Practical Manual

THEORY & PRACTICES OF SILVICULTURE

Course No. SAF -103 Credit Hrs. 3(2+1)

For B.Sc. (Hons.) Forestry II Semester students

PANKAJ LAVANIA
RAKESH KUMAR
MANMOHAN J DOBRIYAL

2019

College of Horticulture & Forestry
Rani Lakshmi Bai Central Agricultural University
Jhansi-284003

Syllabus SAF -103 3(2+1)

Acquaintance with modern silvicultural tools. Visits to different forest areas/types. Study of forest composition. Visiting plantations raised by forest department, Exercise on nursery practice- seed collection, seed pre-treatment- nursery stock preparation- field preparation- marking, alignment and stacking, pit making-planting, various tending operations- weeding, cleaning, singling, pruning, pollarding, lopping, and thinning- fertilization in trees-plant protection and sanitation measures.

Name of Student .....

Roll No. .....

Batch .....

Session .....

Semester .....

Course Name : .....

Course No. : .....

Credit .....

Published: 2019

No. of copies: ……..

Price: Rs.

CERTIFICATE

This is to certify that Shri./Km. .....ID No.....
has completed the practical of course.....course No. ..... as per the syllabus of B.Sc. (Hons.) Forestry ..... semester in the year .....in the respective lab/field of College.

Date: Course Teacher

INDEX

Practical No. 1

Objective: To acquaint with modern silvicultural tools and machinery.

Tool: The tool is equipment that is used in order to make and repair something. A **tool** can be any item that is used to achieve a goal. Modern tools give more accurate results as compare to the traditional tools.

Machine: A machine (or mechanical device) is a mechanical structure that uses power to apply forces and control movement to perform an intended action. Modern machines are complex systems that consist of structural elements, mechanisms and control components and include interfaces for convenient use.

Machinery: a group of large machines or the parts of a machine that make it work.

Observation

List the silviculture tools used in different forestry operation.

S. No	Forestry operation	Traditional tools	Modern tools/machinery
1.	Forest mensuration		
2.	Forest Nursery		
3.	Planting		
4.	Maintenance and protection		

Conclusion: ……

……

……

……

……

……

Practical No. 2

Objective: To draw the line diagram and also comments on the characteristics of Silviculture tools/machinery

Observation:

S. No.	Tools / machinery name	Uses	Diagram
1		…… …… …… …… …… …… ……	
2		…… …… …… …… …… …… ……	
3		…… …… …… …… …… …… ……	
4		…… …… …… …… …… …… ……	

5		…… …… …… …… …… …… ……	
6		…… …… …… …… …… …… ……	
7		…… …… …… …… …… …… ……	
8		…… …… …… …… …… …… ……	
9		…… …… …… …… …… …… ……	

10		…… …… …… …… …… …… ……	
11		…… …… …… …… …… …… ……	
12		…… …… …… …… …… …… ……	
13		…… …… …… …… …… …… ……	
14		…… …… …… …… …… ……	
15		…… …… …… …… ……	

Practical No. 3

Objective: To observe the composition of different forest, found in Jhansi forest division.

Observation

1. Forest Division:……

2. Range:……

3. Compostion of forest (Pure/Mixed):……..

4. Area (ha):……...

5. Forest composition brief

Location	Forest type	Over storey			Under storey			
		Principal species	Accessory species	Auxiliary species	Shrubs	Herbs	Grass	climber

6. Management strategies used by the Forest Department.

7. Conclusion: ……

……

……

……

Practical No. 4

Objective: To visit and identify the criteria for selection of woody species in forestry plantation.

Observation

1. Location:……..

2. Forest Division:……...

3. Range:……..

4. Species planted:……

5. Purpose of plantation:……

6. Area (ha):……

7. Field work:……

Tree Species		Plantation Area (ha)	Distance		Criteria for Species Selection			
Common Name	Scientific Name		In rows (m^2)	In plants (m^2)	Large-scale industrial Forest plantation	Large-scale nonindustrial forest plantation	Small-scale village/ community forest plantation	Agroforestry systems

8. Objective of plantation: ……

……

……

9. Achievements of different forest plantation to socio-economic status of local people: ……

……

……

……

10. Management strategies used by the Forest Department: ……....

……

……

……

11. **Conclusion:** ……

……

……

Practical No. 5

Objective: To study about seed collection time of different forest species.

Seed collection :……

……

……

……

……

……

Method of seed collection

- ……

  ……..……..

- ……

  ……..……

- ……

  ……..…..

- ……

  ……

Selection criteria for seed trees in timber/fodder/ Fruit tree: ……

……

……

……

……

……..…

……

……

……..…

Observation

1. Location: ……
2. Tree species: ……
3. Month of collection: ……
4. Method of collection: ……
5. Type of seed (Orthodox/ recalcitrant): ……
6. Area (ha):……..

7. Field work

Sr no	Tree species	Month of collection	Adopted criteria for seed trees selection

8. Purpose of seed collection: ……

……

……

9. Conclusion: ……

……

……

……

……

……

……

……

……

Practical No. 6

Objective: To study about the different habits of plant on forest floor.

Plants may be classified into the following three categories based on habits.

Herb- ……

……

……

Shrub- ……

……

……

Tree-……

……

……

Materials required: 1. Measurement tape/ wooden scale, 2. Field note book

Methodology/ Procedure:……

……

……

Observation Table:

S. No.	Habit	Common name	Scientific name	Height (m)
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

Conclusion: ……

……

……

……

……

……

Practical No. 7

Objective: **To study different developmental stages of tree growth and its structure**.

Seedling- ……..……

……

Sapling: ……..……...…

……..…

Pole:……

……

……..

Tree: - ……..……

……

……

Materials required: ……

……

Methodology/ Procedure: Visit to forestry experimental/demonstration area and record different developmental stages of trees like seedling, saplings, poles and tree in different species.

Observation Table

S. No	Tree stage	Name of species	S. No	Reproductive stage	Name of species
1	Seedling		1	Flower bud	
2	Sapling		2	Flowering/Blooming	
3	Pole		3	Fruit setting	
4	Tree (Adult)		4	Immature fruiting	
5			5	Mature fruiting	

Conclusion:……..…

……..

……..

……..…

……..

……...

……..…

……..

……..…..

……

Practical No. 8

Objective: To study the vegetative and reproductive phenological events of important tree species

Phenology: ……

……

……

……

Phenological events:

Foliage change……

……

……

……

Leaf shedding: ……

……

……..

Leaf flushing:……

……

……

……

……..

Flowering: ……

……

……

……

Fruiting:……

……

Seed maturation: ……

……

Materials required: ……

Procedure: Select important tree species occurring in the campus. Record observation of vegetative (leaf shedding, flushing, maturation or leaf expansion) and reproductive (initiation of flower bud, flowering, blooming, fruit set, fruit maturation and fruit fall). phenology of selected species by visiting the same tree at every week intervals. Use the following format for recording phenological events of target species. abbreviations given in the table may be used while recording phenological events. At the end of the experiment, prepare phenogram (example of phenogram is given below) for each of the target species and compare the observations among species.

Phenology Table:

S. No	Name of species	Month-1				Month-2			
		1-w	2-w	3-w	4-w	1-w	2-w	3-w	4-w
1									
2									
2									
3									
4									
5									
6									
8									
9									
10									
Note- L. S-leaf shed, L. R- leaf renewal, LX-Leaf expansion, F.B- flower bud, F.L-flowering, F.S-fruit setting, F.M-fruit / pod maturation development, P. S-pod setting, S, F/FF- Seed falling/fruit falling,									

Conclusion: ……..

……..

……

……..

……

Practical No. 9

Objective: To study dormancy and methods of pre-sowing treatment in forest tree species.

Field Exercise

1. Location from where seed is collected:……..……..

2. Tree species:……..……..

3. Month of seed collection: ……..……

4. Number of seed/kg:……..

5. Type of seed (Orthodox/ recalcitrant):……...

6. Area
(ha):……..……

7. Field work

S. No	Tree species		Type of dormancy	Total number of seed	Number of seed germinate	Germination %
	Common Name	Scientific Name				

Elaborate the pre –sowing treatment given to the seed: ……

……..…

……..…

……..…

9. Conclusion: ……

……..

……..……

Practical No. 10

Objective: To study nursery stock preparation of forest trees and shrubs.

Observation:

1. Name and location of visiting forest nursery:……

2. Date of visit:……

3. Nursery Type: ……

4. Area (ha):……

5. Field work

S. No.	Tree species		Type of dormancy	Plant propagule		Planting material required/ha	Area ha
	Common Name	Scientific Name		Seed	Vegetative		

6. Write the characteristics of quality planting material available in Nursery: ……..

……..…..

……..…..

……

7. Enlist the planting material available in that nursery…….

……...

……..…..

……

8. Conclusion: ……

……..…..

……..…..

Practical No. 11

Objective: To study morphological characters of stem, crown and root of tree.

1. Name and location of visiting forest area: ……

2. Date of visit:……

3. Area (ha):……

4. Field work

S. No	Tree species		Stage of tree	Crown Shape	Remark
	Common name	Scientific name			
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Management strategies used by respective authority:

……

……

……

……

……

……

……

……

……

……

6. Conclusion: ……

……

……

……

……

Practical No. 12

Objective- To execute the field preparation by marking, alignment and stacking in planting site.

Material Required: ……..

Field Exercise:

1. Name and location of visiting site:……

2. Date of visit:……..

3. Purpose of visit:……..……

4. Area (ha):……..……

5. Field work:

S. No.	Tree species		Spacing		Pattern of planting	Other information
	Common name	Scientific name	Row to row	Plant to plant		
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Management strategies used by respective authority:

……

……..

……

……

……

……

……

6. Conclusion: ……

……..

Practical No. 13

Objective- To prepare different kinds of pit, used in afforestation on difficult sites and give suitable comments

Materials Required: …….

Field Exercise:

1. Name and location of visiting site:……..……..

2. Date of visit:……..……

3. Purpose of visit:……..

4. Area (ha):……

5. Field work:

S. No	Pit	Comments	Use	Line diagram
1.	Ordinary pit			
2.	Saucer pit			
3	Ring pit			

4	Ring ditch pit			
5	Shelfed trench pit-			
6.	Double trench pit			
7	Trench ridge pit			

Management strategies used by respective authority:

……

……..…

……

……

……

……

……

6. Conclusion: ……

……..

……..

Practical No. 14

Objective: To adopt procedure of stumps preparation and also planting of stumps in forestry field.

Material used:

……

Procedure for Stump Preparation:

(a.) ……

……

(b.) ……

……

……..……

……..……

(c.) ……

……

……..……

(d.) ……

……

(e.) ……

……

……

……..

2. Procedure adopted for stumps planting in the field

S. No	Steps
1	……... ……..… ……..…… ……...
2	…….... ……..….

	……..…… ……..
3	……... ……...… ……...…… ……..
4	……... ……...… ……...…… ……..

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

2. Date:…….

3. Area (ha):…….

4. Field work:

S. No	Plant species		Stump planting	Pit size	Spacing	
	Common name	Scientific name	Root length		Row to row	Plant to plant

Advantage of stump preparation:

……

……..

.....

.....

.....

.....

Advantage of stump plantation: .....

.....

.....

.....

.....

.....

Conclusion: .....

.....

.....

.....

.....

.....

.....

Practical No. 15

Objective: To study different planting methods (techniques)/ entire.

Material used: ……..

Observation: …….

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

2. Date:……..……..

3. Area (ha):……..……..

4. Field work:

S. No	Plant species		Entire planting		Pit size	Spacing	
	Common name	Scientific name	Root length	Shoot length		Row to row	Plant to plant
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

5. Advantage of entire plantation: ……..……

……..……

……..……

……..

6. Conclusion: ……..……

……..……

……..……

……..……

……..……

……

……..……

Practical No. 16

Objective: To study weeding and cleaning methods/operation procedures for reducing the root competition and improving the growth of forest plantation

Material used: ……

Cleaning: ……

……..

……..…

……..…

Weeding: ……..……..…

……..…

……...

……..…

……..…

……..…

Season

- ……..……..
- ……..……..
- ……..……
- ……

Frequency's-……..…

……..…

……..…

……...…

The following operations are usually done in weeding:

(1)……..…

……..…

(ii)……..…

……...…

(iii)……

……

……..…

The following operations are usually done in Cleaning:

(1)……

……

……

(ii)……

……

(iii)……

……

……

……..……..

Field exercise.(Weeding)

1. Name of the field:……

2. Date:……

3. Field work:

S. No	Weed		Family	Season of weeding	Number of weed	Any other information
	Common name	Scientific name				
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Why weeding is important in forest nursery ……

……..……

……..……

……..……

Conclusion:……..……

……

……

Field Exercise: (Cleaning)

1. Name and location of Cleaning site:……

2. Date of Cleaning:……

3. Purpose of Cleaning :……...

4. Area (ha):……

5. Field work:

Sr no	species		Spacing for		Pattern of planting	Dominant weed at planting site	Cleaning methods	Comments
	Common name	Scientific name	Row to row	Plant to plant				

Management strategies used by respective authority: ……..……

……

……

……

……

Conclusion:……

……

……

……

Practical No. 17

Objective: To study singling procedure for improve tree form and also accelerate linear and straight growth of selected stem.

Material used - Sharp cutting tools.

Singling- ……..……

……

……

……

……

……..……

Significance……

……

Procedures of Singling

- ……
- ……
- ……
- ……
- ……
- ……
- ……

Field Exercise:

1. Name and location of Singling site:……..

2. Date of Singling:……..

3. Purpose of Singling:……

4. Area (ha):……

5. Field work:

S. No	Species		Spacing for		Pattern of planting
	Common name	Scientific name	Row to row	Plant to plant	

6. Management strategies used by respective authority: ……

……

……

……

……

……..……

7. Conclusion: ……

……

……

……

……

……..……

Practical No. 18

Objective: To study different thinning operation used in forestry

Material used: ……

Thinning …….

……

Kinds of thinning

1. Mechanical thinning (also called stick thinning): ……

……

……

2. Ordinary thinning (Also called low thinning or German thinning or thinning from below): …….

……

……

……

……

3. Crown thinning (High thinning or French thinning or thinning from above): ……

……

……..

……

……..

4. Free thinning (devised by Heck): ……

……

……

……

……

……

(v) Maximum thinning: ……

……

……

……

……

……

(vi) Advance thinning (also Craib's thinning): ……

……

……

……..

Thinning in irregular crops: ……

……

……

……

……

Characteristics of irregular crops

- ……
- ……
- ……
- ……

Field Exercise:

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

2. Date:……

3. Area (ha):……

4. Field work:

Sr. no	Plant species		Thinning Type applied	Number of plants removed	Area (ha)	Any other information
	Common name	Scientific name				
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

11						
12						
13						
14						
15						

5. Important of thinning in regular forest: ……..……

……

……....

6. Conclusion: ……

……

……

APPENDICES

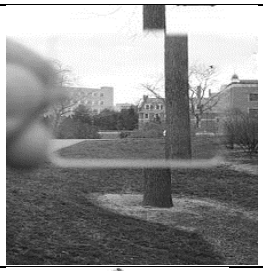
TOOLS

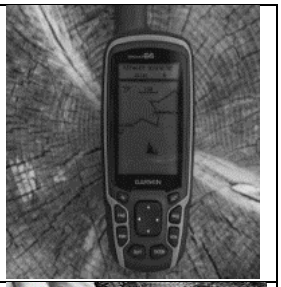
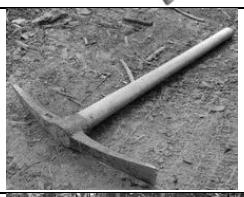
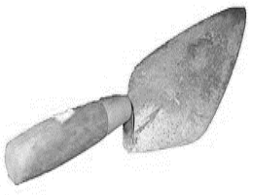
The tool is equipment that is used in order to make and repair something. A **tool** can be any item that is used to achieve a goal. Modern tools give more accurate results as compare to the traditional tools.

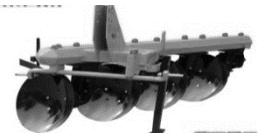
Silvicultural tools/machinery used in different forestry operation.

S. No	Forestry operation	Traditional tools/ machinery	Modern tools
1.	Forest mensuration	Biltmore stick, chain, Hand compass	Tape, caliper, Spiegel Relaskop, Wedge prism, hypsometer, GPS
2.	Forest Nursery	Spades, secateaur, knives, rakes, khurpis, Rose cane	Tractor with trailer, disk plough system, Sprinkler equipment, Germination tray, Seed container, Mist chamber.
3.	Planting	Spades, pickaxe, shovel, trowel.	Tractor with trailer, disk plough system, JCB Dozer.
4.	Maintenance and protection	Pruning knife, axe, rose cane, stone or live fencing	Tractor 50-100 hp, pruning saw, chain saw, barbed wire fencing, secateurs, sprinkler equipment

FORESTRY /SILVICULTURE TOOLS/MACHINE

S. No	Tools /Machine	Characteristics	Use	Picture
1	Tree Caliper	Tree caliper is a device used to measure the distance between two opposite sides of an object. Many types of calipers permit reading out a measurement on a ruled scale, a dial, or a digital display.	Tree diameter	
2.	Measuring Tape	A tape measure or measuring tape is a flexible ruler used to measure size or distance. It consists of a ribbon of cloth, plastic, fibre glass, or metal strip with linear measurement markings. It is a common measuring tool.	Tree's circumference	
3.	Spiegel Relaskop	The Spiegel Relaskop, also known as a Relaskop, is a sophisticated instrument that can be used to measure stand basal area and tree height and diameter at any point up a tree bole. In conjunction with other equipment, the Relaskop can be used in the estimation of distance (range) to an object and the number of trees/ha.	1. Tree s basal area 2. Tree height 3. Slope 4. Upper stem height.	
4	Wedge prism,	The wedge prism is a prism with a shallow angle between its input and output surfaces. This angle is usually 3 degrees or less. Refraction at the surfaces causes the prism to deflect light by a fixed angle.	The wedge prism is used to take measurements in both land management and in timber procurement.	
5	Pro-Pruner loppers	Pro-Pruner loppers designed for forestry pruning large branched trees, up to 65 mm, with less cutting effort, maintenance and sharpening required. The curve blade design holds the loppers steady resulting in a clean cut.	Used for pruning large branched trees	

6	GPS	GPS stands for Global Positioning System. It is a satellite-based navigation system which allows ground users to determine their exact location, velocity, and time 24 hours a day, in all weather conditions, all over the world. It is maintained and developed by the U.S. Department of Defense, and was basically designed to assist soldiers and military vehicles but after some decades it made accessible to anyone having a GPS receiver.	(a) Pre-Harvest & post-harvest cut block traversing. (b) Road systems	
7	Spades	Its typical shape is a broad flat blade with a sharp lower edge, straight or curved. The upper edge on either side of the handle affords space for the user's foot, which drives it into the ground. The wooden handle ends in a cross-piece, sometimes T-shaped	used to dig or loosen ground, or to break up lumps in the soil.	
8.	Secateaur /Pruning shears/Hand pruner	It is strong enough to prune hard branches of trees and shrubs, sometimes up to two centimetres thick.	Used in gardening, arboriculture, plant nursery works, farming, flower arranging and nature conservation	
9	khurpis,	A khurpis is a short handled cutting tool with a flat blade farms. It is traditionally used while in a squatting posture.	Used in various processes like tilling, bed preparation and digging at planting site	
10	Pruning knife	Put tension on the stem or vine to keep it tight, then cut it with a sharp slicing motion away from your body.	Use of a pruning knife is to clean up pieces of bark left hanging after a branch has been cut.	
11	Axe	It Cuts across the grain of wood, as in the felling of trees. In single or double bit (the bit is the cutting edge of the head) forms.	*Axes* designed to cut or shape wood Felling *axe*	
12	Pickaxe	A standard pickaxe has a pointed end on one side of its head and a broad flat "axe" blade opposite. A gradual curve characteristically spans the length of the head. The next most common configuration features two spikes, one slightly longer than the other.	Used for making pit for planting	
13	Shovel logging / Hoe Chucking	It is a modified excavator or 'shovel'. the loader moves slowly across the harvest area, grabbing logs/trees within reach, and swinging them around to drop them closer to the road.	Typical of the 'shovels' used for shovel logging. it also uses a log loader to swing logs to the forest road	
14.	Trowel	It is a tool with a pointed, scoop-shaped metal blade and wooden, metal or plastic handle.	A trowel is a small hand tool used for digging, plastic handle applying, smoothing, or moving small amounts of viscous or particulate material.	

15	Disk plough system	A disc plow having a stump jump capability. The plow includes a frame and at least one trailing arm secured thereto. The trailing arm supports at least one concave disc thereon.	Used in losing the soil.	
16	JCB Dozer	The JCB is commonly used heavy equipment all around the world.	The JCB is also used in construction, agriculture, waste handling and demolition.	
17	Tractor with trailer	• The model tractor includes forestry trailer at the rear with model tree trunks • Made of both plastic & metal • High quality die cast miniature design	Great for use with farmyard model sets. It uses for transport the logs from filling site.	
18	Disk plough system	disc plow mounted on a tractor through a rear mounted three-point linkage. During the working process of the implement, the motive power is transferred to the gear case of the disc plow through a back power take off shaft (PTO) of the tractor to drive the discs of the disc plow to rotate.	Disc plough is used for primary tillage	
19	Tractor 50-100 hp,	TRACTOR is the term used mainly for the vehicle which is capable of doing multiple works. A tractor is used for different types of works i.e. agriculture use, construction use, transportation use etc. tractor is the basic module used in forestry & for other communal services.	It is use in sowing, farming, tillage, harvesting, etc.	

FOREST COMPOSITION

It refers to all plant species found in a stand or landscape, including trees, shrubs, forbs, and grasses. It also refers to forest communities at the stand or landscape level whose canopies may be dominated by a single tree species or contain a mixture of species.

Objective: the main objective of study forest composition is to study the effect of anthropogenic activity on the composition of forest of that area.

Classification of forest base on composition: On the basis of the number of species present, the forest is classified into–

1. Pure forest: Pure forest is defined as a forest composed of almost entirely of one species, usually to the extent of not less than 80%. It is called pure crop or stand.

2. Mixed forest: Mixed forest is defined as a forest composed of trees of two or more species intermingled in the same canopy; in practice, and by convention, at least 20% of the canopy must consist of species other than principal one. the species composing the mixture may be distinguished as principal, accessory and auxiliary.

a) **Principal species:** the species first in importance in a mixed stand either by frequency, volume or silviculture value.

b) **Accessory species:** a useful species of less value than the principal species, which assists in the growth of the latter and influences to a smaller degree the method of treatment.

c) **Auxiliary species:** a species of inferior quality or size, of relatively little silvicultural value or importance, associated with the principal species.

FOREST PLANTATION

It is defined as "a forest crop or stand raised artificially, either by sowing or planting'. In the literature, afforestation and reforestation is used to distinguish new planted forests. The term afforestation is used in describing forests established artificially on land that previously did not carry forest. Whereas, reforestation is the re-stocking of forests that have previously been cut down.

Criteria for Species Selection by Forest Plantation Systems:

Large-scale industrial Forest plantation	Large-scale nonindustrial forest plantation	Small-scale village/ community forest plantation	Agroforestry systems
• Fast growth • Short rotation • Suitable clone of tree • Market oriented • MPTs Species • Easy propagation • Coppicing Multiple uses • Site-specific	• Intensive root system • Good survival and growth • Suitable for marginal lands • Multiple uses • Good natural regeneration • Easy propagation Coppicing • Soil improvement • Robust against browsing Site-specific	• Easy propagation • Coppicing Multiple uses • Fast growth • Short rotation • High acceptance Site-specific	• Multiple uses N_2- fixation • Deep rooting • Coppicing • Fast growth Light crowns • High acceptance • Site-specific

CLASSIFICATION OF PLANTS

1. **Herb-** It is a plant whose stem is always green and tender and its height is usually below one metre. According to the span of life, herb is called annual herb, biennial herb and perennial herb.
2. **Shrub-** It is a woody perennial plant, having persistent and woody stem and less definitely from a tree in its low stature and its habit of branching from the base. Generally, many shrub species attain height of about 1-6 m.
3. **Tree-** It is a large woody perennial plant having a single well-defined stem (bole or trunk) and a more or less definite crown. Usually tree attains more than 6 metre in height, depends up on species and growing habits. Trees height is more in evergreen forest than deciduous forest.

PHENOLOGY

Phenology is the study of calendar of events taking place in life history of plants or timing of biological events and their relationship to seasonal and climate changes. The seasonal progresses of the date and these events have to be studied for tree species. It helps to manage the seed collection time in the forest. In case of species like Bamboo, where gregarious flowering occurs. It helps in managing harvest and forecasting of final yield. *This* study is very useful in breeding programme of forest tree species. There is a variation in flowering, fruiting, leaf shedding and leaf flushing among different trees of a species.

Phenological events:

Foliage changes: The knowledge of foliage change is very much essential which helps in the identification of species. The time of development of new foliage depends on locality and weather condition like chinar, temperate spices.

Leaf shedding: Shedding of leaves is determined by climatic factors. Evergreen species are usually never leafless. They continue shedding leaves for short period during winter and new flush of leaves occurs during February to March. In deciduous species, leaflessness condition occurs during winter for considerably long period. When the tree is leafless condition, it is physiologically inactive. It is observed that low temperature, high relative humidity and high rainfall tend to decrease the period of leaflessness.

Leaf flushing: The time of development of new foliage differs with species to species and in the same species it depends upon locality and climatic factors.

Flowering: The higher plants in terrestrial ecosystem predominantly reproduce by the way of sexual reproduction, however, in aquatic plants, reproduction occurs through vegetative method. Hence, the environment brings about the initiation of flower formation. The temperature is very essential factor of environment that induces and regulates the process of flowing. Generally, the initiation of flowering is control of genetic trait of tree; however, duration of flowering is control by local environment.

Fruiting: The period required for fruit maturation depends upon species, locality and site condition. Some species

finish their fruit or seed maturation process within 3-4 months. However, in most of the deciduous species, period required for fruit development and maturation is more than 7-8 months. In many species, seeds are effectively protected in a strong fruit coat or covered by pulp adhered to which attracts the seed disseminating animals/ birds.

Seed maturation: It states the physiological maturation of pod/fruit/seed in a tree. Colour change during the process of fruit or seed maturation helps in judging the seed collection time. Maturation of fruit/pod or seed depends upon the external environment and internal storage food. Quantity of fruit/ seed produce depends upon species, locality condition, pollination and pollinator availability, synchrony in flowering and sexual habit of plants Like dioecy, monoecy and polyecy. In some of the species, early fruit drop occurs that are physiologically not matured.

REPRODUCTIVE VEGETATIVE GROWTH

Tree growth starts from the seed germination stage till maturation until the death of the tree. Growth may be horizontal and vertical. Diameter growth is considered as horizontal growth and height growth is considered as vertical growth. Height growth is fast at the early stage of plant growth from seedling to pole and later the height growth will almost stagnate at the mid age. However, rapid diameter growth starts from pole stage, especially after stagnating height growth. Further, growth of trees depends upon several environmental factors like site, climate, topography, physical and chemical properties of soil, species competition, space, *etc.* These factors not only affect the growth but also the tree structure like crown, bole, root, *etc.,*

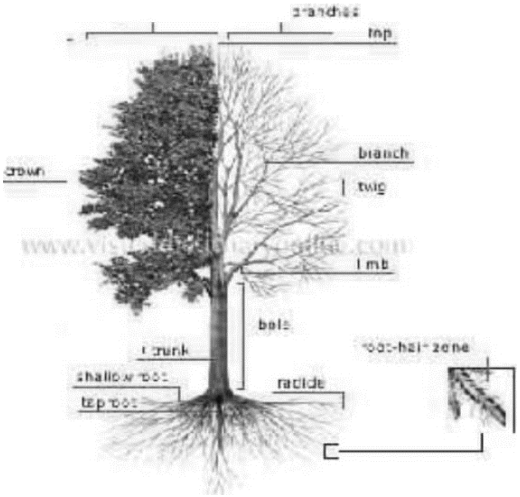
The first stage of tree's recognized as small seedling which grows by increase in length and diameter of its shoot and root. As the shoot grows upwards, its developments develop branches and foliage. The root grows downward and develops lateral roots and its branches. Thus, the seedling grows not only by increase in size of its shoots and roots. Therefore, increase in size is commonly referred to as growth or increment and formation of new organs is referred to as development.

Different developmental stages of tree growth

Vegetative growth	Reproductive growth
1. Seed	1. Flower bud
2. Seedling	2. Flowering/Blooming
3. Sapling	3. Fruit setting
4. Pole (Reproductive stage)	4. Immature fruiting
5. Tree (Reproductive stage)	5. Mature fruiting
5 a. Juvenile.	6. Fruit falling
5 b. Mature	
5 c. Over mature	

TREE STRUCTURE

1. **Seed -** It is a mature ovule produced in plants through the process of pollination and fertilization.
2. **Seedling-** It is a plant grown from seed till it attains a height of about one metre *i.e.,* before it reaches the sapling stage.
3. **Sapling:** It is defined as a young tree from the time when it reaches about 1 m (3 feet) in height till the lower branches begin to fall. A sapling is characterized by the absence of dead bark and its vigorous height growth.
4. **Pole:** It is defined as a young tree from the time when the lower branches begin to fall off to the time when the rate of height growth begins to slow down and crown expansion becomes marked. Appearance of Reproductive stage.
5. **Tree:** It is the stage of growth beyond the pole stage when the rate of height growth begins to slow down and crown expansion becomes marked.



Adult tree features: Single stem, bark cover over stem, taproot spread through few primary roots, some secondary roots and many tertiary/ minute roots or root hairs, well developed crown through main branches on the principal stem, each branch containing leaves, flowers and fruits/pods, seeds. Following picture is describing the tree structure.

SEED COLLECTION

Seed are generally collected from the genetically superior tree which is superior to other trees in its habitat from the point of view of its size, length, shape of stem, height, diameter and volume increment, timber quality, resistance to disease and other specific quality, *viz*., high resin yielding capacity.

Seeds are collected from seed production area, seed orchard, seed stands and seed trees to fill filled the large-scale plantation activity. *Seed production area* is defined as a crop of vigorously growing, middle aged to mature trees of good

quality, properly thinned and left to contain trees of good vigour and well-developed crowns, with clean boles and managed exclusively for seed collection. *Seed orchard* is defined as a plantation of genetically superior trees isolated to reduce pollination from genetically inferior ones, and intensively managed to produce frequent, abundant, and easily harvested seed. *Seed stands* are groups of trees, in either natural forests or plantations, identified as having superior characteristics - such as straight stem form or rapid growth. Seed stands are managed for seed production, but only seldom benefit from selective thinning or other management intended to improve the quality of seed produced from the stand. *Seed trees* are individual trees from which seed is collected. They should have superior characteristics - such as straight stem form or rapid growth. They may be in either natural forests or plantations.

Time of seed collection: Seed should be collected on ripening before dispersal.

Method of seed collection:

- Collected from the ground of seed which has fallen either naturally or by shaking of the tree.
- Collection of seed by lopping the branches of trees or from freshly felled trees
- Collection of seed from standing trees

Criteria for seed trees selection: Seed tree selection criteria differ for various tree types.

Timber tree criteria

- Above average tree height and stem diameter
- Straight stem form
- Long, clear merchantable bole
- Uniform crown, without heavy branches or double-stem
- Free of pests and diseases
- Good quality timber
- Middle age tree that produces ample quantities of seed

Fodder trees and living fences

- Rapid growth
- High leaf production
- High nutritive values of leaf
- Good coppicing ability
- Tree stature and shape that fits the intended planting system and site
- Free of pests and diseases
- Drought resistance
- Middle age tree that produces ample quantities of seed.

Fruit trees

- Good growth
- Abundant, sweet, and big fruits
- Uniform crown with low branches
- Free of pests and diseases
- Middle age tree that produces ample quantities of seed

Seed collection time (month) of some species is shown below:

S. No	Tree species	Seed collection (Month)
1.	*Acacia Arabica*	May
2.	*Acacia catechu*	January-Feburary
3.	*Ailanthus excels*	April- May
4.	*Abies pindrow*	October-November
5.	*Adina cordifolia*	April-June
6.	*Albizzia procera*	Feburary- March
7.	*Albizzia lebbek*	January-Feburary
8.	*Acer caesium*	September-october
9.	*Azadirachta indica*	June-July
10.	*Bombax ceiba*	April- May
11.	*Boswellia serrate*	May- June
12.	*Dalbergia Sissoo*	December-feburary
13.	*Eucalyptus citriodora*	May- June
14.	*Gmelina arborea*	May- June
15.	*Prosopis juliflora*	May- June
16.	*Pterocarpus marsupium*	December-April
17.	*Tectona grandis*	November-January
18.	*Shorea robusta*	June-July
19.	*Toona ciliate*	May-June

SEED DORMANCY

Dormancy is defined as the physiological state in which viable seed cannot readily germinated, even when subjected to favourable conditions.

Categories of Seed dormancy:

Exogenous dormancy: Exogenous dormancy is caused by conditions outside the embryo and is often broken down into three subgroups: i. Physical dormancy ii. mechanical dormancy and chemical dormancy.

Physical dormancy: Physical dormancy is typified by a hard, thick or waxy impermeable seed coat that prevents water from being absorbed by the seed. Without absorbing water seeds cannot germinate. Seeds of the following species demonstrate physical dormancy: *Paraserianthes falcataria* (falcata), *Acacia mangium* (mangium), *Sesbania grandiflora* (turi), *Calliandra calothyrsus* (red calliandra) and many more.

Mechanical dormancy: Mechanical dormancy is caused by the presence of a hard-encasing structure in the fruit that prevents the radical from expanding and exiting. Water may enter the fruit but embryo development is physically restricted. Fruits of the following species demonstrate mechanical dormancy: *Tectona grandis* (teak), *Gmelina arborea* (gmelina), *Aleurites moluccana* (candlenut), and *Canarium ovatum* (pilinut).

Chemical dormancy: Chemical dormancy is caused by chemical compounds in the fruit, seed or embryo that prevent germination, even in the presence of water. This type of dormancy occurs in *Gmelina arborea* (gmelina), *Xanthoxyllum rhetsa* (nyalin), and *Maesopsis eminii* (musizi or African wood).

Endogenous dormancy: Endogenous dormancy is caused by conditions within the embryo itself, and it is also often broken down into three subgroups: physiological dormancy, morphological dormancy and combined dormancy.

Physiological dormancy: Physiological dormancy prevents embryo growth and seed germination until chemical changes occur. These chemicals include inhibitors that often retard embryo growth to the point where it is not strong enough to break through the seed coat or other tissues. Physiological dormancy is indicated when an increase in germination rate occurs after an application of gibberellic acid (GA_3) or after Dry after-ripening or dry storage.

Morphological dormancy- In morphological dormancy, the embryo is underdeveloped or undifferentiated. Some seeds have fully differentiated embryos that need to grow more before seed germination, or the embryos are not differentiated into different tissues at the time of fruit ripening. Immature embryos – some plants release their seeds before the tissues of the embryos have fully differentiated, and the seeds ripen after they take in water while on the ground, germination can be delayed from a few weeks to a few months.

Combined dormancy- Seeds have both morphological and physiological dormancy. Morpho-physiological or morphophysiological dormancy occurs when seeds with underdeveloped embryos, also have physiological components to dormancy. These seeds therefore require dormancy-breaking treatments as well as a period of time to develop fully grown embryos.

Under natural conditions, dormancy may prevent seeds from germinating for days, weeks, months and even years. In order to operate efficient nursery and tree planting programs, methods are required that overcome seed dormancy and accelerate germination. These methods are called seed pre-sowing treatments.

Seed Pre-Sowing Treatments:

Pre-sowing treatments are methods applied to overcome seed dormancy to ensure rapid, uniform and timely seed germination that facilitates seedling production. Pre-sowing treatments are applied to seeds immediately before sowing. Most methods require only a few minutes to 24 hours. However, some pre-sowing methods require a few to several days. Appropriate pre-sowing treatment methods depend on the dormancy characteristics of the seed being treated. Different pre-sowing treatments methods are-

***Soaking in cool water*:** Soaking in cool water is applied to overcome the physical, mechanical or chemical seed dormancy of some species. Most often seeds are soaked in water for 1 day, the seeds of a few species may require soaking for 2 days. This method is applied to the seed of *Sesbania grandiflora* (turi), *Tamarindus indica* (tamarind), *Gmelina arborea* (gmelina), *Gliricidia sepium* (gliricidia), and *Dalbergia latifolia* (rosewoods).

***Soaking in hot water*:** Soaking in hot water is applied to overcome the physical dormancy of seeds with hard, thick and waxy seedcoats. Water is boiled and removed from the source of heat. Seeds are soaked in hot water while being stirred for 2-5 minutes, and then soaked in cool water for 1 day. Caution: if seed is soaked while the water is being boiled, the seed might be cooked and die. This method is applied to the seed of *Paraserianthes falcataria* (falcata), *Acacia mangium* (mangium), *Calliandra calothyrsus* (red calliandra), and Leucaena leucocephala (subabul).

Mechanical (scarification) methods: Mechanical, or scarification, methods are used to overcome the physical and mechanical dormancy of hard and thick seedcoats or fruit shells. Small holes are cut or scrapped in the seedcoat or fruit shell with a knife, metal file or abrasive material to allow water absorption. Mechanical machines are available for this purpose. After scarification, seeds are usually soaked in cool water for 1 day. These methods are used on the seed of the species mentioned under the hot water pre-treatment, as well as, *Eusideroxylon zwageri* (ulin or ironwood). The hard shells of some fruits are cracked with a hammer. The fruits are then soaked in water for 1 day.

Fire or heating methods: The fire and heating methods are used to overcome mechanical dormancy of fruits with thick shells. Fruits are spread on the ground and covered with a 2-cm layer of dry grass or straw, which is then burned. Alternatively, fruits may be heated in a pan over a fire. Further details concerning these methods are provided in Table 3 of the appendix, under the entries for *Tectona grandis* (teak) and *Aleurites moluccana* (candlenut).

Soaking in chemicals: Soaking seeds in sulfuric acid, hydrochloric acid, or hydrogen peroxide for a 10-20 minutes overcomes physical and mechanical dormancy. Seeds are removed from the chemical soak, rinsed with water for 2-5 minutes and then soaked in cool water for 24 hours.

Seed pre-sowing treatments for some tree species.

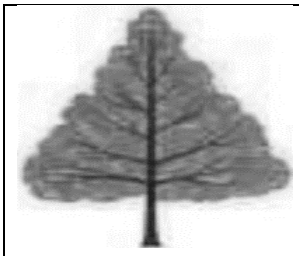
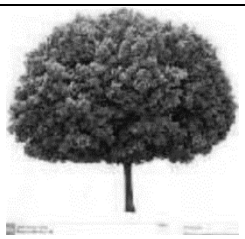
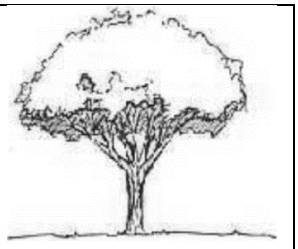
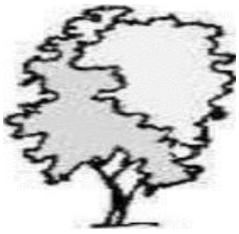
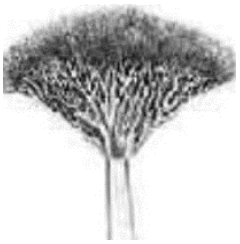
S. No	Common name	Scientific name	Pre-sowing treatment
1.	Khair	*Acacia catechu*	i) Soaking in water for 24-48 hours. ii) treatment with sulphuric acid for 2-5 minutes
2.	Israeli babul	*Acacia tortilis*	i) Soaking in water for 48 hours. ii) Dipping in hot water (80-90 ^{o}C) and soaking it overnight. iii) treatment with 50 % commercial sulphric acid for 30-40 minutes, followed by washing and then drying in shade
3.	Siris	*Albizzia lebbek*	Soaking in water brought to boil and allowing it to cool for 24 hours.
4.	Amaltas	*Cassia fistula*	Soaking in boiling hot water for five minutes than allowing it to cool for 24 hours.
5.	Khark	*Celtis australis*	Soaking in water for 48 hours.
6.	Kapur	*Cinnamomum camphora*	Soaking in water for 24 hours.
7.	Tendu	*Diospyros melanoxylon*	i) Soaking in cool water for 24 hours ii) Alternate soaking and drying for few days.
8.	Bakain	*Melia azedarach*	The seed are kept in liquid farmyard manure for 7 days to improve germination
9.	Khejri	*Prosopis cineraria*	Putting in hot water (80^{o}c) and then allowing it to cool and soak for
10.	Indian rosewood	*Dalbergia latifolia*	Soak seed in cool water for 1 day hours..
11.	Bijasal	*Pterocarpus marsupium*	i) soaking pods in cowdung slurry or camphor water for 48 hours
12.	Ritha	*Sapindus mukorossi*	i) Soaking in cold water for 24 hours ii) keeping in cowdung paste till it germinate
13.	Indian Laurel	*Terminalia alata*	Cold water treatment for 48 hours
14.	Bahera	*Terminalia belerica*	Alternate soaking and drying for few days
15.	Gmelina; Melina	*Gmelina arborea*	Soak seed in cool water for 2 days.
16.	Sandalwood	*Santalum album*	Soak seed in cool water for 1 day.
17.	Turi	*Sesbania grandiflora*	No treatment necessary, but soaking seed in cool water for 1 day will hasten and improve germination.

CRITERIA FOR QUALITY PLANTING MATERIAL OF SOME IMPORTANT PLANT SPECIES

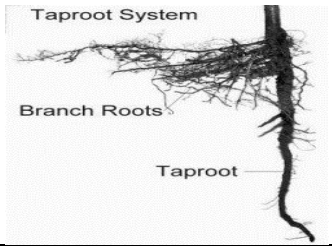
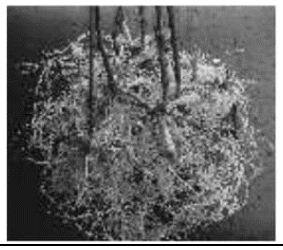
Tree	Propagation method	Quality standards
Acacia auriculiformis	Seed	15-30 cm tall
Acacia nilotica	Seed	5 months old
Albizia lebbeck	Seed	5-6 months old
Azadirachta indica	Seed	1 year old
Casuarina equisetifolia	Seed	35-45 cm tall, 5-6 months old
Dalbergia sissoo	Seed	60 cm tall, 5-6 months old
Dendrocalamus strictus	Seed	45-60 cm tall, 1 year old
Eucalyptus spp	Seed	35-45 cm tall, 6-8 months old

Gmelina arborea	Seed	20 cm tall, 6 months old
Prosopis cineraria	Seed	1 year old
Prosopis juliflora	Seed	1.5 m tall, 1 year old
Sesbania grandiflora	Seed	60 days old
Tectona grandis	Seed	1-2 cm collar dia, 3-4 months old

DIFFERENT CROWN SHAPES OF FOREST TREES

			
Conical (Pyramidal type): The lower branches are longer while the upper branches are gradually shorter *e.g.*Deodar Chir pine other conifer species	Cylindrical type e.g., Fir Spruce, Eucalyptus	Spherical type in Mango, Neem, Ashoka Tamarind, Mahua	Broad and flattopped crown: it mostly seen in *Acacia planifrons, Albizzia stipulata*
			
oval shape crown	Shruby- branching form the base. absence of straight single bole	Broom type crown in the case of Babul	

DIFFERENT ROOT TYPES/MORPHOLOGY

		
Tap root: A *taproot* is a large, central, and dominant *root* from which other *roots* sprout laterally. Typically, a *taproot* is somewhat straight and very thick, is tapering in shape, and grows directly downward.	Fiberous root system: A fibrous root system is the opposite of a taproot system. It is usually formed by thin, moderately branching roots growing from the stem. Fiberous root system of Bamboo	Prop-roots-these roots produces from its branches adventitious roots which remain suspended in the air till they reach the ground. On reaching the ground they enter it and get fixed up in the soil. As they support the thick branches of tree they are called prop-roots.
		
Stilt roots: - Stilt roots are emerging from the butt of a tree above the ground level, so that the tree appear as if supported on flying buttress.eg. Mangroove of the genus *Rhizophora*	Pneumatophore –These are a Knee-shaped or spike like projection of the roots of swamp tree e.g. Heretiera, Bruguiera, enabling the submerged roots to obtain oxygen.	

WEEDS

In all regeneration areas, whether natural or artificial, the individuals of the unwanted species appear much earlier than those of the desired species. Any unwanted plant that interferes with the growth of the individual of favored species' is called a weed. Therefore, removal of weeds, interfering or likely to interfere with the seedlings of the favoured species. Regardless of whether they are woody or herbaceous, whether their crowns are above, at the same level or below those of the seedlings of the desired species, are called weeding. Weedings must be done before

- Weeds have started the suppressing the desire seedling.
- The seedling has stopped growing.

Season of weeding- weeding's are done in plantations during the rains and stopped by the end of September. But, in nurseries, where the object is to produce plants of proper size in the shortest possible time. weeding's are done even in spring and as often as necessary thereafter.

Number of weeding- The number of weeding to be done in a particular year depends upon the intensity of weed growth and the rate of growth of seedlings of the favoured species. Even in other plantations, three weeding are usually done in the first year, two in the second year and one in the third years, though with fast-growing species, one or two weeding is adequate.

Duration of weeding- The duration i.e., the number of years for which weeding should be done also varies with species, the rate of growth, intensity of weeds and the local conditions.

Generally, weeding is carried out for 3 years though fast-growing species may require weedings for one or two per years only.

Methods of weeding: There are three common methods are

Manual weeding -It is by far the commonest method. It includes cut away the competing vegetation. The operation is usually more effective if some hoeing involving turning over the soil rather than scrapping off the weeds is also carried out. Manual weeding needs little skill and supervision and can be carried out on all sites in almost all the weather conditions with all species. Manual weeding as noted above is restricted to line or spot weeding patterns.

Mechanical weeding: In mechanical weeding, a machine operates between the rows of trees and cultivates the ground by harrowing or shallow ploughing and outs/turns down the weed growth. The machine is pulled by a tractor, so it is workable only when the spacing of rows is at least 3 m. Weeds in the rows get missed which can be eliminated by supplementing hand weeding close to the plants. This method is quite effective in hot, dry weather with dry soils as in moist soils, or when it rains soon after the operation. the roots may quickly re- establish. Such cultivation may also increase the rainfall percolation and reduce evaporation from the soil, which is of considerable significance areas with a marked dry season.

Chemical weed control: Herbicides have been extensively used in conifer plantations since chemicals which kill grasses and herbs are unlikely to damage coniferous trees. Only pesticides which are bio-degradable and can be broken down easily in the environment. (Organophosphates and carbamates) should be used. Foliar sprays of brush killer (2. 4, 5 -T and 2, 4 -D) has been observed to be effective in controlling Lamana weed in Pine plantations.

Biological weed control: Biological control is still another method in which diseased organism or insect is used which is harmless to the desired plants but kills weed.

Use of parasitic plants. A moth borer (*Cactoblastis cactorum*) from Argentina was found which attacked only cactus and no other plants. In India. Biological control of exotic weeds *of Lantana, Mikania micrantha and Eupatorium* spp. have been attempted to be introducing exotic insects.

CLEANING

Cleaning is an important tending operation which carried out in the sapling crop, involving the removal or topping of inferior growth including individuals of the favoured species and climbers etc. when they are interfering with the better grown individuals of the favoured species. Cleanings are normally carried out throughout the sapling stage of the favoured species in order to help them to develop into straight and well-grown poles. Cleaning is done keeping in view the site, species and the locality factors. In dry areas only partial cleaning should be carried out. Fast-growing species over top other species and do not need many cleanings. Cleanings may also to be modified according to the light requirements of the crop.

Season of cleaning-

- Growth period of the flavored species.
- Cleanings should be done during the rains but where this is not possible, they may be done during summers and winters.

Frequency's- Frequency of cleanings depends upon the density of shrubs and their rate of growth after cutting. If the shrubs are dense and grow faster, cleanings are done every year; otherwise, they are done at an interval of some years.

Method of Cleanings: Cleaning may be done either selectively round the stems forming the future crop, in which case they are called selective cleaning, or over the whole area depending upon the silvicultural requirement of the species and cost considerations. The following operations are usually done in cleaning:

- Cutting back of shrubs and rank herbaceous growth interfering with the growth of saplings of the desired species as well as its valuable associates;
- Cutting back of the individuals of inferior species when interfering with the growth of better Species;
- Cutting back of the malformed or diseased individuals of the desired species.

SINGLING

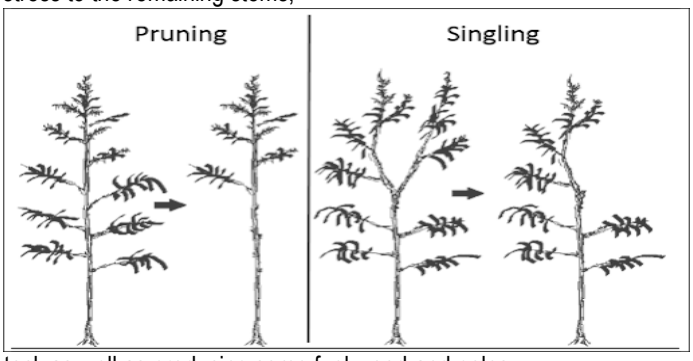
Singling is a tending operation performed in the early stages of the life of a tree when it is 2-4 m tall. Where forked or multiple stems are reduced to a single stem to improve tree form and to accelerate linear and straight growth. It is applied in coppice system.

Objective of singling:

- To improve the quality and growth of the remaining uncut stem,
- To reduce stocking density,
- To produce some fuel wood from cut stems.

Procedures of Singling:

- When several stems are produced – single them by selecting the strongest and/or straightest,
- Singling should be done gradually to minimize the stress to the remaining stems,
- With coppice regrowth e.g. after harvesting broadleaved trees, multiple new shoots are frequently produced from the cut stump. Select 1 or 2 of these and remove the others,
- After being damaged e.g. by snow, wind, frost or grazing, some young trees may develop a forked stem. Singling is used to select the best stem and remove the other.
- In degraded forests forked or multiple-stemmed trees have often been left after the better trees have been harvested,



- Singling is an opportunity to improve the growing stock as well as producing some fuel wood and poles.

PLANTING TECHNIQUES

Planting is also restored to for filling up felled patches of previous year plantation or some old natural regeneration area. Planting is generally done with the seedling raised in nursery.

Methods of planting- Entire planting is the method of planting, in which entire plant is lifted from nursery and planted out in the field

Entire planting with naked root-

- The pit should have the sufficient in size.
- The Pit contains the entire root system without doubling the tap root.
- The plant should be held in vertical position by collar in the center of pit.
- The collar should be kept about 10 cm above the general ground level so that when the soil pressed or it subsides due to rain water, it does not below the ground level.
- The soil should be pushed from the sides, keeping the lateral roots in their natural position.
- The plant should be covered upto collar keeping the soil sloping all direction.
- The test of good planting is that the plant cannot be pulled out easily.

Planting seedling raised in nursery with ball of earth

- The pit should be big enough to contain the ball of plant.
- When planting, the grass or banana leaf wrapping should remove and the plant put in the pit to see if the depth of pit is not too big.
- If pit is big, the plant should be taken out and the pit filled with dug up earth to a point, so that the plant in it, will be about 5 cm above the ground level.
- After filling the earth, it should be pressed well with hands. Then the ball with plant should be placed vertically in the centre of pit.
- When fill is completed up to edge of the ball, the soil filled should be sloped outside.
- It should than the pressed thoroughly by feet with damaging the ball of earth.

Planting of plants raised in planting brick /brick planting-

- Planting of brick plants in moderate or heavy rainfall area is done in same way of ball plant.
- While planting of shifting sands, however, watering of pit before planting has recommended unless it was done after a heavy shower.
- Planting brick is kept in such a way that its tops is about 10 cm below the level of sand to avoid its exposure as a result of blowing sand.

Planting of plants raised in containers-

- Various types of container are used for raising the seedling, on the basis of container, this planting is called dona planting, basket planting, pot planting, tube planting, bag planting.
- Container has to be classified into two categories like as those to be planted in containers and those without them.
- Dona, mose or fibre cubes, butea bark tubes, bottomless earthen pots and basket belong to the categories which is planted with container. These are planted in the same way as ball plants.
- Donas in which tap root may be protruding out, are kept separately to be planted on rainy days after cutting the protruding portion with sharp Knife or rozer blade.
- Earthern pots with bottom, metal tube belong to categories in which container is removing before planting.
- In case of polythene bag plants, the polythene bag is turn out and the ball plant planted.

STUMPS

Generally, stumps or seedlings are used as planting material. For stump preparation, the seedlings have to be maintained in the nursery for about one year. Then the seedlings are uprooted, all the leaves and secondary roots are removed and stumps (4 to 6 cm shoot with 15 to 20 cm tap root portion) were prepared. Some of following steps mentioned as

- For making the stumps, plants are taken out of nursery.
- After taken out the plants, they have to be graded on the basis of their tap root development and collar diameter. Only those plants are made into stumps which have a single tap root of length not less than 30 cm. Plants with forked tap root. or tap root of insufficient length should be discarded.
- The collar diameter is an indication of the thickness of the root. Very thin as well as very thick stumps are discarded. For example, in teak stumps, plants with collar diameter less than 1 cm. or greater than 2 cm should be discarded.
- After selecting the plants, the shoot should be cut off with a sharp knife or pruning scissors, leaving only 2 cm to 3 cm portion of the shoot. Then all the lateral root should be pruned to a total length of about 30 cm.
- The work should be done carefully so that the bark of the tap root is not damaged. After pruning the lateral roots, the tap root is cut at a distance of 20 to 22 cm from the collar. In moister areas, the root length is, sometimes, reduced to 15 cm, while in the drier areas it is increased to, 30 cm.
- The cutting of shoot and root should be done with a very sharp knife or pruning scissors in such a way that they do not spill the planting material.
- Sometimes, billhooks are also used to make stumps speedily; when they are used the plants is laid on a billet of wood and the root and shoot portion are chopped off clean in one stroke each.
- Care should, however, be taken to see that the root length is uniformly the same, particularly when the stumps are to be planted in crowbar holes.

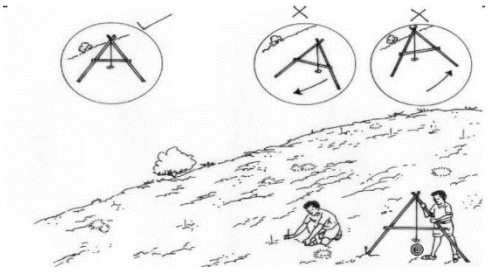
- After preparation, the stumps are tied in bundles of. 100 stumps and dipped thin paste of soil and finally wrapped in gunny cloth and transport to long transport to long distance.

FIELD PREPARATION

- Field preparation for a plantation includes clearance for planting and it involves, bush cutting, soil and moisture conservation works in 'nalas', construction of vegetative or stone check dams, marking of pits for planting of saplings etc.
- In addition, demarcation of boundary wall or fencing and inspection paths should be made to facilitate the movement of people engaged in plantation works.
- This work should be completed by the end of November.
- *Lantana, Eupatorium* and other invading weeds and shrubs should be uprooted.
- On developing the site for planting, care should be taken to retain all indigenous species of trees and shrubs that are naturally growing in the area. They should not be cut and burnt along with weeds and thorny species.
- The planting design, location of plantation and size of plot is to be verified with review of Maps and aerial photo.

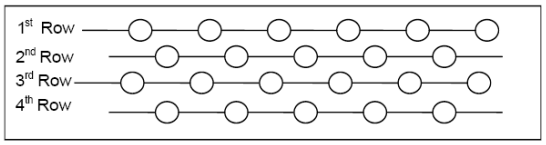
Marking & Digging of Pits

- After clearing the land sites for digging of pits, plantation should be marked on ground using a measuring tape to ensure the desired spacing.
- Wooden pegs or bamboo sticks shall be placed at the spot just at the centre of the pit.
- Pits of the size 30 cm × 30 cm and 30 cm depth should be dug.
- Pits should be deep enough to ensure that the roots of the plants do not curl up once the planting material is placed in it.
- The soil dug from the pits should be dumped close to the pit. While digging stones, roots of trees, grass or shrubs, if any, should be removed so that while filling the dug-up earth back in the pits these are not mixed with the soil.

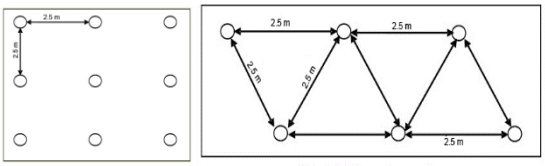


- The spacing of pits varies according to the planting scheme for different areas.
- Generally, the spacing between pit to pit, distances between lines is around 2.5mtr x 2.5mtr along the contour line.
- It may not be possible to follow this spacing strictly due to presence of boulders or trees.
- No pit should be dug within the vicinity of five meters from a tree.
- It is better for complete the pitting works within end of March for better weathering of soil. The spacing between the pits should however, not be less than 2.5mtr x 2.5mtr.
- The size of pits may vary for urban plantation, Bald hill plantation, Avenue plantation, and Bamboo plantation.
- Pits should always be dug along the contour lines.

Procedure of making the contour lines: Adjust 'A' frame on the slope to bring plumb line/string to the centre of the A -frame (Point E). Mark spot on the slope. These spots will form a contour line. Distance between contour Hedgerows should be approximately 4 m - 6 m.



Alignment of pits in areas with undulating topography: The pits in the second line should be dug in such a way that they fall between the pits dug in the first line as shown i.e., staggered. The triangular planting method, which is specially practiced in the hills, checks the flow of rain water and facilitates its percolation in the ground.



PLANTING PITS

Planting pits are the simplest form of in-situ rainwater harvesting for optimum growth and development of plant. This form of micro-catchment is best suited for land with low permeability, such as silt and clay soils. On encrusted soils, three types of conservation practice can be met with planting pits like as soil conservation, water and soil moisture conservation, and erosion protection . The holes are dug 50-100 cm apart from each other with a depth of 5-15 cm in order to prevent water runoff.

Kinds of pits:

Ordinary pit- It is a pit with slanting sides with 30cm depth at base and the upper width is 45 cm. this is useful for clay and saline soil of all moisture regime.

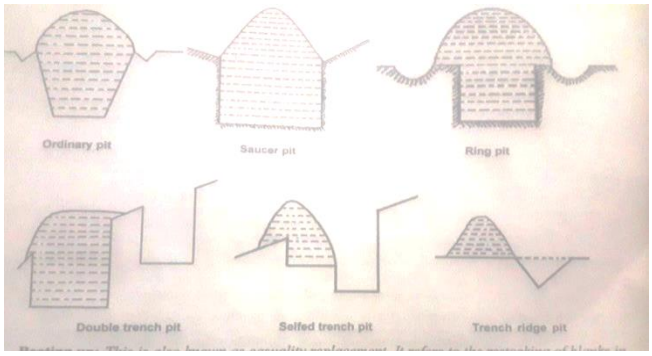
Saucer pit – in this, pit is are made at the centre of the saucer having one-meter radius. A gentle slope from out words to centre is given. This is most suitable for loamy soil in dry region.

Ring pit- This is suitable for sandy soils. This conserves soil moisture by collecting water nearby. For this purpose, trench at 20 cm away from the pit is made around the pit.

Ring ditch pit: This pit is suitable for sloppy region. In this pit is partially filled and ridge is formed along one side. This side of pit may be vertical or slanting one.

Shelfed trench pit- it is suitable trench for clay soil in which a shelf is made on one side of trench. This may be two type-(a) shallow filled shelfed trench (b) Deep filled shelfed trench.

Double trench pit- in this type, another trench is made near to trench made for planting with main aim to harvest water. This type of pit suitable for region having the low water retention capacity such as stony soil.



Trench ridge pit- In this type of pit, the dug-up soil is dumped to form a ridge. The trench dug is used for collection of water. Sowing is done on the ridge. This method is suitable for salt affected soil as ridge sowing improves the leaching out of salt from it.

THINNINGS

It is the reduction of trees in an immature stand for the purpose of improving the growth and form of the trees that remain without permanently breaking the canopy of future trees.

Aims of thinning:

- 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 req.
- To maintain hygienic condition
- To obtain timber of desired quality and strength
- To ensure decomposition of raw humus in temperate forests by increasing light and temperature

How much to thin: The ground area available to each tree influences its growth. Thinning regimes are calculated on a trees–per-hectare basis. Thinning may not result in even distances between trees; however, trees should not be too close (2.5 meters), otherwise competition will restrict growth. On the other hand, spacing between trees greater than 12m apart are likely to under use the available area and waste valuable land.

Basis of thinning in regular forest: Tree classification basis and Statistical basis

Tree Classification Basis

- Before planning the nature and intensity of thinning the preference between the intensity of thinning and quality of thinning should be decided.
- The trees remaining after the thinning should be able to compensate for the loss in increment by trees removed in thinning.
- There will be an optimum stocking for a given site and species.
- Individual trees are classified by height and size of crown and thinning is decided on the basis of which classes of trees are fit to be removed for maintaining the desired qualitative and quantitative nature of the thinning.
- The main purpose of the thinning is to release more space for future development of trees; the freedom of crown is the guiding factor for thinning purpose.
- The retention of trees per unit should be decided first and then the number of trees to be removed should be marked accordingly.
- The development of crown and stem are the deciding factor for sub-classification of the dominance classes of trees for the given site and species.

Tree classification in regular forests is done as under:-

- **Dominant trees:** These crowns extend above the general level of the canopy. They receive full light from above and some light from the sides. Generally, they have the largest, fullest crowns in the stand (Figure 5.5).
- **Codominant trees**: These crowns make up the general level of the canopy. They receive direct light from above, but little or no light from the sides. Generally they are shorter than the dominant trees.

- **Intermediate trees:** These crowns occupy a subordinate position in the canopy. They receive some direct light from above, but no direct light from the sides. Crowns are generally narrow and/or one-sided, and shorter than the dominant and codominant trees.
- **Suppressed trees (Overtopped trees)**: These crowns are below the general level of the canopy. They receive no direct light. Crowns are generally short, sparse, and narrow.

Statistical basis:

- In regular plantations the density and site quality vary considerably ad it is not possible to define crown and canopy classes.
- For this the number of trees to be retained per unit area and their spacing should be numerically fixed.
- After fixing the number of trees per unit area the remaining trees can be marked and removed.

Thinning in Regular crops:

Mechanical thinning (also called 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.

Ordinary thinning (Also called low thiningor German thinning or thinning from below): The method of thinning in common use that consists in the removal of inferior individuals of a crop, starting from the suppressed, then taking the dominated and lastly some of the dominants.

Crown thinning (High thinning or French thinning or thinning from above): A method in which thinning is primarily directed to the dominant trees in a regular crop, the less promising ones being removed in the interest of the best available individuals; the dominated and suppressed stems are retained if they are not dead, dying and diseased.

Free thinning (devised by Heck): A method of thinning in which attention is concentrated on evenly spaced selected stems (called elites or alphastems) 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.

Maximum thinning: It is the modification of Heck's free thinning developed by Gehrhardt. It is defined as a method of thinning which ' 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** (also Craib's thinning): A thinning done in a regular crop in anticipation of suppression. It was developed by Craiband O' Connorfor wattle and pine plantation in South Africa. Thinning is done after the trees have been adversely affected by the competition of their neighbours. It should be done before competition actually sets in.

Thinning in irregular crops: Selection Thinning is applied in 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 neighbors from all sides
- Trees which are less valuable than their neighbors
- Trees which are of no special importance as regards desirable crop mixture presented.
- Trees those reached to the exploitable diameter.

GLOSSARY

Abnormal forest: It is a forest in which, as compared to an acceptable standard. the quantity of material in the growing stock is in deficit or in excess or in which the relative proportions of the age or size classes are defective.

Accessory species: Based on mixed forest, accessory species is defined as a useful species of less value than the principal species, which assists in the growth of the tarter and influence to a smaller degree the method of treatment.

Adventitious Roots: The roots produced from parts of the plants other than the radicle or its subdivision.

Aggregation: Aggregation is defined as grouping followed by establishment of scattered colonizing invaders as a result of propagation.

Albedo: Some part of the incoming solar radiation is reflecting (about 42%) such phenomenon is called as albedo.

Asexual or vegetative reproduction: A new plant is created by some vegetative part of the plant e.g., a portion

of the root or shoot (stem or branch), or a combination of both, a bud or even injured roots. Sometimes, however, after a plant has been utilized, its stump produces new plants. Reproduction through rhizomes, root sucker, coppice is called natural asexual reproduction.

Autogenic succession: It is nothing but succession takes place as a result of autogenic factors which are due only to the individuals in a plant community.

Auxiliary species: Based on mixed forest, auxiliary species is defined as a species of inferior quality size, of relatively little silvicultural value or importance, associated with the principal species. It is also referred to as secondary species or subsidiary species.

Acclimatization: Adaptation to different climatic conditions.

Afforestation: To establish a forest by artificial means on an area from which forest vegetation has always or long been absent.

Autoecology: Ecology of an individual organism or a taxonomic group.

Bioclimate: The climate defined by these modified or adjusted climatic factors is called bio-climate.

Block Plantation: Tree plantations in compact blocks of more than 0.1 ha on lands outside recorded forest areas.

Canopy: Cover of branches and foliages formed by the crown of trees in a forest or total crown of trees present in a stand or forest in combination or together.

Clear bole: The part of the bole that is free from branches.

Clear felling (Clear-cut): The cutting method that describes the silvicultural system in which the old crop is cleared over a considerable area at one time.

Climate: It is defined as the average weather conditions prevalent in any locality.

Climatic climax: A climax which owes its distinctive characters to climatic factors in conjunction with only such biotic influences as plants and animals naturally occurring in the area, bring about.

Climax community: The terminal stage of an ecological succession sequence which remains relatively unchanged as long as climatic and physiographic factors remain stable.

Climax: It is the culmination stage in plant succession for a given environment.

Co-dominant: (a crown class)-Species in a mixed crop that are about equally numerous and vigorous; forming part of the upper canopy of a forest, less free to grow than dominants but freer than intermediate and suppressed trees. Here trees are slightly short dominants at 5/6 of the predominant.

Communal forest: It is a forest owned and generally managed by a community such as a village, town, tribal authority or local government. the members of which share in the produce or proceeds.

Competition: The struggle for the available food, light and moisture that takes place among species and individuals in a group of plants.

Composition: The various species that form a forest crop and their proportion in it.

Coppice forest: A forest constituting of trees developed mainly from coppice shoots or root suckers.

Cover-crops: These are subsidiary species, usually low shrubs sometimes small trees, intentionally introduced into a plantation with the primary object of restoring a cover to the soil as early as possible and minimizing any risk of soil erosion due to exposure. Example: *Indigofera tincroria, Cmtolaria jimcia, Desmodium spp., Leucaena glauca.*

Crop density: it is defined as the relative completeness of the stocking expressed as a decimal coefficient, taking normal number of trees, basal area or volume as unity. The terms over-stocked, full or complete, and incomplete are used to describe crop density, according as it exceeds, equals or is less than one.

Crop morphology: It refers to science which deals with the outer form of the forest crop consisting of trees and its development.

Crop volume: The sum volumes of the individual trees forming the forest crop is the volume of that crop.

Crown: The upper branchy part of a tree which is present above the bole.

Breast height: Almost universally adopted as a standard height for measuring girth, diameter and basal area of standing trees which is 1.37 meter from ground level.

Browsing: Feeding on twigs or shoots, with or without attached leaves of shrubs, trees or woody climbers.

Buttress: An outgrowth formed usually vertically above lateral roots and thus connecting to the base or stem with roots.

Canopy density: The relative completeness of canopy usually expressed as a decimal coefficient, taking closed canopy as unity.

Deforestation: Removals or cutting down of the tree crop from a piece or land without the intention of reforesting or replanting.

DBH: It refers to diameter at breast height, generally measured at 1.37 m height from the ground level.

Deciduous: A tree is called deciduous if it normally remains leafless for some time during the year. In other words, it produces new flush of leaves after all the old leaves have been shed and it has remained leafless for some time. The leafless period varies with species and symptom

Deliquescent branching: A mode of branching in trees in which the trunk divides into many branches leaving no central axis, as in elms.

Dominant trees: It is a classification made on canopy cover/crown formation. All trees which form the upper most leaf canopy and have their leading shoots free. These trees are again divided into pre- dominants and co-dominants.

Dominated tree: Trees which do not form part of the upper most leaf canopy but the leading shoots of which are not definitely over-lopped by the neighboring trees. Their height is about 3/4 of the tallest trees.

Dense forest: All lands with a forest cover having a canopy density of more than 70 %.

Denudation: To lay bare, usually with respect to soil by the removal of its vegetation cover or organic layers.

Dew point: The temperature at which water vapor present in the atmosphere is sufficient to saturate it.

Ecesis: It is also called as establishment. It is defined as the whole process whereby a plant established itself in a new area from germination or its equivalent to reproductions whether sexual or asexual.

Ectendomycorrhiza: Here both ecto and endo mycorrhizal infections are combined, i.e., a condition where typical ectotrophic condition is accompanied by intracellular penetration of the hyphae.

Ectomycorrhiza: The fungi usually belong 10 Basidiomycetes, form a mantle over the rootlets and the hyphae usually radiate from the mantle. The fungi enter the cortex, thus permitting the hyphae to grow in the intercellular space.

Edaphic factor: It is defined as ecological influences characteristic of the soil brought about by its physical and chemical characteristics.

Edaphic: Pertaining to the soil in its ecological relationships.

Endomycorrhiza: The fungi usually belong to Phycomycetes, form of individual hyphae on the root surface and penetrate the cells of the cortex. Roots sometimes become beaded.

Energy forest or Fuel forest: It is a forest raised on village wasteland to supply fuel, small timber, fodder, etc., to the village communities living far away from government forest.

Even-aged or regular forest: It is defined as a forest composed of even-aged woods. The term even-aged used in this definition is applied to a stand consisting of trees of approximately the same age. Differences up to 25% of the rotation age may be allowed in cases where a stand is not harvested for 100 years or more.

Evergreen: An evergreen is defined as perennial plant which is never entirely without green foliage, the old leaves persisting until a new set has appeared. The persistence of the old green leaves after the new leaves have been produced depends upon species and in the same species upon the environment.

Exotic species: An exotic species is one which is grown outside the limits of its natural range. For practical purposes an exotic is defined as an introduction of a species from a foreign country.

Ecology: Study of plants or animals in relation to their environment.

Establishment: Development of new crop by natural or artificial means is considered a safe from normal or adverse factors.

Exploitable age: The age at which an individual tree or crop attains the size or stage of growth, required to full fill the objects of management.

Farm forestry: The practice or cultivating and managing trees in compact blocks on agricultural lands.

Fluting: The tendency to show irregular involution and swelling on the bole just above the basal swelling.

Forest area: The area recorded as a forest in the Government records. It is also referred as "recorded forest area.

Forest cover: All lands more than one hectare in area, with a tree canopy density or more than 10 per cent irrespective of ownership and legal status.

Forest inventory: The measurement of certain parameters of forests to assess the growing stand, stock and other characteristics of forests.

Forest: Forest is an area set aside for the production of timber and other forest produce or forest is a living community, which predominantly consists of trees, shrubs and other woody vegetation usually with a closed canopy.

Frost: Chilling of air below freezing point.

Germinative capacity: Percentage of seeds that germinate during the normal period of germination.

Gregarious flowering: It is the general flowering, within one or a few years and over considerable areas, of all or most of the individuals of certain species that do not flower annually; in some cases, followed by the death of the plant, example bamboo.

Girdling: Cutting through bark and outer living layers of wood in a continuous incision all-round the bole of a tree.

Growing stock: Sum or volume or number of trees growing in the forest or a specified part of it.

Habitat: The sum of effective environmental conditions under which an organism's lives.

High forest: A forest which is originated from the seed.

Host: An organism on or within which, another organism feeds and develops.

Habitat based forests: Habitat refers to the effective environmental conditions in which a forest community exists. Thus, climate and edaphic factors often form the basis of classifying forest vegetation.

Hardening off: It is the natural process by which plants become adapted to drought, cold or heat. For preparing seedlings in a nursery for planting out by gradually reducing watering, shade and/or shelter resulting in hardening of plant.

Hardwood: It is a conventional term used irrespective or physical hardness or softness for broad-leaved trees and their timber as distinguished from conifers and their timber which are known' as softwood.

Herb: It is defined as plant whose stem is always green and tender and height is usually not more than one meter. According to the span of life, it is called annual. biennial or perennial.

Hydrarch succession: The succession beginning in water or wetland as in ponds, lakes and marshes.

Hydroponics: The cultivation of plants, without soil, in water solutions of nutrients required for growth.

Hydrosere: An ecological sere (plant community) originating in an aquatic habitat or the various stages of hydrarch succession are called hydrosere.

Indigenous species: An indigenous species is one that grows naturally in the country or in a region.

Introgression: The entry or introduction of a gene from one gene complex to another.

Increment: The increment in girth, diameter, basal area, height, volume, quality, price or value of individual trees or crops during a given period.

Indigenous: Native lo a specified area or region where a species is not introduced.

Irregular forest: A forest composed of trees of markedly different ages.

Knee: An abrupt bend in a stem or tree trunk, or an outgrowth rising from the roots of some swamp-growing t r ees such a. bald cypress.

Lithosere: It is defined as xerosere which originates on rock surface.

Macronutrients: The nutritional elements, nitrogen, phosphours, potassium, calcium, magnesium, and sulfur essential for normal plant growth, development and reproduction. They are usually derived from the soil.

Microclimate: It is defined as the climate of small areas which for some reason, differs significantly from the general climate of the area more particularly the climate outside that cover.

Micronutrients (trace elements): Nutritional elements necessary in minute quantities for normal plant growth, such as boron and manganese.

Migration: Migration is defined as the mass movement of plants from one place to another

Mixed forest: It is defined as a forest composed of trees of two or more species intermingled in the same canopy; in practice and by convention, at least *20%* of the canopy must consist of species other than the principal one.

Mixed plantation: It refers to a plantation of several species in the same plantation area. Mixed stand: The stand formed by several species is called mixed stand.

Morphology: means the science of form, especially that of the outer form, inner structure and development of living organism and their parts.

Mycorrhiza: This is as a structure produced from the combination of the modified rootlet with fungal tissue.

Mangroves: Salt tolerant evergreen forest ecosystem found mainly in tropical and sub- tropical coalal and/ or inter- tidal regions

Moderately dense forest: All lands with forest cover having a canopy density between 40 to 70 %.

National forest: A forest which is maintained and managed to meet the needs of the defense, communications, industry and other general purposes of public importance.

Natural pruning (self-pruning): The freeing of the stem of a standing tree of its branches by natural death, disintegration, and/or fall, from such causes as decay, or deficiency of light or water, or snow, ice and wind breakage.

Non-capillary porosity: It is the air space in a soil at field moisture capacity.

Normal forest: It is defined based on the growing stock, where a forest, which for a given site and given objects of management, is ideally constituted as regards growing stock, age class distribution and increment and from which the annual or periodic removal of produce equal to the increment can be continued indefinitely without endangering future yields.

Normal yield table: A table showing, for one or more species in a fully stocked stand, the growth pattern of a managed even-aged stand derived from measurements at regular intervals covering its useful life. It includes mean d.b.h. and height, number of stems, and standing volume per unit area.

Nurse crops: These are raised with primary object of helping up a Jess hardy species and are usually removed at an early stage as soon as they have served this purpose. They are usually raised to protect the main crop from sun, frost and other natural and biotic factors. Example *Milcaranga* spp., arhar, castor and *Gmelilla arborea*

Ontogeny: Developmental history of an individual or organism over its whole life cycle: often extended to cover that of a taxonomic group, e.g. species.

Open forest: Lands with forest cover having canopy density between I0 to 40 %.

Over wood: The upper most story of a storeyed high forest or any crops in which two or more distinct crown layers occur, either temporarily or permanently. e.g. seed bearers over regeneration, standards over coppice or a crop of trees over bamboo.

Pole: The young tree from the time, when the lower branches began to fall off to the time when the rate of height growth begins to slow down and crown expansion becomes marked.

Pure bamboo: Area having bamboo density of 200 or more bamboo clumps per hectare.

Panchayat forest: It is any forest where management is vested in a village panchayat.

Perfect flower: A flower having both stamens and carpels; may or may not have a perianth.

Phenology: It is the seasonal change that occur during the life cycle of the plant growth like flushing, leaf senescence, flowering, fruiting and seeding.

Phenotype: The plant as observed; the product of the interaction of the genes of an organism (genotype) with the environment.

Photoperiodism: The physiological response of an organism to the periodicity and duration of light and darkness which affects many processes including growth, flowering, and germination.

Phyllodes: A flat expanded petiole that replaces the blade of a foliage leaf and which functions in photosynthesis.

Physiognomy base of forest: Physiognomy means the general appearance or a forest community and therefore, forms an easy basis for rough differentiation of very broad classes.

Physiography based forests: Physiography, the natural features of the earth surface, is modified by the other interaction factors like climate, edaphic and biological and form the microclimate, hence. results in different vegetation occurring in the same climate on different aspects of the hill slope, it forms a good basis for classifying vegetation.

Pioneer: A plant capable of invading a newly exposed soil surface and persisting there until supplanted by successor species.

Pneumatophore: Pneumatophore is a knee shaped or spike like projection of the roots of swamp tree. Example: Heretiera and Bruguiera are enabling the submerged roots to obtain oxygen.

Pole: Pole is defined as a young tree from the time when the lower branches begin to fall off to the time when the rate of height growth begins to slow down and crown expansion becomes marked.

Pole size: A young tree with a d.b.h. of not less than 10.2 cm (4 in). A small pole has a maximum d.b.h. of 20.3 cm (8 in), and a large pole has a maximum d.b.h. of 30.5 cm (12 in).

Pool frost: The accumulation to a considerable depth of heavy cold air flowing down into natural depressions from adjoining areas.

Primary succession: The succession which takes place on sites which have previously not borne vegetation. Primary succession is, sometimes, termed asautogenic succession.

Principal species: The species first in importance in a mixed stand either by frequency, volume or silvicultural value or the species to which the Silviculture of a mixed forest is primarily directed.

Proclimax: It is defined as a term applied to all communities that suggest something of a permanence or extent of a climax but are not typical of the existing climate.

Production forest: It is a forest managed primarily for its produce. It is also sometimes referred to as national forest.

Propagule: A plant part such as a bud, tuber, root or shoot used to reproduce (propagate) an individual plant vegetatively.

Prop roots: Adventitious roots derived from branches, which remain suspended in the air till they reach the ground and then enter it and get fixed up in the soil. Such type of root is called as prop root. Example: *Ficus bengalensis*

Protected forest: Itis a part of state forest, where an area subject to limited degree of protection under the provisions of Chapter IV of the Indian Forest Act.

Protection forest: An area wholly or partly covered with woody growth, managed primarily to regulate so-earn flow, prevent erosion, hold shifting sand or to exert any other beneficial influence.

Provenance: The original geographic source of seed, pollen, or propagules.

Psammosere: Xerosere which originates on sand.

Pure forest: Itis defined as a forest composed of almost entirely of one species, usually to the extent of not less than 80%. It is also called pure crop or pure stand.

Pure plantation: Plantation of a single species.

Pure stand: The stand consisting of single species, which is raised by means of artificial is called pure stand.

Radiation frost: Freezing confined to ground level, ice crystals forming on the surface objects, soil or ground vegetation.

Reaction: The effect of vegetation on the site and is the most important factor responsible for succession.

Recreational forest: It is a forest which is managed only to meet the recreational needs of the urban and rural population.

Regular forest: Same as even-aged forest.

Reproduction: In order to maintain continuity of its own species and also to multiply its numbers, it bas to reproduce itself. Such phenomenon is called as reproduction.

Root: The root is that portion of the plant which develops from radicle and grows inside the soil and away from light.

Recorded Forest Area (RFA): Geographic areas recorded as forests in Government records. (Same as Forest Area).

Regeneration: Renewal of a forest crop by natural or artificial means.

Reserved forest (RF): An area so constituted under the provisions of the Indian Forest Act or other Stale Forest Acts, having full degree of protection. In reserved forests, all activities are prohibited unless permitted.

Riparian forest: Tree growth that owes its existence or conditions to its proximity to a watercourse, lake, swamp or spring.

Rotation: The planned number of years between the formation or regeneration of a crop and its final felling.

Sapling: A young tree from the time when it reaches about one metre (3 feet) in height till the lower branches begin to fall. A sapling is characterized by the absence of dead bark and its vigorous height growth. (A tree more than 0.9 in (3 ft) in height and less than 10.2 cm (4 in) in d.b.h.)

Scarification (for seed): Pregerminative treatment to make seed coats permeable to water and gases; accomplished usually by mechanical abrasion or by soaking seeds briefly in a strong acid or other chemical solution.

Scrub: Degraded forest lands having canopy density less than 10 per cent.

Secondary succession: Succession which Lakes place on site after the destruction of the whole or part of the original vegetation. This succession is, sometimes, termed as allogenic succession.

Seed tree: The cutting method that describes the silvicultural system in which the dominant feature is the removal of all trees except for a small number of seed bearers left singly or in small groups, usually 20 to 25 per hectare (8 to 10 per acre). The seed trees are generally harvested when regeneration is established. An even-age stands results.

Seedling: A tree grown from seed that has not yet reached a height of 0.9 m (3 ft) or exceeded 5.1 cm (2 in) in d.b.h., which would qualify it as a sapling.

Selection forest: An uneven aged crop containing many, theoretically all age class or gradations. Otherwise a forest managed under selection system.

Sere: A sequence of plant communities that successively follow one another in the same habitat from the pioneer stage to a mesic climax.

Sexual reproduction: In trees, this is achieved by the production of flowers, their pollination, and finally by fertilization resulting in development of seeds.

Shade-tolerance classes: Very intolerant, intolerant, intermediate tolerant, very tolerant.

Shrub: It differs from perennial herbs in its persistence and woody stem and less definitely from a tree in its lower stature and its habit of branching from the base.

Silvics: Study of life history and general characteristics of trees with particular reference to environmental factors as the basis for the practice of Silviculture.

Silvicultural system: A process whereby forests are tended, harvested and replaced resulting in a forest of distinctive form. Systems are classified according to the method of carrying out the fellings that remove the mature crop with a view to regeneration and according to the type of forest thereby produced. These are individual tree selection, group selection, shelterwood, seed tree. and clear cut.

Silviculture: Art and science of cultivating forest crops. Also branch of forestry, which deals with establishment, development, care and reproduction of stands of timber.

Site class: A measure of the relative productive capacity of a site based upon the volume or height (dominant, codominant or mean) or the maximum mean annual increment of a stand that is attained or attainable at a given age.

Site index (SI): A measure of site class based upon the height of the dominant trees in a stand at an arbitrarily chosen age, most commonly at 50 years in the East and 100 years in the West.

Site quality: A measure of relative productivity of a site for a particular species.

Site: A complex of physical and biological factors of an area that determines what forest or vegetation it may carry.

Snow: It is type of precipitation occur at higher altitudes due to decrease in temperature.

Soil porosity: The extent to which the gross volume of the soil is unoccupied by solid particles.

Sporadic Flowering: It is the flowering of one or a few culms in a clump or a few clumps in a locality. Annual flowering is also met with in certain species of bamboos, e.g., *Arundinaria wightiana, Bambusa lineate and Ochlandra stridula*, but is not followed by the death of bamboo.

Stand density: A measure of the degree of crowding of trees within stocked areas, commonly expressed by various growing-space ratios such as crown length to tree height, crown diameter to diameter at breast height (1.37 m or 4.5 ft above the ground) (d.b.h.); crown diameter to tree height; or of stem (triangular) spacing to tree height.

Stand: Aggregation of trees occupying a specific area and sufficiently uniform in composition (species), age arrangement and condition to be distinguishable from the forest on adjoining area.

State forest: It is a forest owned by State Government.

Stem: The principal axis of plant from which buds and shoots are developed; in trees, stem, bole and trunk are synonymous', but bole is 'sometimes used to refer to only lower part of the stem up to a point where the main branches are given off, i.e., clean bole.

Stilt roots: Stilt roots are adventitious roots which emerge from the butt of a tree above ground level, so that the tree appears as if supported on flying buttresses. Example: mangrove species like *Rhizophora species*.

Stool: A living stump capable of producing sprouts.

Stratification: A pregerminative treatment to break-dormancy in seeds and to promote rapid uniform germination accomplished by exposing seeds for a specified time to moisture at near-freezing temperature sometimes with a preceding exposure to moisture at room temperature.

Suppressed tree: Trees which reach only about 1\2 to 5/8 of the height of predominant with their leading shoots definitely over Lopped by their neighbours oral least shaded on all sides by them.

Sustained yield: The material that a forest can yield annually or periodically in perpetuate.

Symbiosis: A broad tern covering a variety of close relationships between two or more kinds of organisms particularly when the relationship appears to be mutually beneficial.

Sympodial: A branching growth pallern in which the main axis is formed by a series of successive secondary axes, each of which represents one fork of a dichotomy.

Synecology: Ecology of a community.

Taper: The decrease in diameter of the stem of a tree or of a log from the base up wards, is known as taper.

Taungya method: The raising of a forest crop in conjunction with a temporary agricultural crop.

Topography: It is the description of the physical features of a place. It describes configuration of the ground, its altitude. slope, aspects. etc.

Tree: A large woody perennial plant having a single well-defined stem (bole or trunk) and a more or less definite crown. A tree is usually more than 6 metres in height which can, according to species, be upto 127 metres. (Tree is the stage of growth beyond the pole stage when the rate of height growth begins to slow down and crown expansion becomes marked).

Tree cover: Comprises of tree patches outside the recorded forest area exclusive of forest cover and less than the minimum mapable area of I hectare.

Tree Outside Forests (TOF): Trees growing outside recorded forest areas.

Unclassed forests: An area recorded as forest but not included in reserved or protected forest. Under growth: The lowest stratum of woody and other vegetation above the ground cover.

Very dense forest: Lands with forest cover having a canopy density of 70 per cent and above.
Virgin forest: Natural forest uninfluenced by human activity; It may or may not be a climax forest.
Village forest: A village forest is a state forest assigned to a village community under the provisions of the Indian Forest Act.
Wind firm: Tree able to with stand against strong winds without being thrown or broken. Wind throw: Uprooted by wind; a tree so up-rooted.
Xerarch succession: The succession initiated in extremely dry situations such as bare rock, windblown sand, rocky talus slopes, *etc.*
Xerophyte: A plant that is adapted to dry or and habitats.
Xeroseres: Successional stages of xerarch succession are called xeroseres.