Barnala
4. Century Pulp and Paper, Lalkuan
5. JK Paper, CPM Unit, Songadh
6. West Coast Paper Mills, Dandeli
7. Tamilnadu Newsprint and Paper Ltd., Pugalur
8. International Paper APPM Ltd., Rajahmundry
9. ITC Ltd., Bhadrachalam
10. JK Paper Ltd., Rayagada

ITC Ltd. (Information and Communications Technology) is one of the largest paper and pulp manufacturers in India.

Field Exercise:

1. To visit a pulp & paper plantation in your area

- a) Name of the visiting pulp and paper plantation sites:
- b) Date of visit:
- c) Locality:
- d) Area(ha):
- e) Presence of prioritized tree species to the specific Pulp and Paper plantation sites:

S. No.	Tree Species		Rotation (Year)	Uses	Distance		Other Information
	Common Name	Scientific Name			In rows (m ²)	In plants (m ²)	

f) **Achievements of Pulp and Paper plantation area to socio-economic status of local people:**

g) **Major Tree and their clone used in Pulp and Paper plantation:**



S.No.	Tree species	Clone
1.		
2.		
3.		
4.		
5.		
6.		
7.		

- h) **List of successful Pulp and Paper plantation:**
- i) **Give the list of Pulp and Paper Industries operating in India:**
- j) **Important schemes being implemented for Pulp and Paper plantation:**
- k) **Conclusion:**



Exercise

11

Aim: To know about the choice of species for plantation

Right species in right place i.e. correct choice of species has strong bearing on the success of plantation programme. The ideal job of a forester is to choose the most suitable species in consonance with climatic-edaphic conditions prevailing at the site and at the same time meeting the requirement of forest products. Slight error in the selection of species may result in the failure of the plantation which leads to huge loss of money, time and energy. The success and failure of any plantation depends largely on evaluation of site quality and sound judgment in fitting a species to that site.

Factors which influence the choice of species for plantation:

1. Site quality
2. Purpose of plantation
3. Economic consideration
4. Silvicultural characters
5. Effect on site
6. Resistance to pest and disease.

1. Site quality: Before deciding choice of species study of ecological factors such as climate, landform, soil profile, moisture, depth and fertility is required. The inherent capacity of the soil to produce biomass is site quality, which depends upon following factors:

Climate condition

- Temperature (Average maximum & minimum)
- Rainfall (number & distribution of rainy days)
- Relative humidity
- Wind
- Solar radiation

Edaphic Factor

- Soil Type
- Soil profile
- Physical & chemical properties of soil (pH, C:N & SOM)
- Soil Moisture

Topographic/Physiographic features

- Configuration of land
- Altitude
- Slope



- Aspect

Biotic Interaction

- Relationship between plant & plant
- Relationship between Plant & animal
- Relationship between Plant & man

2. **Purpose of plantation: Choice of the tree for plantation** largely depends upon the objective for which the plantation is generally raised like:

- **Domestic use:** fuel, fodder, fiber, edible fruits/nuts/flowers/buds etc.
- **Protective use:** soil & water conservation, wind break, shelterbelt, rehabilitation of degraded land
- **Industrial use:** to meet the demand of wood based industries like pulp & paper, plywood industry
- **Other use:** Beautification, landscaping etc.

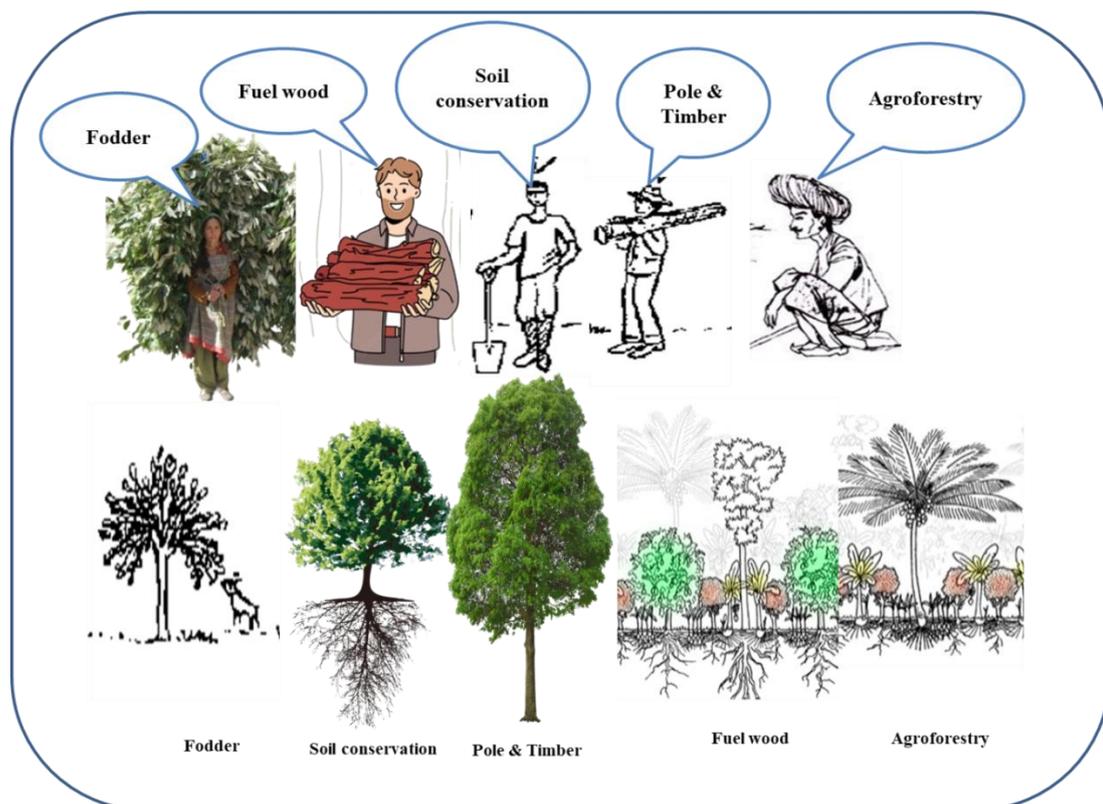


Figure.1 What is the purpose of plantation?

3. **Economic consideration:**

- **Demand and supply:** Since market is dynamic in nature, demand and supply of wood depends on number factors which affect the choice of species. In an



area where industrial units have been setup, choice of species should regulate the supply of raw material for such industries.

- **Cost of raising plantation:** Those species are preferred for plantation whose cost of establishment is less and gives higher returns.

4. **Silviculture characters:**

- Rate of growth: fast growing species with short rotation are generally preferred to meet the industry demand.
- Ease of establishment: propagating material of the species is easily available
- Non exacting in nature ie doesn't have specific requirement
- Good coppicing ability
- Tolerant to adverse climatic condition (drought hardy, frost hardy, wind firm)
- Stem form: straight & clean cylindrical bole
- Least variability in growth pattern
- Tree having long tap root system
- Preferably should have self-pruning ability

5. **Effect on Site:** species to be planting should have positive effect on the site and improve the growing condition by:

- Adding organic matter in the soil profile
- Fix atmospheric Nitrogen in the soil
- Deep tap root system to draw nutrients from deep layers of the soil horizon and add to the upper layers through leaf litter

6. **Resistance to pest and diseases:** disease resistant varieties and clones should be selected for plantation.

Field Exercise:

1. **To visit the agroforestry field in your vicinity to access the preference of tree species by the farmers**

- a) Name of village:
- b) Date of visit:
- c) Presence of prioritized tree species to the specific Agro- forestry plantation sites:



S.No	Farmer Name	Land area	Rotation (Years)	Tree Species				Use(s)
				Common Name	Scientific Name	Spacing	No. of plants	
1.								
2.								
3.								
4.								
5.								
6.								
7.								

d) Criteria adopted by the farmer of Bundelkand region of Uttar Pradesh while selecting the tree species for plantation:

e) Conclusion



Exercise

12

Aim: To know about the economic considerations in plantation

Plantation forestry, the practice of establishing and managing forests for the production of timber, fuel wood and other forest products, involves various economic considerations. These considerations play a crucial role in the decision-making processes of investors, policymakers, and forest managers. Some key economic aspects to consider in plantation forestry:

Key factors for economic factors to consider in plantation management are:

- 1. Cost of Establishment:** The initial cost of establishing a plantation, including land procurement, site preparation, planting, and initial maintenance, is a significant economic consideration. This cost varies depending on factors such as site quality, species selection, and local labor and material prices.
- 2. Choice of Species:** The selection of tree species to plant is critical for economic success. Factors such as growth rate, market demand for timber and other products, site suitability, and resistance to pests and diseases influence the choice of species. Fast-growing species may provide earlier returns on investment but might have lower market value compared to slower-growing, high-value species.
- 3. Management Practices:** Effective management practices, including thinning, pruning, and pest control, impact the economic viability of plantation forestry. Proper management can enhance tree growth rates, improve timber quality and reduce losses due to pests and diseases, thereby increasing overall profitability.
- 4. Rotation Length:** The rotation length, or the time between planting and final harvest, significantly affects the financial returns of plantation forestry. Longer rotation lengths may result in higher timber volumes and quality but require more extended periods of investment before realizing returns. Shorter rotations may provide quicker returns but could sacrifice timber quality and overall productivity.
- 5. Timber Markets and Prices:** Understanding timber markets and price trends is essential for making informed decisions in plantation forestry. Factors such as supply and demand dynamics, international trade policies, and fluctuations in global economic conditions influence timber prices and market opportunities.
- 6. Organization and Labour costs:** Pay, allowances of field and office staff and their travelling and medical expenses etc. Labour costs is the payment made to the labour for undertaking different operations like survey & demarcation, weeding, cleaning, causality replacement, fire protection etc.



7. Technological Innovations: Advancements in forestry technology, such as remote sensing, precision forestry, and genetic improvement, have the potential to improve productivity, reduce costs, and enhance the economic competitiveness of plantation forestry operations.

Field Exercise:

1. To identify the key economic factors in a plantation site

- a) Name of plantation sites:
- b) Date of visit:
- c) Forest Division:
- d) Range:
- e) Area (ha):
- f) Purpose of plantation:
- g) Economic consideration: (Cost-Benefit Analysis):
- h) Achievements of plantation to socio-economic status of local people:
- i) Conclusion:



Exercise

13

Aim: To know about Plantation Journal/Records

Plantation journal is a register in which all the details works carried out in a plantation are recorded and properly maintained for reference. These records are essential tools for managing plantations effectively. They help in tracking various activities, monitoring progress, and making informed decisions. It is an important record and should be maintained separately for each plantation and kept upto date information for decision-making, performance assessment, and regulatory compliance.

Table 8. Key components of plantation journals/records:

Sr. No.	Components	Particulars Remark(s)
a.	Plantation Map	<ul style="list-style-type: none"> On the first page of the journal
b.	Site Information	<ul style="list-style-type: none"> Description of the area Details of old vegetation Crop felled Revenue received Method of site clearance Soil (Work) preparation Soil analysis reports.
c.	Species Inventory	<ul style="list-style-type: none"> List of species selected for planted, including scientific names, common names, and planting dates Details on planting density, spacing, and arrangement (e.g., rows, blocks)
d.	Planting Details	<ul style="list-style-type: none"> Planting methods used (seedling planting, cutting planting, direct seeding, etc.) Planting techniques and equipment employed. Planting depths, spacing, and orientation
e.	Maintenance Activities	<ul style="list-style-type: none"> Records of cultural operations (soil working, weeding, irrigation etc.) Pest and disease management interventions (e.g. pesticide applications, biological control methods) Replacement of causalities Dates and methods of pruning, thinning, and canopy management
f.	Detail of Fencing	<ul style="list-style-type: none"> Type of fencing and its specifications
g.	Monitoring and Observations	<ul style="list-style-type: none"> Last page contains the remarks of inspecting officer regarding the progress of plantation w.r.t plant health, growth rates, survival rates and establishment success
h.	Financial and Budgetary Information	<ul style="list-style-type: none"> Tabular form showing expenditure data for each activity



The inspecting officer records his remark in the plantation register for the guidance of field staff. It is a very important document to be preserved for ever. It is maintained in duplicate, one in the Range Office and other in the Division Office. They offer the best option for assessing progress of young plantations. Plantation journals should have provision for suitable sampling strategy for the survey. Nowadays the plantations are well recorded and in many of the cases their positional coordinates are also mentioned in the records.

Field Exercise:

1. To analyze the Plantation Journal/Records

- a. Circle:
- b. Forest Division:
- c. Range:
- d. Plantation Name:
- e. Area (ha):
- f. Plantation Journal:

Circle	Division	Range	Plantation Name	Plantation Year	Scheme	CA MPA Projects	Area (ha)	No. of plants planted	Raising survival	1 st year	Survival 2nd year	Survival 3rd year	Survival Raising cost (Lakh)

- g. Objective of preparation of plantation journal:
- h. Conclusion



Exercise

14

Aim: To study the differences between government and private plantations

Government Plantations: Owned and managed by government bodies. These plantations often follow policies and guidelines set by government agencies.

Private Plantations: Owned and managed by private individuals or companies. They operate with the goal of maximizing profit and may have more flexible management practices.

Government and private plantations play complementary roles in sustainable forest management and contribute to environmental conservation, economic development, and social welfare. In addition to promoting balanced approaches to land use and natural resource management, collaboration between the public and private sectors can increase the success of plantation projects.

Table 10. Characteristics features government and private plantation:

Sr. No	Characteristics	Government Plantation	Private Plantation
a.	Ownership/Legal status	Land belongs to Government organization/Institutes	Land belongs to Industry, Private company, Farmers or individual
b.	Objective	Goals of Government plantation are in accordance with: <ol style="list-style-type: none"> National Forest Policy 1988 (i.e. minimum of one-third of the total land area of the country under forest or tree cover.) Long term goals with major emphasis on ecological services Often have multiple objectives, including economic, social, and environmental goals. They may focus on sustainable development, conservation, and providing public goods. 	Goals of private plantation depend upon: <ol style="list-style-type: none"> Attitude of owner i.e. individual landowners, companies, or investors Short term goals with respect to productive function of the forests Primarily driven by profit motives. Their objectives are usually focused on maximizing yield and financial returns
c.	Purpose	<ul style="list-style-type: none"> To meet the demand of local and urban people To meet the demand of cottage industries To increase the green cover of the country Emphasis on the protective functions of forest 	<ul style="list-style-type: none"> To meet the demand of wood based industries Commercial timber production for profit Carbon offset projects for voluntary or compliance markets To realize highest income



Sr. No	Characteristics	Government Plantation	Private Plantation
		<ul style="list-style-type: none"> • Recreation and aesthetic opportunities 	
d.	Management	<ul style="list-style-type: none"> • Managed by agencies at various administrative levels, such as forest departments, state forest corporations, or Government institutes • Management responsibilities include planning, execution, monitoring & regulation of plantation activities. • Government plantations may be established on public lands, including state-owned forests, degraded lands, or designated plantation areas. 	<ul style="list-style-type: none"> • Managed by private landowners, forestry companies, agribusiness firms, or investment funds • Management practices may vary depending on the objectives of the plantation, market demands, and ownership structure • Private plantations may be established on privately-owned lands or through lease agreements with landowners
e.	Funding and Financial Management	Funded by government budgets, grants, and subsidies. Financial management is subject to public sector regulations.	Funded by private investment, loans, and reinvested profits. Financial decisions are made based on market conditions and business strategies.
f.	Selection of species (Choice of Species)	Generally indigenous species with long rotation are selected for plantation	Fast growing species / clones (Indigenous and exotic) with short rotation are selected for plantation
g.	Species composition	Preferably mixed forest	Mostly one or two species are selected
h.	Rotation	Mostly long rotation is preferred (Physical Rotation, Silvicultural Rotation or Rotation of Highest Income)	Generally short rotation are preferred (Technical Rotation, Economic Rotation)
i.	Rate of growth	Both fast and slowing species are planted	Fast growing species are given preference
j.	Character of Crop	Uneven age or Even aged	Generally Even age
k.	Sustainability Practices	Often prioritize sustainability and conservation. They may implement long-term projects for ecological balance and biodiversity.	While some private plantations may adopt sustainable practices, their primary focus is on profitability, which can sometimes lead to short-term exploitation of resources.
l.	Scale	Generally larger in scale plantation are preferred due to government resources.	scale plantation depends upon the budget and resource but private plantations aim for high efficiency and productivity to maximize profit.
m.	Examples	<ul style="list-style-type: none"> • Social Forestry 	<ul style="list-style-type: none"> • Industrial Plantation



Sr. No	Characteristics	Government Plantation	Private Plantation
		<ul style="list-style-type: none"> • Urban Forestry • Community Forestry • Plantation under watershed management • Plantation under Green India Mission and CAMPA • Plantation as per the working plan 	<ul style="list-style-type: none"> • Farm Forestry • Agroforestry

Field Exercise:

1. Visit and compare government and private plantations in your area.

- i. Name and location of visiting site of Govt. Plantation:
- ii. Name and location of visiting site of Pvt. Plantation:
- iii. Govt. Plantation area (ha):
- iv. Pvt. Plantation Area (ha):

v. Field work

S.No.	Type of Plantation	Tree Species		Rotation Period	Purpose	Uses	Distance		Other Information
		Common Name	Scientific Name				In rows (m ²)	In plants (m ²)	
1.	Govt. Plantation:								
2.	Pvt. Plantation:								

- vi. Achievements made by Govt. and Pvt. plantation to socio-economic status of local people:



Appendix

C:N	Carbon Nitrogen Ratio
CAMPA	Compensatory Afforestation Fund Management and Planning Authority
Cm	Centimetre
e.g.	Example
EP	Energy Planting
FDC	Forest Development Corporation
Ft	Feet
Fig.	Figure
FYM	Farm Yard Manure
Govt.	Government
Ha	Hectares
i.e.	That is
K cal	Kilocalories
Kg	Kilogram
Km	Kilometre
M	Meter
m ²	Meter square
MGNREGS	Mahatma Gandhi National Rural Employment Guarantee Scheme
MoEF&CC	Ministry of Environment Forest and Climate Change
MPT's	Multipurpose Tree Species
No.	Number
NTFPs	Non- Timber Forest Products
PPCU	Provincial Project Coordination Unit
Pvt.	Private
SOM	Soil Organic Carbon
Sp. Gravity	Specific Gravity
Sr.no	Serial Number
%	Percentage



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