Practical Manual of

Silvicultural Practices

SAF 503 (1+1)

Dr. Garima Gupta

Dr. Pankaj Lavania

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Department of Silviculture and Agroforestry
College of Horticulture and Forestry

Rani Lakshmi Bai Central Agricultural University

Jhansi-284003

Silvicultural Practices SAF 503

To different forest sites to study the influence of site factors on composition; Determination of site quality; Studies on stand structure and composition of different forest types; Practicing pruning and its impact on wood quality; Characterizing methods of thinning; Working out intensity of thinning Study of stand densities in natural forest stand and plantation stand; Afforestation techniques, Wood management techniques for forest tree crops; Planning and designing a tree planting programme; Exercise on precision silviculture practices; Exercise on mechanized silvicultural practices.

Name of student:……

Roll No…….

Batch:……..

Session:……..

Semester:…….

ANI LAKSHMI BAI CENTRAL AGRICULTURAL UNIVERSITY, JHANSI-284003

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Exercise-1

Objective: To study the influence of site factors on composition and distribution in a forest

Equipments required: measuring tape, vernier calliper, wooden pegs/nails, knife,

Procedure:

This study aims to analyze the diversity, composition and distribution pattern of tree species data will collected in quadrant method, where at different places with 50m regular intervals will be plotted.

Measurement of Species Diversity in tree, shrubs and herbs by quadrate method

- Lay the required number of quadrates of appropriate size
  a. Laying 10x10m quadrates for tree species
  b. Laying 5x5m quadrates for shrub species
  c. Laying 1x1m quadrates for herb species
- Note presence (+) or absence (-) of each species in each of the quadrates and record them in table 1 and 2.

Table1: Data sheet for recording the observations in the field

S.No.	**Plant species**	**Quadrates 1 2 3 4 5…….**	**Total no of quadrates of occurrence (Qo)**	**Total no of quadrates of studies (Qs)**	**Percentage frequency = (Qo)/ (Qs)x100**

Table 2. Data sheet for recording the observations in the field

S. No	Plant species	Quadrates 1 2 3 4 5……. (Q)	Total no individuals (I)	Total no. of quadrates of occurrence (Qo)	Total no. of quadrates studied (Qs)	Density = Q/Qo x100	Abundance = Q/I x 100

Calculate frequency, density and abudence using the following formulae

$$\text{Frequency (\%)} = \frac{\text{No. of quadrates in which the species occurred}}{\text{Total no. quadrates studied}} \times 100$$

$$\text{Density} = \frac{\text{No. of individuals}}{\text{Total no. quadrates studied}} \times 100$$

$$\text{Abundance} = \frac{\text{No. of individuals}}{\text{Total no. quadrates of occurrence}} \times 100$$

Estimating Basal area

Basal area is the main characteristics determining dominance of plant species.

1. Measure the diameter of the stem of plant at ground level of a number of plants
2. Calculate average diameter for each species
   Average Basal area $A = \pi r^2$,

Where, r is the radius of stem of plant

Importance Value index (IVI): The index expresses the dominance and ecological success of any species. This index utilizes here characteristics, viz, relative frequency, relative density and relative dominance.

Table 3. Data sheet for calculating IVI

Species	Q1	Q2	Q3	Q4	Q5	Average diameter	Density	Frequency	Total Basal Area

$$\text{Relative density} = \frac{total\ no.\ of\ individuals\ the\ species}{Total\ no.\ of\ individuals\ of\ all\ the\ species} * 100$$

Relative frequency $= \frac{freuency\ of\ one\ species}{Total\ frequency} * 100$

Relative abundance $= \frac{\text{abudance of one species}}{\text{Total abudance}} * 100$

Relative dominance$= \frac{\text{basal area of one species}}{\text{Total basal area}} * 100$

IVI = relative density + Relative frequency + Relative dominance

Other Indices quantifying forest inventory of trees Species composition and diversity:

Species diversity index, SDi = S/N

Margalef's index, R = (S-1)/Ln(N)

Shannon-Wiener's diversity index, H$= -\sum_{i=1}^{n}$ Pi In Pi

Simpson's diversity index, D$= \sum_{i=1}^{n} Pi^2$

Species evenness index, E = H/ Ln (S)

Here, S = Total number of species, N = Total number of individuals of all the species, i = is the proportion of each species in the sample; Ln Pi = natural logarithm of this proportion; n=Actual number of individual of one species in a stand;j = the number of species common to both habitats; a= number of species in site a; b= number of species in site

Results:……
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Exercise-2

Objective: study of thinning and its intensity

Thinning and management objectives

The definition of thinning is the felling of trees in an immature stand to improve the development and form of the remaining trees without permanently breaking the canopy. The formulation of thinning principles is such that they are only applicable to pure, even-aged, or comparatively even-aged crops or even-aged groups of trees within a crop. The principles of thinning have been devised based on the natural development of the stand. Thus, thinning occurs naturally in densely populated forests in accordance with the law of survival of the fittest.

Objectives of thinning

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Methods of Thinning:

1**) Mechanical Thinning:**

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2) Ordinary Thinning:

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3) Crown Thinning:

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4) Numerical Thinning:

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5) Advance Thinning:

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Grades of Ordinary Thinning:

i) **Light Thinning (A Grade):**
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ii) **Moderate Thinning (B Grade):**
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iii) **Heavy Thinning (C Grade):**
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iv) **Very Heavy Thinning (D Grade):**
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v) **Extremely Heavy Thinning (E Grade):**
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Response of individual trees to thinning:

The response of trees to thinning is an important judgement to make and is generally controlled by the age of the tree, canopy position and shade tolerance of the species as described in Table3.1 Repeated observation of a number of young even-aged stands that are thinned using a traditional approach (intermediate thinning at Marginal Thinning Intensity (MTI) on a five year cycle) will lead to the conclusion that 2 to 3 years after thinning they could be thinned again.

Table: Factors affecting the response of a tree to thinning

Age of the tree	The development of any tree passes through three phases: juvenile, full vigour and senescence. In the juvenile phase growth is relatively slow, in full vigour growth can be very rapid and then during senescence it slows again trees in the full vigour phase can respond very quickly to thinning and it can appear that a young stand needs thinning again 2 to 3 years after the last intervention.
Canopy position	Trees with access to direct sunlight (dominants and co-dominants) can generally respond better to thinning. However, to some extent this also depends on species shade tolerance.

Shade tolerance	Species that are shade tolerant or intermediate can respond to thinning if they have been suppressed or over-topped much better than light demanding species

Exercise-3

Objective: study of pruning and its impact on wood quality

Pruning is performed on branches on the lower portion of the stem with the goal of manipulating wood development. It is an essential silvicultural practice for clear wood production. Pruning is beneficial because it prevents the development of major structural defects and ensures that the majority of trees in the crop have the potential to produce higher quality timber.

Object of pruning

There are many reasons to prune trees, these include the following:
- To remove multiple stems (singling);
- To improve plant form (formative pruning);
- To reduce the occurrence of knots and defects in future wood (high pruning);
- To remove an obstruction or nuisance e.g. with roadside trees or to improve access (brashing);
- To ensure healthy vigorous growth in new plants by removing damaged roots and shoots;
- To maintain health and vigour by removal of dead, diseased and rubbing limbs;
- To improve flowering and / or fruitfulness.

Case Study

Location:…….
Tree Species: ……
Age:……
Spacing:……
Design: …….
The pruning treatments (Intensity):-
……
……
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Effect of pruning intensity: on growth of some timber tree species after one, two and three years from pruning

Pruning intensity	Tree Species:			
	Height (m)	Collar Diameter (cm)	DBH (cm)	volume (m3 / tree)

Results:
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Exercise-4

Objective: Measure stand density in natural forest stand and plantation stand method study of pruning and its impact on wood quality

Equipments required: wedge prism, meter tape, tree caliper

Procedure: A quantitative measure of tree cover on an area, i.e., the amount of tree material per unit area or space. The terms stand density and stocking synonymously used.

1. A quantitative measure of tree stocking expressed either relatively as a coefficient, taking normal numbers, basal area or volume as unity, or absolutely, in terms of number of trees per acre, total basal area, or volume, per unit area.

2. More precisely, a measure of the degree of crowding of trees within stocked areas, -- of crown length to tree height; crown diameter to DBH, or crown diameter to tree height; or of stem spacing to tree height.

Measurement of Stocking

1. A general term for the quantity of anything on a given area, especially in relation to what is deemed optimal.
2. In a forest, an indication that is more or less subjective of the number of trees in relation to the optimal number for "best" results.
3. Precisely, the proportion of an area that is truly occupied by trees, expressed, for example, in terms of stocked quadrats or percent crown closure, as opposed to their stand density.
4. Sufficient quantity of a given material to meet a management objective. Consequently, stands may be "understocked," "fully stocked," or "overstocked." A forest that is overstocked for one management objective may be "understocked" for another.

Density Indices

The bases of the various indices of stand density used by foresters fall into four categories:

- Number per unit area (equivalent to "density" in ecological usage)
- Basal area per unit area
- crown closure usually expressed as % crown cover

The number of trees on a defined area may be a satisfactory index of density if tree size is uniform or differences in size can be ignored, e.g., young stands following establishment where the main concern is whether or not the area is sufficiently stocked and whether refilling is necessary. Stocking here implies 'stems per unit area' and is a qualitative expression of the adequacy of tree cover on an area. Thus we use the relative terms 'under-stocked', 'fully stocked', 'over stocked' in describing a young forest stand.

Stand Basal Area (SBA): It is simply the cross-sectional area of all the trees at breast height per hectare of forest or plantation (m^2/ha). Stand basal area can be measured by two methods: angle count sampling or fixed area plot measurement is another index incorporating number of trees and dbhob.

$$BA = \sum_i \pi/4 \, D^2_{ik}$$

D = diameter at breast height; i = indices for tree i, and plot k.

Stand basal area is widely used in the management of even-aged stands for a number of reasons, viz. it is a practical index of stand density; it is easily measured; it is the natural base for deriving stand volume; and volume increment and basal area increment are usually well correlated.

Crown competition factor (CCF): CCF is defined as the sum of the MCA values for all trees in a stand, divided by the area in acres. maximum crown width (MCW) of a completely open-grown tree is predicted indirectly by regression, using diameter breast height (D) and perhaps other characteristics. Maximum crown area can then be expressed as a percentage of an acre:

$$MCA_i = 100\,\frac{0.7854\,(MCW_i)^2}{43{,}560} = 0.001803(MCW_i)^2,$$

where

MCA_i = maximum crown area for the *ith* tree,

MCW_i = maximum crown width for the *ith* tree,

and CCF is computed by

$$CCF = \frac{1}{A}\sum_{i=1}^{n} MCA_i,$$

where

A = area in acres,
n = number of trees on the area.

Stand Density Index (SDI) that relates the current stand density to an equivalent density in a stand with a quadratic mean diameter (Dq) of 10 inches. Reineke's SDI can be expressed as:

$$SDI = N(Dq/10)^b$$

N = trees per acre Dq = quadratic mean diameter (inches) b = exponent of Reineke's equation, often reported to equal –1.605

Number of observations of species

Tree number	Species	Diameter	BA /tree	BA/ acre	Tree/acre	SDI

Results

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Exercise-5

Objective:. To execute suitable planting and stand management practices of *Eucalyptus tereticornis* in bundelkhand region

Required material:- Field exercise with observation

(A) Planting techniques

The planting techniques in *Eucalyptus tereticornis* possible by

a) In block planting

- The ridge 20-30 high are made at the intervals of 4 m. the planting is done on the ridge in pits 30 cm 3in size and 1.25 meter apart.
- Block plantation are established at regular spacing that varies from 1x 1.5 m to 4x 4 m
- The pit used varies from 30 to 60 m^3.
- In waterlogged condition, planting is done upto 1 meter.
- In Srip planting ,the rows are planted 1m X 1 m or 3 m X 1 m along road the railways and road side
- Single row or line planting serves as effective wind break and having the spacing of 0.5 m to 4 meter .
- The seedlings are field planted at a spacing of 2 x 2 m in pits measuring 30 cm^3. Quality of seedlings is determined by the thickness of the root collar region than by height.

(B)Stand management:-

(a)**Weeding:-**weeding is important in the first year and may also have also done in the second and third year .

(b) **Fertilization** :-. Application of 100g of NP or NPK (3:2:1) fertilizer to each tree at planting to assist establishment of growth is common. Crown die-back during dry-season as a result of boron deficiency is prevalent in few places. A dosage of 10-20 g of borax per tree depending on soil type is applied.

(C) **Pruning:-**

- Remove all side branches from the lower third of the main stem.
- Shorten by half all the sideshoots on the middle third of the main stem.
- Leave the sideshoots on the top third of the main stem unpruned, apart from the removal of dead, diseased or damaged growth

(D) **Thinning:-**Thinning are generally not necessary in the short rotation crops.

(E) **Coppice maintenance**:-.The trees are felled at the end of seven years. Thereafter two coppices are taken at intervals of five year each. Coppice management is important in eucalyptus. Hundreds of new shoots develop on the margin of the cut stem. Felling of the trees prior to or immediately after the monsoon helps in rapid callus formation and thicker coppice shoots. Care should be taken to fell the trees with a gentle slope at the cut so that rainwater does not collect as a pool and cause decay of the callus tissue. Though hundreds of coppice shoots develop yet only four to five stems ultimately remain on the stump and the others are edged out in natural competition. There is no need to manually regulate the number of coppices as nature itself does the job. The health and number of coppice stems are positively related to the diameter of the sdsmp. The productivity of coppice plantation is generally higher by 20 -25 % than the first seedling plantation. At the end of the second coppice growth it is necessary to uproot the roots. Its rotation is about 8 - 10 years.

(F) **Adopted silviculture system:** This crop is clear-felled of each rotation and regenerated by coppices.

g) **Pests and diseases:-**Most plantations have been free of pests and diseases. Termites will attack the young plants unless they are protected.

Field Exercise:

1. Name and location of the plantation area:……..……..……

2. Date:……..

3. Area (ha):……

4. Field work:

Sr.n	Name of site	Regular spacing In Block	Spacing In Srip planting	Weeding(yes/No)	Fertilization(es/ No)	Pruning (Yes/No)	Thinning(Yes /No)	Coppice maintenanc	silviculture system	Pest and disease (Yes/No)
1										
2										
3										
4										
5										

Conclusion: ……

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Exercise-6

Objective: To execute suitable planting and stand management practices of *santelum album* in bundelkhand region.

Required material:-

Field exercise with observation

Planting techniques

Raising plantation has been obtained successfully by following methods

(A)**Direct seed sowing**

(i) Dibbling of seeds into bushes

(ii) Dibbling of seeds in pits or mounds

(i) Dibbling of seeds into bushes

i. Dibbling of seeds into bushes
ii. This methods is adopted in open scrub jungles with lot of bushes.
iii. Seeds are sown during monsoon with help of bamboo dibbling instrument.
iv. An instrument can be made using a bamboo pole of 4 to 6 cm internal diameter and a length of 1.5 m for the purpose of sowing seeds. The septa at the nodes are removed and one end of the pole is sharpened or a hollow metal piece is attached.
v. The pole is introduced at the base of the bush and through the hole 4 to 5 seeds are transferred to the base of the bush. Fairly good success has been achieved by this method.

Dibbling of seeds in pits or mounds

The usual trench mound technique adopted in forest for other species is also adopted for sandal.But here a perennial host plant is also grown along with sandal either on the mound or in the pit.

(B)Entire planting.

- Plantable seedlings of about 30 cm height can be raised in 6-8 month's time. A well branched seedling with a brown stem is ideal for planting in the field.
- Pits of 50 cm^3 are dug out at an espacement of 3 m x 3 m. or 4 m x 4 m
- Healthy sandal seedlings, preferably above 30 cm in height are planted in the pits.
- Miscellaneous secondary forest species as host plants are planted in the same pit or they may be planted in separate pits in a quincunx pattern.
- This method has proved successful in many forest areas. At the time of planting in the field a perennial host, if given, increases the growth of sandal, otherwise it shows stunted growth with pale yellow leaves and ultimately dies in about one year.
- Sandal has over 150 host plants, some of the good hosts being *Casuarinaequisetifolia, Acacia nilotica, Pongamiapinnata, Meliadubia, Wrightiatinctoria*and *Cassia siamea.*
- Sandal with mango as secondary host :Spacing : 6 mt X 3 mt (Sandal), 6 mt x 6 mt (Mango)

(C)Vegetative method through Air layering

- In the air layering ,branches approx. 2 cm in diameter are chosen during June-julywhen there are frequent shower.
- A ring of bark 1 cm in width is removed alround and the exposure branch is dusted with seradix-B and covered with moss.
- The wound is kept moist.
- Callous formation occurs in 35-49 days in 95 % of treated wounds and in15-20 % cases roots emerge.when the roots develop to about 8 cm, the branch lets are separated from the tree and planted along with host ina pit or pot.
- Vegetative propagation is done through air layering or through root suckers. Techniques of tissue culture of sandal using different types of tissues like nodal, internodal segments from young shoots, and suspension culture, using different organs have been standardized.

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(B)Stand management

(a) Hoeing and cleaning

- Soil working to a radius of 50 cm once in 6 months is to be done.

(b) Pruning:-

- The host plant tending to over grow sandal may be pruned, so that sandal gets maximum sun light.
- Adequate protection against fire and grazing is very necessary.
- To achieve a clean bole and maximum heartwood in the stem, side branches may be pruned periodically on the lower half of the main stem.
- The branches should be pruned with a sharp knife close to the stem without leaving a fork which may attract borers.

g) Pests and diseases:-

Spike disease is one of the important diseases of sandal. This disease is caused by mycoplasma-like organisms (MLO). It can occur at any stage of development of the tree. As the disease progresses, the new leaves become smaller, narrower or more pointed and fewer in number with each successive year until the new shoots give an appearance of fine spike. At the advance stage of disease the inter nodal distance on twigs becomes small, haustorial connection between the host and sandal breaks and the plant dies in about 2 to 3 years.Spread of disease is sporadic and the disease is transmitted in nature by insect vectors.

Field Exercise:

1. **Name and location of the plantation area:……..……..……**

2. **Date:……**

3. **Area (ha):……**

5. **Field work:**

Sr.n	Name of site	Regular spacing In Block	Spacing I Srip planting	Weeding(ves/No)	Fertilization() es/ No)	Pruning (Yes/No)	Thinning(Ye /No)	Coppice maintenanc	silviculture system	Pest an disease (Yes/No)
1										
2										
3										
4										
5										

Conclusion: ……

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Exercise-7

Objective: To exercise the best Planting and stand management practices of *Swietenia macrophylla* in bundelkhand region

Required material:-

Field exercise with observation

Planting techniques-The seedlings can be planted in the field when they are about 50–100 cm tall, when they are sufficiently strong and not tender and their fresh shoots have a chance to mature and harden.To increasethe survival rate at the planting site, the seedlings should be handled carefully and roots kept moist. Some methods include wrapping the roots of the bundles in dry grass and soaking, putting bundles in wet sacks and putting individual plants in polythene bags, which are in turn placed in wet sacks to keep them cool (Lamb 1966). Bundles, bags or sacks should then be kept in the shade until planting out.

Entire planting.-

- All weeds should be cleared from the planting sites.
- The use of close spacing can shade the ground and thus reduce the growth of weeds. Close spacing will also serve to reduce the development of vigorous lateral branches.
- The spacing for planting S. macrophylla is usually 2–3 m.
- Wider spacing of about 4–5×4–5 m is also commonly applied by smallholders.
- To obtain multiple yields by intercropping the S. macrophylla trees with cassava, corn, peanut, pumpkin and other agricultural crops

(B)Stand management

(a) Weeding, Hoeing and cleaning

- Weeding is required to ensure maximum growth and survival of seedlings.
- Weeds that are as tall as or taller than the seedlings should be removed.
- During the first 2 years after planting, weeding and hoeing should be done 4 times every 6 months.
- Either line weeding (along the rows of main species) or ring weeding (in a 1-m diameter around the seedling) is recommended.
- To prevent the regrowth of weeds, cut grass is placed as mulch around the seedlings.

(b) Fertilizing :-

- **fertilisers are usually applied after planting at a dose of 75–100 g NPK (chemical fertiliser) per plant in a ring around the seedlings.**

(c)Infilling :-

- Replanting can be done twice during the rotation.
- The first replanting normally takes place in the rainy season at 1 month after planting to

replace any dead seedlings and the second one is at the end of the second year.

(d) Pruning:-

- Pruning consists of removing dead or non-productive branches from the lower trunk to encourage the production of clear wood .
- It also reduces the risk of disease and pest infestations (e.g. shoot borer).
- Pruning is usually done for the first 3 yearsthis is expected sufficient to reduce the threat of shoot borer as the moth usually attacks young trees only.
- The best time for pruning is just before the rainy season. Sometimes S. macrophylla trees have 2 or 3 stems during early growth at 6–9 months. In this case, pruning and singling should be done by removing the co-dominant stem

(e) Thinning

- The first time of thinning should be done around 5–10 years, depending on site quality and initial stand density.
- The number of thinnings required in a rotation also varies depending on initial density and site quality.
- The interval period between thinnings is 5–10 years.
- Multiple thinnings are suitable only instands planted at closer spacings (3 m × 3 m – 2 m × 3 m).
- For stands with high initial planting density (spaced at 2m × 3 m), four thinnings in a rotation is recommended to obtain high timber volume at the end of the rotation.
- For intermediate initial density stands (spaced at 3 m × 3 m), two–three thinnings appears to be essential for obtaining high timber volume, while in a wide spacing (4 m × 4 m) one thinning option is suitable.
- The intensity of thinning should be heavier in the first thinning (45–55% of the standing trees removed) for high initial density in order to maintain high growth rates and shorten the rotation length. The intensity of subsequent thinnings should then be reduced gradually to 25–30%. For stand of low initial density (spaced at 4 m × 4 m) the suitable thinning intensity is about 30–43%.

Field Exercise:

1. **Name and location of the plantation area: …….**
2. **Date:……**
3. **Area (ha):……**
4. **Field work:**

Sr.n	Name of site	Regular spacing In Block	Spacing I Srip planting	Weeding(yes/No)	Fertilization(es/ No)	Pruning (Yes/No)	Thinning(Ye /No)	Coppice maintenanc	silviculture system	Pest an disease (Yes/No)
1										
2										
3										
4										
5										

Conclusion: ……

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Exercise-8

Objective: To draw line diagram line and execute suitable planting and stand management practices of *Tectonagrandis* in bundelkhand region.

Required material:-

Planting

(a) Designing a planting system:-

The planting systems are appropriate for teak including monoculture (single species) ,mixed species and agro forestry. It applies an agro forestry system on fertile soil because the benefits from land use can be maximised. it applies as a monoculture or mixed species system on infertile soil, rocky soil or rocky terrain to improve soil quality and to prevent landslides or erosion.

(i) Monoculture:- In the monoculture system only one species is planted. Land owners usually prefer this system when they do not need multiple products from the land, for example, agricultural crops, The advantage of a monoculture planting system is more timber volume and better and uniform quality timber can be produced from the same area of land, compared with the mixed species or agro forestry system.

Monoculture systems are easier to manage because there is a single crop species. The disadvantage is that monocultures are more susceptible to pests and diseases.

(ii) Agro forestry planting system:-

This system can be applied on or around farmland, including paddy fields. The advantage of an agro forestry system is that farmers gain short-term income from agricultural crops such as maize, peanuts, cassava, taro, patchouli and spices, such as turmeric, ginger and *temuireng*; and medium- to long-term income from timber.

The maintenance activities for seasonal crops like tillage and fertilization benefit the growth of teak. For example, an experienced farmer can prune teak roots while tilling the soil for planting crops .Agricultural crops in the Solanaceae family (aubergine, for example) should not be planted when teak is still young because they are hosts for wilt.

(iii) Mixed plantation system: A mixed plantation island planted with various tree

(iv) Species, evenly or unevenly aged stands. The mixture of several tree species, with varying harvest schedules and canopy height, resembles a forest. This planting system offers several advantages like as it is more resistant to pests and diseases, better use of growing space and root system, variation in land can be used more effectively, more resistant to wind, and improves species diversity. The differences in timber harvest cycles and harvest of non-timber products create a steady and diversified income stream over the short, medium and long term. This diversified production can reduce the market risk associated with single crop systems. This system has two main disadvantages likes If teak splanted closely with fast-growing species, such as acacia

then the teak will face strong competition for nutrients,moisture and light resulting in slower growth. Because of differences in production and rotation age, more caution is required when harvesting to prevent damage to surrounding trees. The best tree species for intercropping with teak are species that are equally suited to the planting purpose and land conditions.

Select tree species that are suited to the climate and conditions of the planting site.

- In highland areas, trees that intercrop well with teak include mindi (*Melia azedarach*), warugunung (*Hibiscus macrophyllus*) or suren (*Toona*sp).
- Teak on arid land are best combined with species that can grow well in dry areas, such as sandal wood(*Santalumalbum*).
- On relatively fertile land teak can be combined with fast- growing species, such as Gmelina (*Gmelina arborea*).:

Slow-growing species to diversify timber production: mahogany (*Swietenia macrophylla*), sonokeling (*Dalbergia latifolia*),

Species that produce fodder and fuel wood: tayuman (*Bauhinia purpurea*), lamtoro (*Leucaenaleucocephalai*), caliandra (*Caliandracalothyrsus*), gliriside (*Gliricidiasepium*),

Tree species that produce other nontimber products: sandalwood (*Santalumalbum*).

Prepare the land for teak planting:- Land preparation includes the following activities: site selection, clearing land of bushes and weed roots, stump destruction, ploughing , harrowing, and stone removal. Activities are required before planting llike arranging the space, preparing and installing markers, and Preparing planting holes

Space.

In a monoculture system, the most commonly used spacings are 2.5×2.5 m, 3×1 m, 2×3 m and 3×3 m. Planting hole (size).30cm x 30cm x 30cm.

Best way to plant seedlings:-

- If the nursery is far from the planting site, seedlings may dry out from exposure or lack of water during travel.
- In such cases, seedlings should not be planted immediately.
- Maintain seedlings near the planting site for 1 week; this allows them to adapt to the planting environment and recover from dessication.
- Plant seedlings in the rainy season or when rainfall has made the soil moist.
- Before planting ,apply to each planting hole basic fertilizer of 10kg compost (derived from leaves) or manure (derived from cattle waste).
- Make sure that the manure used is completely composted and not harmful to the seedlings.
- Seedlings can be planted 2–4 weeks after you apply the fertiliser.
- Remove the seedlings from the polybag carefully to keep the medium undamaged.
- Place the seedlings into the planting hole, and backfill it with topsoil or humus.
- Compact the soil by holding the seedling by the stem and slowly tamping down

the soil around the seedlings with your feet.

- Place the seedling bag at the end of the marker, as a sign that the seedling has been planted and to demonstrate that the polybag has been removed.

2. Stand management :-Teak grows well, grows fast, and produces high-quality timber when the land and trees and well maintained.

Maintenance includes weeding, fertilizing, replanting, pruning, thinning , maintaining coppices and controlling pests and diseases.

(a) Weeding :- In a young teak plantation weeds including vines, shrubs and grass need to be cleared regularly around teak trees. These weeds compete for light, water and soil nutrients. Left uncontrolled, the weeds could hinder the growth and even kill the teaktrees. In a mature teak plantation after the canopy closes, weeding can be done less frequently. Under storey weeds below mature trees generally die by themselves.

(b) Fertilizing:- Applying fertilizer when the trees reach 1, 2 and 3 years in age recommended. The recommended dose per tree is 50 g of NPK in the first year, 100 g in the second year and 150 g in the third year.Apply manure or compost at a dose of 10 kg per planting hole before planting the tree. Another way is to apply fertiliser in holes 10-15 cm deep that ring the teak tree at **a distance of 0.5–1.5 m from the stem, about the width of the tree's canopy.**

(c) Infilling :- Infilling is the replacement of dead plants with new seedlings and also maintains the intended spacing or density of teak trees in theplantation.It useful for replacing broken , unhealthy or poorly growing plants. The best time of practice should be done in the rainy season.

(d) Pruning:- Pruning is the removal of branches which increases clear bole height and reduces knots on the main stem. By removing unnecessary branches or twigs, the tree's growth will concentrate around the tree's main stem and its canopy. Pruning commences in the third year.Clear branches and twigs from the lower half of thetree.Pruningmorethan50%canhinderthe tree'sgrowth. Prune early in the rainy season, around August. Prune when branches and twigs are still young and small.

(e)Thinning:- Competition for light, water and nutrients is greater in closely spaced plantations causingslower tree growth and tall, skinny stems.

The removal of stressed, unhealthy and slow-growing trees will encouragebettergrowthforthegoodqualitytreesthatremain. (Goodqualitytreesarefast-growingandhealthyandhavegood stemform.)

In monoculture teak stands, thin every 3–5 years until the trees reach the age of 15. Thinning should be conducted more frequently if only a few trees are cut perthinning. After most trees in the stand reach the age of 15 years, thin every 5–10 years. Select trees for thinning that are diseased, otherwise defective, slow-growing, stressed or have poor form. Poor form means the timber will be worth less at market. In understocked plantations, teak trees with poor stem form do not require thinning to maximise growth of the

remaining trees, because competition is low.

(f) Coppice maintenance

After teak trees are harvested, the remaining stumps will produce coppices that can be managed to produce healthy trees. Early growth from a coppice is usually faster than early growth from seed, allowing for quick re-establish teak plantation.

To improve root system development and reduce the possibility of hollow stems, cut the stumps as close to the ground as possible.

(g)Controlling pests and diseases:-

- The stem borer *Monohammus rusticator*, called *ulan-ulan*. This pest can cause swelling of stems and holes in stems, often resulting in brokenstems.
- ,*Eutectona machaerallis* and *Hyblaea puera*are caterpillars that commonly eat teak leaves.

Controlling of *inger-inger* for Preventing the spread of *inger-inger*attacks, the regular thinning is needed because the infected trees before the beginning of the rainy season when *inger- inger* begin to emerge. the second way is Cut and burn the infected parts of trees.At last , Chemical control to kill *inger-inger*is accomplished with fumigant insecticides (phostoxin ¼ tablet) or insecticides containing fenpropatrin (Meothrin 50 EC).

Controlling of stem borer

The Stem borers can be controlled with a fumigant insecticide of phostoxin,injectedtotheinfectedstemthroughboredholes.

control Caterpillar

When caterpillar attacks are severe, use an insecticide containing the active ingrediantsdeltamethrin (Decis 2.5 EC), permethrin (Ambush 2 EC) or LAMDAsihalotrien (Matador 25).

Field Exercise:

1. Name and location of the plantation area:……..……..……

2. Date:……..

3. Area (ha):……

6. Field work:

Sr. no	Name of site	Regular spacing In Block	Spacing In Srip planting	Weeding(yes/No)	Fertilization()yes/ No)	Pruning (Yes/No)	Thinning (Yes/No	Coppice mainten	silvicultur e system	Pest and disease (Yes/No)
1										
2										
3										
4										
5										

Conclusion:

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Exercise-9

Objective: To exercise the suitable planting techniques and stand management practices of *Dalbergia latifolia* in bundelkhand region.

Required material:-

Field exercise with observation

Planting techniques

The planting techniques in Dalbergialatifolia is possible by

A. Direct seed sowing
B. Root suckers
C. Stump planting
D. Entire planting.

(A)Direct seed sowing :-

- Direct sowing is to be the best method for regeration in the moist or semi evergreen forest.
- The manner of direct seeds sowing are in line.
- it may be done at 1.8 meter apart and 27 kg pods being required per hectare.
- In this practice, the spacing between line to line 3.6 m apart with a 5 seeds per Sq. meter.

(B) Root suckers:-

- The natural or induced root-suckers with 5 cm bits of roots from selected mother trees are collect and planting in polythene begs.
- In next planting next planting season they attain the height of 60-70 cm and lock more vigorous in growth in camparison to seedling of same age.

(c) Stump planting

- Stump planting is very successful using stumps from 2–3-year-old seedlings with a collar diameter of 5–15 mm, a root length of about 15 cm and a shoot length of about 5 cm.

(D)Entire planting:-

- Rose wood has successful been raised by planting out of nursery seedling.
- The plants are raised in dona by direct sowing or transfering seedling from nursery beds to dona.
- The pit planting should be done with well worked soil.
- The planting may be in form of naked root and polythene beg seedling.
- The minimum size of pit should be 30 cubic cm.
- As pure stands, D. latifolia is spaced at 1.2 - 2.5 by 1 - 1.8. Wider spacing may produce crooked stems. But for narrow spacing is adopted 1.2 m x1.2 m and agroforestry systems spacing of 3 by 1 - 6 by 2 m are common.

(B)Stand management

(a)Weeding and Hoeing :- After planting or direct sowing, regular weeding is necessary until trees can withstand weed competition. Loosening soil around seedlings also improves growth. weeding and soil loosening should be done before weeds become dense.

(b) Fertilizing :-.

(c) Infilling

(d) Pruning:-Pruning is recommended at 5–10 years after planting

(e) Thinning :- In India an initial spacing of 5 m × 5 m, followed by thinning of alternate trees, is recommended. It is recommended at 5–10 years after planting.

(f) Coppicemaintenance

(g) **Adopted silviculture system***Dalbergialatifolia* is generally grown in pure stands, usually managed by clear felling followed by artificial regeneration, but sometimes it is mixed with other timber species such as mahogany (*Swietenia* sp.). In agroforestry systems it is intercropped with annual crops or fruit trees.

(g)Controlling pests and diseases:- The fungal organisms like as *Trametes corrugate and Polyporusgilvus* cause white spongy rot and white sap and bark rot in the tree and controlled by……..

The insect of families coccidae and Membrocidaefeed on the sap and bark on the tree and controlled by

Field Exercise:

1. Name and location of the plantation area:……..……..……

2. Date:……

3. Area (ha):……

7. Field work:

Sr. no	Name of site	Regular spacing In Block	Spacing In Srip planting	Weeding (	Fertilization()yes/ No)	Pruning (Yes/No)	Thinning (Yes/N)	Coppice mainte	silvicultu re	Pest and disease (Yes/No)
1										
2										
3										
4										
5										

Conclusion:

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Exercise-10

Objective: To draw line diagram line and execute suitable planting and stand management practices of *Dalbergia sissoo* in bundlel khand region.

Required material:-

Field exercise with observation

(B) Planting techniques

The planting techniques in Dalbergialatifolia is possible by

a) Direct seed sowing
b) Root suckers
c) Stump planting
d) Entire planting.

a) **Direct seed sowing** :-

- Broken pods or clean seed is sown at the rate of 35 kg per hactere.
- Afer the rain start, line sowing has done in 2-3 meter and the depth of sowing is 1.5 cm.

b**) Root suckers:-**

- Its produce root suckers in abundance and these areused for artificial regeneration.
- Felling the tree ground level and exposing the root, leads to the production of rootsuckers .

c**) Stump planting**

- Stump planting is carried out in order to raise forest and avenues ofsissoo inU.P., West Bengal etc.
- For making the stumps,12-16 month of seedling are preferred.
- Stump cuttings should be 17-22cm below the root collar and 2-3 cm above. Root collar diameter should be 1 cm.

d)Entire planting:-

- Planting – seedling are raised in the nursery – 9-12 months old stock when it has 0.6 meter tall .. With spacing 2.5 X 2.5mt.
- D. sissooplantations are established in block or strip plantations at 1.8 x 1.8 m to 4 x 4m.
- For line planting, the spacing between plant to plant adopted 4.0 meter.
- In the dry area, planting is usually done in staggered trenches.
- For road side Avenues, Oversize (2 m tall) plant raised in basket, are planted on mounds surrounded by ditch to protect against browing animals.

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(B)Stand management

(a)Weeding,Hoeing and cleaning

- Weeding are essential in the year of formation.
- Weed free, proper soil working – proper growth in earlystage.
- Two to four weeding in the first year– Seed germinate, stump.
- Soil working along with last weeding – conserve moisture
- In Second year ,one or twoweeding has required.
- In thirdyear, No weeding ,except in special case – weed&Grass growth.
- In irrigated plantation – raised by coppice – cleaning – firstyear, or early second year, reducing the coppice shoot to two or three perstool.

(**b) Fertilizing** :- The application of fertilizer like as superphsphate increase the height of seedling.

(c) Infilling

(d) Pruning:-Pruning is recommended at 5–10 years after planting

(e) Thinning

- Sissoo being a strong light demander.
- In irrigated mixed Sissoo –mulberry plantation-
- 3 thinning -6th, 10th, 14thyear to helpmulberry, Where the growing stock is mainly Sissoo – two – 6thand 11thyears.
- New plantation – first thinning is more or less mechanical and the second being C – gradeone.
- Un-irrigated canal plantation of U.P.– 3, 6,10,15 and20 years – pure or plantation.
- Tarai and Bhabar –mix plantation 3,5,10,15,20,30,40 and 50years

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(f) Coppice maintenance:-The coppice shoots also must be thinned in the First year or second year. The 2 or 3 shoots per stool retained for good growth of coppice forest.

(g) **Adopted silviculture system:**

- The general trend to work the crop by Clear felling on a rotation of 50-60 year with artificial regeneration or Selection felling coupled with thinning with the natural regeneration from seed, coppice or suckers.
- Exploitable diameter being 40-60 cm and felling cycle 10-16 year.
- In some cases with partial (1/3 th) crops being taken every 20 years.

g) Pests anddiseases:-

(a) Insect--Leaf defoliator – *Plaeoptera reflexa, Dichomeris eridantis Ascotisselenaria*

Leaf miner – *Leucoptera sphemograpta*

Leaf roller – *Apoderus sissu.*

Sap sucking bug – *Droscicha magifera*

(b)Fungi–"Wilt" – *Fusarium solani*in natural forest Chlorisis and leaf drop artificial plantation

Ganoderma lucidum– Root disease

Polyporus gilvus– fungal pest.

Controlling measures:-

Field Exercise:

1. Name and location of the plantation area:……..……..……

2. Date:……

3. Area (ha):……

8. Field work:

Sr. no	**Name of site**	**Regular spacing In Block**	**Spacing In Srip planting**	**Weeding(yes/No)**	**Fertilization()yes/No)**	**Pruning (Yes/No)**	**Thinning (Yes/No**	**Coppice mainten**	**silvicultur e system**	**Pest and disease (Yes/No)**
1										
2										
3										
4										
5										

Conclusion:

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Exercise-11

Objective: To execute the Silvicultural characteristics Planting and stand management practices of *Azadirachta indica* in bundelkhand region.

Required material:-

Silvicultureal Characters:-

- Azadirachta indca is remarkable adopted to a wide range of climatic, edaphic and tropical factors .
- Strong light demander but tolerates fairly , heavy shad during the early stage.
- Weeds retard the growth of seedling.
- The seedling and sapling .Sensitive to frost.
- Seedling intolerant water logging
- Tap root dwarf excessive moisture.
- Stand in Drought but not in excessive rainfall.
- Tree coppices and root sucker in dry localities.
- **Planting techniques**

Neem can be easily raised through direct sowing, entire / poly pot seedlings or root-shoot cuttings. For degraded areas direct sowing is more successful. Entire / polypot seedlings or rootshoot cuttings are more relevant for agro-forestry / silvi pasture and road side avenue plantations.

(a)Direct seed sowing :-

Direct sowing is done either by dibbling in bushes, broadcast sowing, line sowing, sowing on mounds or ridges, sowing in trenches in sunken beds in circular saucers or by aerial sowing. The choice varies with edaphic, climatic, biotic and economic conditions of the site.

(b)Stump planting:-

The stumps are prepared from 12-13 months old seedlings, keeping 2.5- 5 cm of shoot portion and 23 cm of root and are planted in crow bar holes at the break of rains. stumps from two years old plants have given higher survival and better height growth than one year old root stock. 53% success from root-. The success of root-shoot cuttings depends upon rains, prolonged drought may affect survival to a great extent..

(c)Entire planting. Planting is done during the rainy season.

i. Planting in pits is carried out by using 20 to 45 cm tall seedlings. Taller ones promise better survival. Seedlings which have attained 20-25 cm height by the beginning of the rainy season are planted out in pits of 30 cu. cm at a spacing of 3x3 mtrs. or any other spacing depending on the purpose of plantation.

ii. Pruning of leaves except at the tip and roots has been proved successful.

iii. These plants of 45 cm height are used for this purpose, since smaller plants are found

incapable of bearing the stress of drought period.

iv. For raising a block plantation under farm forestry a closer spacing of 5mx5m accommodating 400 trees per ha may be followed.

v. The wider spacing of 7 m x 7 m accommodating about 200 trees per hectare may be on the broader side where Agro-forestry can also be practiced for farm forestry.

.**(B)Stand management**

(a) Weeding, Hoeing and cleaning :-

Carry out weeding operation at juvenile and maturity stage. Keep field clean and weed free. Presence of heavy weeds can cause poor growth. Proper watering and weeding are very essential during the first two years for proper establishment and growth of neem crop. Weedings also help in loosening the soil for better aeration and root growth

- Weeding are essential in the year of formation.
- Two to three weeding in the first – Just after the germination
- Second – one month after the first weeding
- Third – may also be necessary – before the close of rains.
- Second year - One weeding necessary Loosening of the soil – prevent caking and to promote soil aeration Unweeded plants – poor development or suppressed

(**b) Fertilizing** :- Apply 50gm of VAM fertilizer, 20gm of Azospirillum and Phosphobacteria to be applied regularly.

(d) Pruning:-

(e) Thinning:- First mechanical spacing is done – age of 3 -4 years. Second – 6 years. Thinning schedule can be worked out depending upon t site quality and growth.

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(f) Coppice maintenance:-

***(g)* Adopted silviculture system:**

It is being established in the plantations by clear-felling and planting in conjuction with field crop undertoungya system.

g) Pests and diseases:-

- Plavinaria maxima pest feeds on the sap and cause considerable damage to to young tree.
- Nymphs of *Helopeltia antonii feeds on sap shoots mays die.*
- Tip borer *Laspeyresia koenigiana,* Tea mosquito bug (*Heliopeltis antonii*) affect seedlings and young plants.
- A Pulvinaris maximum is a scale insect now regarded as key pest & Heliothrips haemorrhoidalis a potential pest ofneem.
- Neem seedlings get severely affected by damping off Rhizoctonia leaf web blight, leaf spot & blights induced by Colletotrichum, Alternaria & Pseudocercospora

- .Fungi like as *Genoderma lucidum* caused root rot.Fungi like as *corticium salmonicolor* caused stems and twig blight. *Cerocospora subsessilis* cause leaf spot.

Field Exercise:

1. Name and location of the plantation area:……..……..……

2. Date:……

3. Area (ha):……

9. Field work:

S	Name of site	Regular	Spacing In	Weeding(	Fertilizatio	Pruning (Yes/No)	Thinning(	Coppice	silviculture	Pest and
1										
2										
3										
4										
5										

Conclusion: ……

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Exercise-12

Objective: To Visit and comments on environment requirement, Silvicultural characteristics Planting and stand management practices of Melia *dubia* in bundelkhand region.

Environmental requirements :-

Temperature :- The species grows well in temperature ranges of 30-45 oC .

Altitude :- 650 – 1800 m.

Rainfall :- The species requires a mean annual rainfall of 750 - 2500 mm.

Soil :- It grows in well drained red, red loam and black loam soils with pH ranging from 5.5 to 7.0 and depth 50-150 cm, requires moderate soil fertility and can come up in soils with salinity of <4 dS/m.

Silvicultural characterstics :-

- Large deciduous and fast growing tree with wide spreading branches on a stout, straight, tall boleHigh (when young)
- Medium Competitiveness
- Planting site :-Field border,Avenue
- fast growing
- Moderate Drought Tolerant
- Coppice and pollard well
- Frost tolerant (seedlings)

Propagation methods:-

Natural propagation :- by seeds

Artificial propagation :-

Juvenile stem cuttings, branch lets and mature branches of *Melia dubia* can be tried for rooting or sprouting.

Cuttings of size 15 cm and above respond better to rooting.

Nursery practices:-

Seed sowing:

a) Cleaned and dried drupes should be sown in the open raised nursery beds, in drilled lines, 5 cm apart.
b) About 6-7 kg of dried drupes containing about 1500 numbers are required for one standard nursery bed (10 x 1 m).

Nursery pests Application:

Application of Derrimax 0.3 ml/lit of water can control the mites.

Plantation practice:-

- The species performs best in wide spacing of 5 x 5 m in staggered rows, though lesser sp acings of 4 x 4 and 3 x 3 are also adopted.

- Planting should be done prior to the rains.
- Pit size of 60 cm x 60 cm x 60 cm is essential.

Create pits keeping a space of 6m x 6m to 10m x 10m or more depending on whether you're intended to prefer agroforestry system. For monoculture 6m x 6m spacing is ideal. No. of melia dubia plants per acre will be around 425 if following 10m x 10m spacing, and the no. will increase if the spacing is decreased. Prepare pits with mixture of Potassium, Nitrogen, and Phosphorous of @50 gram each for every seedling or stem based root to be planted. Application of compost is a great choice to enhance growth rate extra with fertilizers. Fertilizing once in three months and regular watering in the morning is essential for speedy expansion of plants. Stay away from overwatering at the initial stage. Depending on the need, consider time to time pruning and remove diseased, damaged, or dead branches from plants to avoid unwanted insect attack that hinders growth. If everything goes systematic, Malabar neem tree is likely to emerge nearly 40 ft after 3 years. If any major change, consider expert consultancy.

Stand management

a) **Weeding**

With scheduled weeding sessions to get rid of unwanted shrub growths in plant adjoining areas in the rising stage and elimination of decayed/ deceased tree branches, planters can keep the trees vivacious and fast growing.

b) **Irrigation:-**

During the summer days, the need of irrigating the cropland is crucial. As per necessary, 3-4 irritation once in 7-10 days interval is ideal. Unless the rainfall is found erratic during the rainy period, there is no need of irrigation. Nevertheless, downpour may lead to water logging in the field that needs pumped out or drained pass up decayed root. In dry lands or plains, regular watering and protecting plants from extreme heat or frosty environment are some preconditions.

c) **Agroforestry**

Farmer interested to incorporate agroforestry model with Melia dubia plantation, it offers a great scope of earning throughout its farming period. Some of the most matching species that can be cultivated with needed space include Ground nut, Turmeric, Chili, Papaya, Banana, Watermelon etc.

Pest control

While Melia dubia trees are found resistant to common termites, needed care should be taken especially in the nursery period.

Mites like red spider may found under the leaves which destroy its soft tissues causing dying of seedlings. Similarly, during the rainy reason, polyphagous defoliator, mealy bugs, or leaf miners may invade growing stumps.

Application of pesticide of Methyl parathion 0.2 ml in one liter water and spaying on the sprouting shrub can produce fast results. Water stagnation at the base of plants can cause infestation with diseases and pests like leaf miners, wood borders, sap-sucking pests etc apart

from rotten roots. Depending on the type of pest attack, consider the use of suitable pest control solutions.

Field Exercise:

1. Name and location of the plantation area:……..……..……

2. Date:……..

3. Area (ha):……

10. Field work:

S	Name of site	Regular	Spacing In	Weeding(	Fertilizatio	Pruning (Yes/No)	Thinning(	Coppice	silviculture	Pest and
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2										
3										
4										
5										

Conclusion: ……

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Exercise-13

Objetives: Afforestation of different kinds of waste lands- Salt affected soil

The salt affected soils are classified into three categories viz; saline soil, alkaline soil and saline alkaline soil. These soils contain excess amount of soluble salt such as chlorides and sulphate that affect plant growth.

Afforestation techniques in saline soils: -

Ridge- trench method:

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Sub-surface planting in auger holes:

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Planting in furrow cum irrigation channel:

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Irrigation:

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Choice of species:

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Conclusion

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Exercise-14

Objective: Afforestation of different kinds of waste lands- **Mined out areas**

Mining refers to activities that extract ore or raw materials from earth both from surface as well as subsurface. In India, mining activities spreads over 7 lakhs ha across the country. Maximum number of mines occurs in Rajasthan, Bihar, Orissa, Madhya Pradesh, Tamil Nadu and Maharashtra. Mining is of two kinds viz; open cast mining and surface mining.

a) Open cast mining: Refers the deep excavation of earth lithosphere to get the ores And Raw Materials. The Characteristics feature of open cast mining is given below:
   - High rock temperature
   - Presence of explosive gases Presence of noxious fumes
   - Out bursts of toxic fluids
   - Unpredictable rock behavior
   - Interference of subterranean water course

b) Surface mining: Refers to the excavation of minerals and ores from the surface of earth itself.

Problems related to re-vegetation of mine spoils

1. Salinity and acidity

2. Inadequate supply of nutrients

3. Severe soil erosion

4. Bulk density is less than (10-20%) the original soils

5. Low infiltration rate and porosity

Afforestation measures:

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Choice of species

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Conclusion:

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Exercise-15

Objective: Afforestation of different kinds of waste lands- **Gullied and ravine lands**

These lands are severely eroded by water. Here soil depth is limiting factor besides devoid of organic matter content. As a result, soil fertility is poor in these lands. Vegetation is also poor.

Afforestation measures:

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Species suitable for different slop positions

Slope positions	**Species suitable**
slope head, flat tops	
Eroded slopes	
valley bottoms	

Conclusion:

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