Hornbill Classes

2024

APPSC

FOREST RANGE OFFICER

TOOLKIT

The Ultimate Guide to Success

Module - 4

General Forestry – 2

[Unit – VII] Forest Inventory

[Unit – VIII] Forest Mensuration & Remote Sensing

[Unit – VIII] Forest Planning & Monitoring

[Unit – VIII] Forest Surveying & Engineering

~~[Syllabus]~~ Silviculture System

Congratulations

To all our successful candidates in

MADHYA PRADESH FOREST SERVICE 2020

Assistant Conservator of Forest (ACF)

Ashish Vijaywar

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Shubham Soni

Rahul Chouhan

5 Out of 6 Selections in MPPSC Forest (ACF) 2020

RANGE FOREST OFFICER (RFO)

Gourav Dubey

Saurabh Dubey

Pawan Sharma

Manish Sharma

Kuldeep Baghel

Sushil Parmar

Lantav Jain

Shubham Raghuvanshi

Manisha Mukati

Vedant Goutam

Parag Jain

Shri Ram Dwivedi

Anil Kumar

Shashi Prakash Pandey

Anubhav Jain

Ravindran Gupta

Kuldeep Bohare

Shubham Tiwari

Yogesh Dhote

Piyush Shukla

Yogendra Singh Baghel

Abhilash Pathak

Manav Patidar

Omkar Nath Mishra

Amit Singh Chandel

Module - 4

CONTENT

CHAPTER

1

FORESTRY MENSURATION [INTRODUCTION]

The term mensuration has traditionally been defined as a branch of mathematics that deals with the measurement of lengths, areas, and volumes. In forestry, it encompasses determining the dimensions, form, weight, growth, volume, health, and age of trees, individually or collectively.

► **Definition :** Forest is the *branch of forestry that deals with the determination of dimensions (i.e., diameter, height, volume), form, age, and increment of a single tree, stand, or a whole forest, either standing or after felling*[***]

FOREST BIOMETRY

Forest + Bio (living thing) + Metry = Measurement

Forest **Biometrics** is the science of **forest** (Bio) **measurement** (metrics). It includes quantifying the biological and physical attributes of trees and their vegetation, insects, diseases, wildlife, topography, soils, and climate, both individually and collectively. These characteristics include all quantifiable attributes within forestry, both temporal, and spatial.

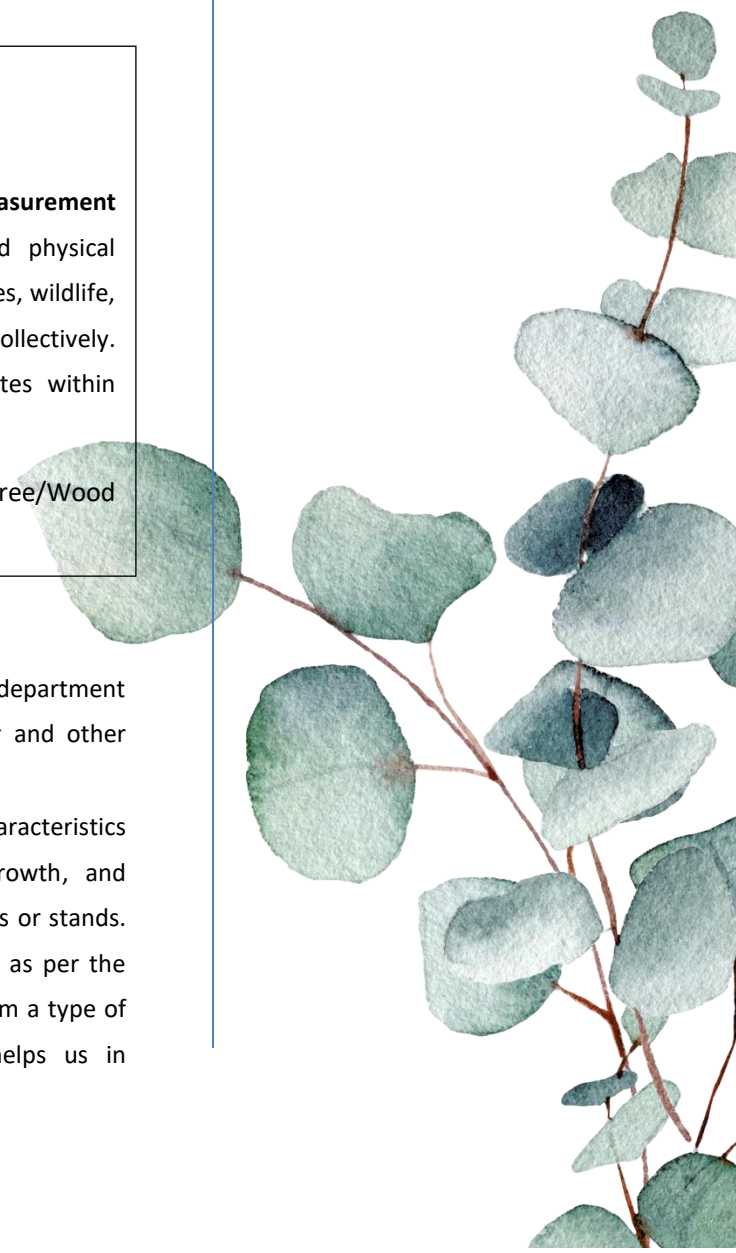
Similarly, Dendrometry : Dendron (Greek word) = tree/Wood
+ Metrum (Latin) = measure

► **OBJECTIVES**

- **The basis for sale** : Before any sale, the forest department estimates the quality and quantity of timber and other forest products and prices them accordingly.
- **For research** : (a) quantifying stand characteristics (volumes, weights, etc.), measuring past growth, and predicting the future growth of individual trees or stands. (b) To obtain a specific size or quality timber as per the requirement of our industries, after giving them a type of silvicultural treatment. Mensuration here helps us in

Chapter Outline

- Definition
- Objectives
- Scope
- Measuring units



CHAPTER 2

DIAMETER & GIRTH MEASUREMENT

2.1 OBJECTIVES BEHIND DIAMETER/GIRTH MEASUREMENT

- To estimate the quantity of timber, firewood, and other forest produce, *i.e.*, Cubic feet of wood in a teak tree.
- Measure the rate of tapering, its form, and the shape of logs that will help in determining timber quality (Volume of logs).
- To know the basal area of trees/crop
- It helps in making an inventory of growing stock as well as correlating height – Volume – Age –increment of a tree or crop.

2.2 CONCEPT OF DBH AND GBH

► **BREAST HEIGHT (BH)** is a universally accepted standard height above ground level for measurement of Girth, Diameter, and basal area of standing trees. If we take the diameter at that height, we call it *diameter at breast height* (DBH), and if we take the girth, it calls *girth at breast height* (GBH).

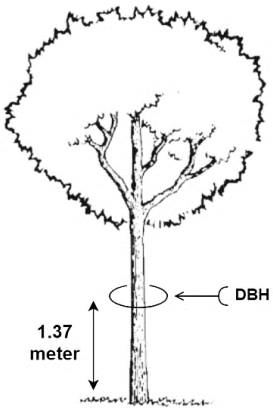
In India***, Burma, S. Africa, USA & other British colonies	In UK, Europe & FAO***
BH = 1.37 m (4 feet 6 Inches)	BH = 1.30 m (4 feet 3 Inch)***

It is important to note that the place of measurement of diameter/girth may vary depending on the conditions –

► **THE BREAST HEIGHT HAS BEEN ACCEPTED AS THE STANDARD FOR DIAMETER & GIRTH MEASUREMENT BECAUSE OF THE FOLLOWING REASONS**

- The bases of the trees are generally covered with grasses, shrubs, and thorns, so the measurement of

Chapter Outline



CHAPTER 6

WEIGHT & BIOMASS

6.1 WEIGHT

The weight of a standing tree cannot be measured directly, but it can be predicted by using many other variables like tree diameter-weight relationship, Volume and Density relationship, etc.

Importance

- Purchasing and selling of small wood, Paper and pulp industry
- Most of the minor forest produce and fuelwood trade on a weight basis, *i.e.*, Grasses, gams, resin marketing.

Advantages of Weight Scaling

- The method is fast, requires no special handling, and saves time for both buyer and seller.
- It encourages the delivery of freshly cut wood to the mill.
- Wood-yard inventories are more easily maintained because of greater uniformity in record keeping

Factors Affecting Weight

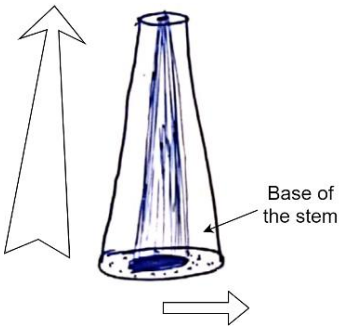
- **Density** : it is the mass of wood per unit volume. It decreases from the Base to the top and from the center to the outer surface of a log/stem.

  Note : *Specific gravity* or *Relative density* = $\frac{\text{Density of wood}}{\text{Density of water}}$

DENSITY OF CERTAIN IMPORTANT INDIAN TREE SPECIES

SN	Species	Specific gravity	Mass Per Unit volume
1.	*Abies pindrow*	0.37	
2.	*Cedrus deodara*	0.47	
3.	*Tectona grandis****	0.55	550 kg/m^3
4.	*Acacia nilotica****	0.67	670 kg/m^3
5.	*Dalbergia sissoo*	0.70	700 kg/m^3

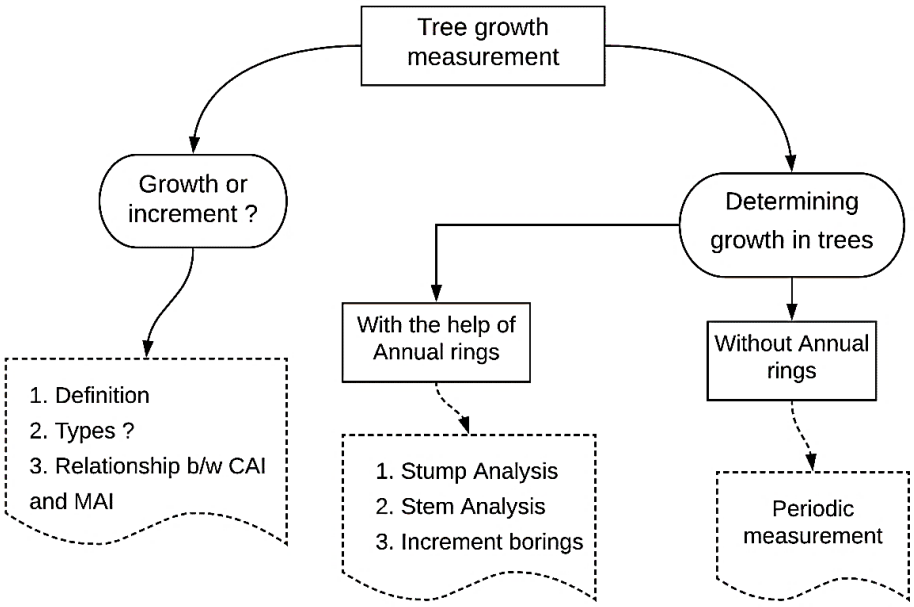
Chapter Outline



CHAPTER 8

TREE'S GROWTH DETERMINATION

Trees' growth means incrementing their size through elongation and thinking of roots, stems, and branches. So here we will study –



8.1 INCREMENT AND INCREMENT %

- **Increment** : means an increase in girth, diameter, basal area, height, and the volume of a tree during a given period of time.
- **Types** : Current annual increment (CAI), Mean annual increment (MAI), Periodic annual increment (PAI).
- **Increment percentage** : The average annual growth in diameter, basal area, or volume of a tree during a specific period of time expressed in % as it has at the beginning.

1. **Pressler's formula**[***]

   * Diameter increment % (P) = $\frac{200}{n} \times \frac{D-d}{D+d}$

   * Volume increment % (P) = $\frac{200}{n} \times \frac{V-v}{V+v}$

2. **Compound interest formula**[***]

   * Diameter increment % (P) = $100\left[\left(\frac{D}{d}\right)^{1/n} - 1\right]$

Where,

d = Initial diameter

D = end diameter

n = number of years

v = Initial volume

V = Volume after n year

n = number of years

CHAPTER 9

FOREST INVENTORY

Inventory is a commercial term, which means to display the quantity and value of articles in a store. [Synonyms in India = *Enumeration*.]

- **Definition** : A forest inventory is a systematic collection, evaluation, and presentation of specific information about forest area like size and shape of the area, quantity, and quality of growing stock, Species composition, etc.

- **Objective** : The issue of conservation and rational use of forest resources (both tangible and intangible) has become more important with the escalation of climate change. Now, our Forest Policy (Draft 2018) is Aiming toward more sustainable forest management and forest certification, with a target of 2.5 to 3 billion tonnes of carbon sequestration under the framework of JFM. However, we know that all these practices depend on the quantity and quality of information available in the forest.

  - Determine the volume and increment (MAI, CAI, and PAI) of timber growing in the forest area.
  - National and regional forest inventories for searching new possible raw materials, which form the basis for forest policy decisions and long-term planning of the forest industry.
  - Management inventories that are required for management decisions and more particularly, for the construction of working plans like preparing a map about the distribution and composition of growing stock, Age class, Basal area, Site index, etc.
  - Health and vitality of forest ecosystem : can be determined through selected ecological indicators. Those indicators are mainly observations of the presence or absence of affecting biotic or abiotic agents and environmental problems (or their symptoms) as well as an overall assessment of the condition of forests and trees.
  - Biological diversity of tree species and wild animals in that area.
  - Assess the Environmental and socioeconomic services provided by the forest.
  - Inventories to assess and estimate the impact of pollution on the growth of trees and forests.

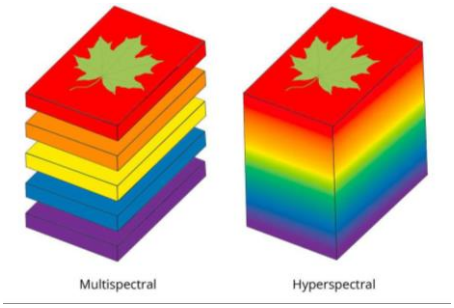
Figure : Forest inventory contribution toward SDG.

- **SCOPE OF ENUMERATION**

  - Data collection
  - Green budgeting or Zero carbon budgeting
  - Carbon trading
  - Sustainable Forest Management

► **Classification based on the number of bands**

- **Panchromatic remote sensing** : the collection of reflected, emitted, or backscattered energy from an object or area of interest in a *single band of the electromagnetic spectrum* (*i.e.*, 0.4 — 0.7 um).
- **Multi-spectral remote sensing** : To increase spectral discrimination, remote sensing systems are designed to record data in a few broad bands (typically 3-10) across the visible and near-infrared spectrum.
- **Hyperspectral remote sensing** : Captures hundreds of narrow, contiguous bands across a wider range of the spectrum, including parts invisible to the human eye like infrared and ultraviolet.



Parameter	Multispectral	Hyperspectral
Wavebands numbers	5 to 10 bands of the spectrum	Hundreds of bands of the spectrum
Spectral resolution detail	Poor spectral resolution	High spectral resolution
Band narrowness	Broader wavebands	Narrower wavebands
Processing methods	Process limited images	Use spectral and images

12.2 ADVANTAGE OF REMOTE SENSING

- Remote sensing provides a *synoptic view of a large area* of the earth's surface as a whole.
- It Provides a *3D view of terrains & objects* under study (by using a stereoscope).
- *Insect and disease attacks* on trees can be determined earlier by using Remote sensing.
- Very useful for collecting *data from remote & inaccessible areas* with a short duration of time & easier
- Require *less time and more accuracy* in data collection.

► **Challenges** : Design Modelling and sensors. Types of habitats bring more challenges in image processing, including meteorological, physical, and biological heterogeneity.

WHY THE USE OF MICROWAVE REMOTE SENSING IS NOW INCREASING IN FOREST BIOMASS ESTIMATION

- *Deep penetration capability* within tree canopy thus allowing more information on tree structure and under the canopy.
- As an active sensor, it *can capture data during day and night* without any adverse effects due to atmospheric distortions.
- Microwave data is *weather-independent*.
- Provides information on *surface moisture* content and dielectric.
- Imaging the earth's surface from different types of polarizations serves as a means for better feature extraction.

Of all the available Microwave bands, the **L-band** is widely used for forest biomass estimation due to their longer wavelengths and deep penetration from tree canopy and better interaction in the form of backscatter from branches and tree trunk

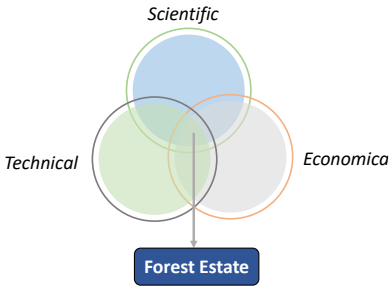
CHAPTER 1

FORESTRY MANAGEMENT
[INTRODUCTION]

The foundation of our policy shifted from a *production forestry* point of view to *protection forestry*. Even in the case of production forestry areas, we *started considering the impact of harvest practices on the local ecology and biodiversity, Wildlife, watershed, Tribal livelihood, and Carbon sequestration ability of forest*. These lay down the foundation for more smooth and sustainable regulation of forest resources with *strategic* and *Tactical harvest planning*.

1.1 DEFINITION

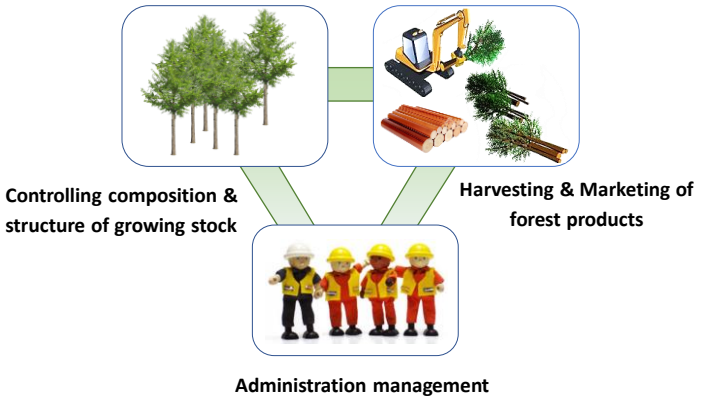
The *practical application* of the *scientific, technical,* and *economic principles* of forest estate for the achievement of *certain objectives*.



Forest Management is the application of *business methods* and *technical forestry* principles to the operation of a forest property.

1.2 SCOPE

Controlling the structure & composition of growing stock - through Site-selective tending operations, Choice of species, Regeneration methods, stand manipulation and Protection measures, etc.



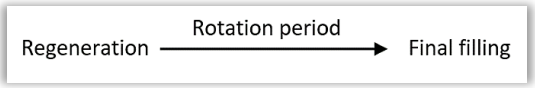
Chapter Outline

CHAPTER 4

ROTATION [PRODUCTION PERIOD]

4.1 ROTATION

A rotation or production period is the *time period* which a *forest crop* takes between its *formation* and *final felling*. Put simply, it is the period of time a crop of trees is allowed to grow.



The number of years fixed by the *working plan* between its regeneration and the final felling of a crop **[Brasnett]**.

The rotation or Production period is the interval of time between the formation of a young crop by seeding, planting, or other means and its final harvesting **[Osmaston]**.

Rotation age is the age of trees or crops at which when they are felled, objects of management, for the time being, are best served **[Knuchel]**.

Rotation is the period which elapses between the formation of wood and the time when it is finally cut over **[Jerram]**.

IMPORTANCE OF ROTATION

- Rotation length is an important tool for controlling tree size – the longer the rotation the larger a tree can grow.
- Rotation length influences timber yield, profitability, regeneration methods, and productivity of the Forest
- It facilitates better planning & organization of forest work
- Will increase transparency in the production system, as everyone knows when to cut, how to cut, and what amount of timber will be cut and supplied in the market.
- We can decide the rotation period as per our plantation's objectives, *i.e.*, Protection purpose or commercial purpose.

LIMITATIONS

Chapter Outline

CHAPTER 7

YIELD REGULATION

YIELD REGULATION : *Yield regulation is the determination of the yield and its expression in a management plan prescription, including where, when, and how the yield should be extracted*. It means fixing in advance, usually for the Working Plan period, the amount of timber and other produce that may be removed from the forest annually or periodically.

► **BASIS OF YIELD REGULATION** – (a) Area, (b) Volume, (c) Area and Volume, (d) Increment, and (e) Volume & Increment.

BASIS	YIELD REGULATION METHOD
A. Area only	A1 : Annual coup by gross area A2 : Annual coupe by reduced area.
B. Volume only (Growing stock volume)	B1 : Von Mantel's formula B2 : Howard's modification B3 : Simmon's modification B4 : Smythies' modification B5 : Burma modification
C. Area and Volume	C1 : Permanent Periodic blocks allotment method C2 : Revocable Periodic blocks allotment method C3 : Single Periodic blocks method C4 : Floating Periodic blocks methods C5 : Judeich's stand selection method (management method)
D. Increment	D1 : Increment method D2 : Swiss method D3 : Biolly's check method or Methode du Controle
E. Volume and increment of whole growing stock.	E1 : Formula method – (i) Austrian, (ii) Heyer's, (iii) Hundeshagen's, (iv) Karl's, and (v) Breymann's/ E2 : Hufnagl's method. E3 : French method and its modification – Melar's methods, Symthies modification, and Chaturvedi's modification. E4 : Hufnagal's diameter class method E5 : Brandis' diameter class method (or Indian method). E6 : Volume unit method. E7 : Symthies safe-guarding formula (or UP safe-guarding formula).

CHAPTER 1

FOREST ROADS & BRIDGES

Chapter outline

1.1 FOREST ROADS

Road is an open and wide way connecting one place to another and makes it easy to move vehicles and people. If these roads are constructed in or around the forest areas, they are called **Forest roads**.

TYPES OF ROADS

- Based on the time period, it will be used.

TEMPORARY	PERMANENT
	
Usable only for dry & winter Months	All weathered and motorable road

- Based on **LOCATION** : (a) inside the forest, and (b) peripheral road
- Based on **USE**
  - (i) **Main motorable road** : main road connected HQ to the forest block, important rest houses and forest depots. They are the metalled road with well-drained and are being used throughout the year.
  - (ii) **Branch (Feeder) Jeepable road** : these are the feeder road connecting interior forest areas with the main road. These are the usual earth roads, though in some cases, the surface may be improvised by spreading sand, gravel, or laterite stones.
  - (iii) **Bridle paths** : Prepared for a quick and direct route from place to place to transport the timber by animals.
  - (iv) **Inspection paths** : the narrow path of 06 to 1-meter width, usually constructed in and around each sub-compartment, make them assessable

CHAPTER 2

SURVEYING

[INTRODUCTION]

Chapter outline

2.1 INTRODUCTION

Surveying is the art of determining the relative positions of different objects on the earth's surface by measuring the *horizontal distances* between them and preparing a map to any suitable scale [In this branch, the measurements are taken only in the horizontal plane].

- **Leveling** is the art of determining the relative *vertical distances* of different points on the earth's surface. Therefore, the measurements are taken only in the vertical plane in leveling.

NEED, OBJECTIVES & SCOPE OF SURVEYING IN FORESTRY

Surveying and Map readings are important tools for protecting, managing, and administering a forest estate. A forester is often required to map out fire-burnt areas; demarcate and/or check forest boundaries; layout felling Coupes; prepare plantation maps and stock maps; detect and rectify encroachments and illicit possessions; prepare plans of areas to be cleared, or fenced or planted; align extraction roads and paths and for a variety of other purposes connected with his duties.

- To prepare a *topographic map* of a forest area that shows the hills, valleys, rivers, and forest villages of a forest area.
- To prepare a *cadastral map* showing the boundaries of the compartment, blocks, etc.
- To prepare plantation, stock, and management maps
- Determining the direction and distance Between different offices, plantation sites, and available water sources like rivers, streams, etc.
- Construction of forest roads and bridges
- To map out fire burnt areas
- To detect encroachments on the forest land, forest resources allocation, etc.

CHAPTER 6

PLANE TABLE SURVEY

Chapter outline

6.1 INTRODUCTION

Plane table surveying is a graphical method of survey in which the field observations and plotting are done simultaneously. A plane table survey does not involve the use of a field book. It is mainly suitable for filling interior details when traversing is done by theodolite.

6.2 PRINCIPLE

parallelism, meaning that the rays drawn stations to objects on the paper are parallel to the lines from the stations' objects on the ground. The relative positions of the objects on the ground are represented by their plotted positions on the paper.

6.3 ACCESSORIES OF A PLANE TABLE

- **Plane table** : a well-seasoned drawing table of wood 75 cm by 60 cm in size. The top surface of the table is well leveled
- **Alidade** : a metallic ruler with a sight vane
  - **Plane Alidade** : consists of a metal or wooden ruler of length of about 50 cm
  - **Telescopic Alidade**: consists of a telescope meant for inclined sight or sighting distant objects clearly.
- A **spirit level** : a small metal tube containing a small bubble of spirit. The bubble is visible on the top along a graduated glass tube. Uses - to levelled plane table every time
- **Trough compass** : to fix the direction of a table
- **Circular Box Compass** : It carries a pivoted magnetic needle at the center. The circular box is fitted on a square base plate.
- **U Fork** with **plumb bob** : for cantering plane table at a targeted point. Uses - to centering the table over a station.

CHAPTER 8

LEVELING TOOLS

Chapter outline

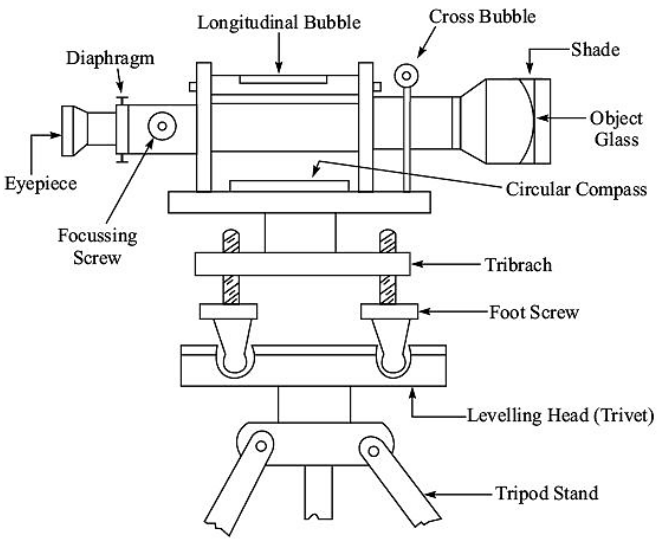
8.1 CEYLON GHAT TRACER

Ceylon Ghat Tracer is a very useful instrument for setting out gradients. It essentially consists of a long circular tube having a peephole at one end and cross-wires at other ends.

IMPORTANCE

- To measure the slope
- Contouring (Set out gradient)

8.2 DUMPY LEVEL



Note : Commonly used instrument – **Dumpy level**

CHAPTER 1

CLEAR FELLING SYSTEM

Silviculture is the art and science of cultivating forest crops. It deals, in a general way, with the natural laws of growth and development of trees and forests, the effect of environment on them, techniques of regenerating them naturally or artificially and the methods of tending them. Since the techniques of regenerating forest crops vary with types and sub-types of forests, and physical conditions in which they exist, it becomes necessary to identify different methods or techniques for different sub-types in different localities. These methods or techniques are called Silvicultural Systems.

- **SILVICULTURAL SYSTEM** : *a method of the silvicultural procedure worked out in accordance with accepted sets of silvicultural principles, by which crops constituting forests are tended, harvested and replaced by new crops of distinctive forms*.

  OR

  it is a planned silvicultural treatment which is applied to a forest crop, throughout its life, so that it assumes a distinctive form. It begins with regeneration fellings, tending the crop to its final felling.

1.1 CLASSIFICATION

In India, silvicultural Systems have been classified primarily based on the mode of regeneration and then the felling pattern.

A. **HIGH FOREST SYSTEMS** : All those silvicultural systems in which the *regeneration is usually of seedling origin, either natural or artificial* (or a combination of both). So, rotation is generally long. These are further classified based on *the pattern of felling,* which in turn, affects the *concentration or diffusion of regeneration* and characteristics of the new crop [Figure 1.1].

B. **COPPICE SYSTEMS** : All those silvicultural systems in which the crop originates from coppice growth, so usually crop rotation is shorter than the high forest system. Based on the pattern of felling, it is further divided into - The Simple Coppice System, The Shelterwood Coppice System, The Coppice Selection System, The Coppice-with-Standards System, The Coppice-with-Reserves System and The Pollard System [Figure 1.1].

1.2 NEEDS OF SUCH CLASSIFICATION ?

- **Systematization of knowledge and precaution against wrong use** : It helps foresters to understand the essence of each system and the conditions in which it is applicable. In the absence of such knowledge, there is a great possibility of applying a particular silvicultural system in conditions in which it may not be appropriate, resulting in failure. For example, the coppice system can be applied only to species that are strong coppices.

CHAPTER

5

COPPICE SYSTEM

Instead of getting regeneration by seed, here we used coppicing power of tree stools to regenerate the area again.

► **TYPES : ON THE BASIS OF PATTERN OF FELLING**

- The Simple Coppice System***
- The Shelterwood Coppice System
- The Coppice Selection System
- The Coppice-with-Standards System***
- The Coppice-with-Reserves System***
- The Pollard System***

5.1 | SIMPLE COPPICE SYSTEM

► **Definition** : a silvicultural system based on stool coppice, in which the old crop is clear-felled completely, and the new crop grows naturally through stool coppice.

► **Pattern and method of felling** : As already stated, the clear-felling Annual coupe.

► **Mode of regeneration** : stool coppice, sometimes if necessary, maybe supplemented by artificial plantation

► **Tending operation** : climber cutting, Singling (if the aim to produce logs), etc.

► **Characters of the crop** : Even-aged

► **Advantages**

- A very simple system in the application and does not require a high level of skill as required in shelterwood systems.
- Regeneration is more certain.
- As coppice shoots grow faster in the beginning. So, the cost of weeding, cleanings, and protection is much less than the high forest.
- The coppice growth rate is faster = higher mean annual increment than that we obtained under a high forest system. Although the wood produced is small-sized and comparatively of inferior quality.
- The net return on investment is relatively higher primarily due to shorter rotation and lesser amount invested.

► **DIS-ADVANTAGES**

CHAPTER 1

FOREST COVER MONITORING

Chapter Outline

SYLLABUS

Forest cover monitoring. Approaches *viz.*, (i) site-specific planning, (ii) strategic planning, (iii) Approval, sanction, and expenditure. (iv) Monitoring (v) Reporting and governance.

1.1 INTRODUCTION

Forest Cover : All lands more than 1 hectare in an area with tree canopy density of 10 % or more, irrespective of land ownership, use, and legal status.

Forest Cover Monitoring : it is the process to check or record forest cover regularly by using modern tools to understand the scenario and effects of various causes over forest cover.

Remote Sensing : This is the technique of acquiring information about some property of an object with the help of recording devices such as a camera, laser, radiofrequency receiver, radar system, etc., without any physical contact with them.

METHODS OF FOREST COVER MONITORING

► **Traditional Methods** : Collecting and assessing data manually. The use of airborne remote sensing, including balloons and Dakota aircraft, has been limited. We relied on this method until 1981 when FSI began developing and using space-based remote sensing.

Issues with this ?

- Less effective, time-consuming, and too expensive.
- The majority of aerial remote sensing data is recorded in the black and white spectrum. Because of this, it is virtually impossible to identify invasive species, detect stress on the forest ecosystem, and trees species these days.

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Durgesh Jee Pandey

Sourabhn Kumar Chourasiya

Anita Surwayamshi

Rohit Sharma

Pooja Baghel

Ravikant SIrvaiya

Pushparaj Singh Sikarwar

Shubham Kulhade

Ashish Singh Sikarwar

Anupam Mishra

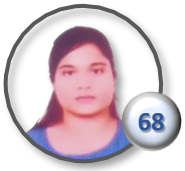
Amar Singh Bhadoriya

Somesh Sharma

Keshav Meena

Sunil Singh Jadon

Atul Kumar Patel



Meenakshi Suryawanshi

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61 Out of **90** **Selections in MPPSC Forest Ranger (RFO) 2020**

Gwalior

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