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FORESTRY

TOOL KIT SERIES

APSC

ASSAM PSC

STATE FOREST SERVICE

2025

Detailed Syllabus Based study material + **Linkage of Concepts with PYQs** + **Infused with Infographics & Maps**

Module - 2

- Wood Science & Technology
- NTFPs
- Ethnobotany
- Forest Mensuration
- Remote sensing
- GIS/GPS
- Forest management
- Rotation, Growing stocks
- Working Plan
- JFM

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Assam PSC

FORESTRY

FOREST RANGER / SOIL SONSERVATION RANGER

EDITION : 2026

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Module - 2

CONTENTS

Module 2

Previous Year Questions

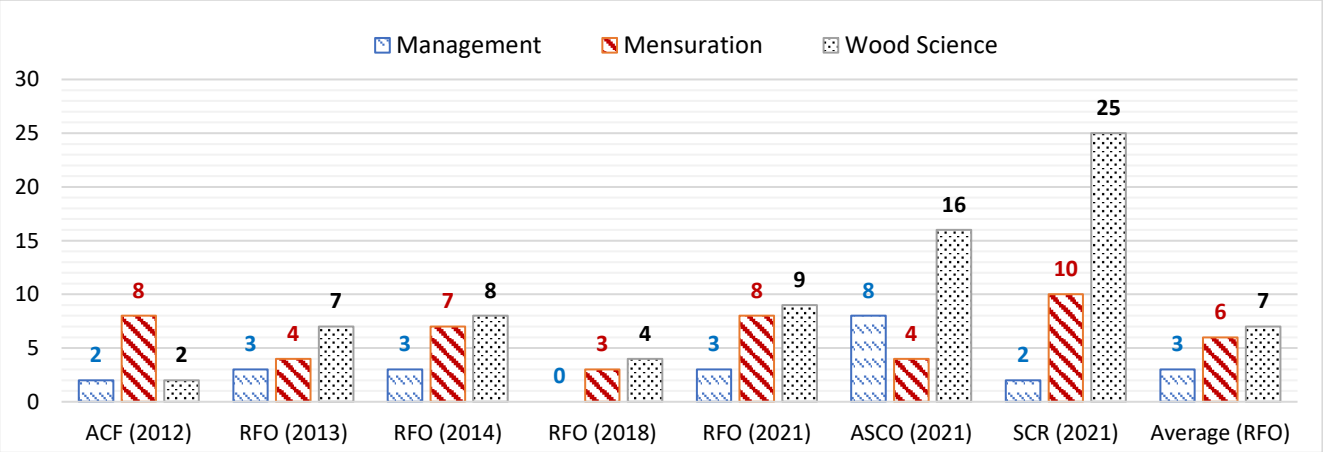
SYLLABUS

- ◈ **Forest Management** : ◈ ***Objective***, ***Principles***, and techniques; ◈ Concept of ***Sustained Yield*** (its principle, scope, and limitation); ◈ ***Rotation***, its types, and steps for reducing rotation age; ◈ ***Normal Forest***; ◈ ***Growing Stock***; ◈ ***Stand Structure*** and dynamics; ◈ Forest cover monitoring. ***Joint Forest Management (JFM)*** : ◈ Formation of Village Forest Committees, Joint Forest Participatory Management. ***Forest Working Plan*** : ◈ ***Forest Planning***, ***Evaluation***, and monitoring tools and approaches for integrated planning; ◈ Multipurpose development of forest resources and forest industries development; ◈ ***Working Plans*** and ***Working Schemes***, their role in nature conservation, bio-diversity, and other dimensions; ◈ ***Preparation*** and control. Divisional Working Plans, Annual Plan of operations.
- ◈ **Forest Mensuration** : ◈ Methods of measuring – diameter, girth, height and volume of trees; ◈ Form-factor; ◈ volume estimation of stand, current annual increment; mean annual increment, ◈ Sampling methods, and sample plots. ◈ Yield calculation; yield and stand tables. ***Remote Sensing*** : ◈ Forest cover monitoring through remote sensing, ◈ Geographic Information Systems for management and modelling.
- ◈ **Forest Resources and Utilization** : Environmentally sound forest harvesting practices; logging and extraction techniques and principles, transportation systems, storage and sale. Anatomical structure of wood, defects and abnormalities of wood, timber identification general principles. Need and importance of ***wood seasoning and preservation***; general principles of seasoning, air and kiln seasoning, solar dehumidification, steam heated and electrical kilns. ***Composite wood*** – adhesives - manufacture, properties, uses, plywood manufacture-properties, uses, fibre boards-manufacture properties, uses; particle boards manufacture; properties, uses. Present status of composite wood industry in India and future expansion plans. ***Non-Timber Forest Products*** (NTFPs) – definition and scope; gums, resins, oleoresins, fibres, oil seeds nuts, rubber, canes, bamboos, medicinal plants, charcoal, lac and shellac, Katha and Bidi leaves, collection; processing and disposal. ***Pulp paper*** and ***Rayon***.

Degree level + PYQ Based

(In short)

PYQs Analysis



Forest Management

1. _____ is defined as the practical application of the scientific, technical and economic principles of forestry [Assam PSC (RFO) 2014]
   (a) Forest Economics
   (b) Forest management
   (c) Forest utilization
   (d) All the above

2. Forests are divided into compartments and blocks for proper management and working. Which of the following statements is correct? [Assam PSC (RFO) 2013]
   (a) Compartments are divided out of blocks with boundary pillars in a forest
   (b) Blocks are the largest units in a forest with well-defined boundaries,
   (c) Sub-compartments are the smallest units in a forest
   (d) Both (B) and (C)

3. Who is the head of forest division? [Assam PSC Ass. Soil Conservation Officer (ASCO) 2021]
   (a) Ranger
   (b) DFO
   (c) CF
   (d) WPO

4. Which is the ***Smallest Functional Territorial Unit*** of administration of forest administration / department? [Assam PSC (RFO) 2021]
   (a) Beat
   (b) Range
   (c) Circle
   (d) Block

5. Annual felling areas are otherwise called as [Assam PSC Ass. Soil Conservation Officer (ASCO) 2021]
   (a) Working circle
   (b) Working area
   (c) Beat
   (d) Coupe

6. ***Rotation*** means [Assam PSC (ACF) 2012]
   (a) Life span of a tree
   (b) Age of a tree till death
   (c) Exploitation of age of a tree
   (d) None of the above

7. The planned number of years between the formation or regeneration of a crop and its final felling is known as [Assam PSC Ass. Soil Conservation Officer (ASCO) 2021]
   (a) Rotation
   (b) Runderal
   (c) Regolith
   (d) Regeneration area

8. _____ ***Rotation*** is adopted in industrial plantation for supply of raw material [Assam PSC Soil Conservation Ranger (SCR) 2021]
   (a) Physical
   (b) Silvicultural
   (c) Technical
   (d) Financial

9. The total increment up to the given age divided by that age is called [Assam PSC Ass. Soil Conservation Officer (ASCO) 2021]
   (a) MAI
   (b) CAI
   (c) PAI
   (d) All of the above

Working Plan

10. Does ***Working Plan*** deal only with future plan for scientific exploitation of mature trees in a forest area? [Assam PSC (ACF) 2012]
    (a) Yes
    (b) No
    (c) Not at all
    (d) Partly yes.

11. As per the ***National Working Plan Code*** [Assam PSC (RFO) 2013]
    (a) The working plan is approved by the ministry of MOEF
    (b) The working plan is written for a larger area
    (c) The working plan is written for a smaller area
    (d) All of the above

12. ***National Working Plan Code*** is to be followed by all the States and the Union Territories. The Code is applicable for [Assam PSC (RFO) 2013]
    (a) Reserved forests
    (b) Proposed reserve forests
    (c) Private forests
    (d) All categories of forests

13. ***Working Plan*** is a document to [Assam PSC (RFO) 2014]
    (a) Manage the forests
    (b) Classify the forests
    (c) Give age of forest crop
    (d) None of the above

14. In forest, the standard color given for the regeneration status excellent (80-100%) is [Assam PSC Ass. Soil Conservation Officer (ASCO) 2021]
    (a) Green
    (b) Red
    (c) Black
    (d) Yellow

15. The smallest unit of ***Working Plan*** is [Assam PSC Ass. Soil Conservation Officer (ASCO) 2021]
    (a) Block
    (b) Working circle
    (c) Felling series
    (d) Compartment

16. Which of the following is the main aim of ***Working Plan***? [Assam PSC Ass. Soil Conservation Officer (ASCO) 2021]
    (a) Sustained yield
    (b) Progressive yield
    (c) Regular yield
    (d) All of the above

17. A ***Written Scheme of Management*** aiming at continuity of policy, controlling the treatment of a forest is called [Assam PSC (RFO) 2021]
    (a) Forest Act
    (b) Forest Policy
    (c) Working Plan
    (d) Working Circle

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18. The smallest permanent ***Working Plan Unit*** of management is [Assam PSC (RFO) 2021]
(a) Block
(b) Compartment
(c) annual coupe
(d) periodic block

Joint Forest Management (JFM)

19. ***JFM*** stands for [Assam PSC (RFO) 2014]
(a) Joint forest management
(b) Join fire management
(c) Joint forestry management
(d) Joint fodder management

20. ***Joint Forest Management*** was first implemented at [Assam PSC Ass. Soil Conservation Officer (ASCO) 2021]
(a) Jabalpur
(b) Ayyalur
(c) Arabari
(d) Jhansi

21. ***Joint Forest Management*** (JFM) was started in [Assam PSC Soil Conservation Ranger (SCR) 2021]
(a) West Bengal
(b) Tripura
(c) Himachal Pradesh
(d) Mizoram

Forest Mensuration

22. How is the age of a tree estimated? [Assam PSC (ACF) 2012]
(a) Height
(b) Diameter
(c) Girth
(d) Annual ring

23. Abney's level is used for [Assam PSC (ACF) 2012]
(a) Yield calculation
(b) Girth measurement
(c) Height measurement
(d) Diameter measurement

24. Quarter girth formula is used for [Assam PSC (ACF) 2012]
(a) Volume Calculation
(b) Girth Measurement
(c) Height Measurement
(d) Diameter measurement

25. DBH of a tree is measured at the height of [Assam PSC (ACF) 2012]
(a) 1.31 m
(b) 1.37 m
(c) 1.47 m
(d) 1.57 m

26. Mensuration deals with the [Assam PSC (ACF) 2012]
(a) Calculation of volume
(b) Length/girth
(c) Height
(d) All of the above

27. Is yield table a table where only growth data of tree species is available? [Assam PSC (ACF) 2012]
(a) Yes
(b) No
(c) Not at all
(d) Partly yes

28. We can measure the volume of a piece of log by applying [Assam PSC (RFO) 2013]
(a) Avogadro's number
(b) Quarter girth formula
(c) Yield table
(d) None of the above

29. Breast Height (BH) is a standard height universally accepted for measurement of girth, diameter and basal area of a standard tree. The accepted Breast Height (BH) in India is [Assam PSC (RFO) 2013]
(a) 1.3 m
(b) 1.5 m
(c) 1.37 m
(d) 1.32 m

30. The growth of trees with annual rings can be determined by: the following methods. Which of the following statement is correct? [Assam PSC (RFO) 2013]
(a) Stump analysis gives only diameter increment and height
(b) Stem analysis is used, to determine diameter, height and volume increment
(c) Increment borings give diameter increment and volume increment
(d) All of the above

31. Stump analysis is done by [Assam PSC (RFO) 2013]
(a) Counting annual rings:
(b) Measuring dbh
(c) Measuring seedling height
(d) None of the above

32. The diameter of a standing tree is measured at B.H. the accepted B.H. is [Assam PSC (RFO) 2014]
(a) 1.3 m
(b) 1.32 m
(c) 1.33 m
(d) 1.37 m

33. Qurter girth formula is used to calculate [Assam PSC (RFO) 2014]
(a) Volume of a standing tree
(b) Volume of a piece of wood
(c) Volume of a log
(d) None of the above

34. One can measure the height of a tree by using the [Assam PSC (RFO) 2014]
(a) Albney's level
(b) Theodolite
(c) Telescope
(d) Barometer

35. Quarter girth formula is used for [Assam PSC (RFO) 2014]
(a) Measuring the volume of a log
(b) Measuring the density of wood
(c) Measuring the basal are of tree
(d) All of the above

36. Age of a tree can be calculated by [Assam PSC (RFO) 2014]
(a) Measuring the girth at breast height
(b) Measuring the height of the tree
(c) Counting the number of rings
(d) Counting the number of branches

37. Stem analysis is done is assess [Assam PSC (RFO) 2014]
(a) Diseases of tree crop
(b) Quality of bark tree
(c) Quality of wood
(d) Quality of leaves

CHAPTER 1

WOOD SCIENCE & TECHNOLOGY

INTRODUCTION

Forest utilization refers to the process of ***harvesting***, ***conversion***, ***transportation***, *and* ***disposal of forest produce***. *It also includes the marketing and manufacturing of various commodities derived from forests*[***] The systematic utilization of wood is central to forestry, as it ensures that forest resources are converted into usable forms while minimizing wastage and environmental damage.

Historically, the utilization of timber has evolved in response to changing demands, technological advances, and conservation policies.

1.2 HISTORICAL BACKGROUND

Upto 1860s

During this period, forest clearing was common, and timber extraction was largely unorganized. Merchants paid only a nominal fee for cutting, and extraction was confined to valuable species such as Teak (*Tectona grandis*), Sal (*Shorea robusta*), Sandalwood (*Santalum album*), and Rosewood (*Dalbergia latifolia*).

- Tools : Simple axes were the primary implements, leading to **high timber wastage**.
- Purpose : Timber was mainly used for **fuel and construction**.

From 1860s to 2nd World War

With the *establishment of forest departments* in various princely states and provinces, forest management gradually became systematic. During this period, the *demand for timber increased significantly, particularly due to the rapid expansion of the railways where large quantities of sleepers were required, as well as for domestic construction purposes*. At the same time, technological advancements in forest engineering made it possible to carry out logging operations in areas that had earlier remained inaccessible.

The *introduction of modern tools* and *improved methods enhanced efficiency in timber extraction*. This trend was further accelerated during the two World Wars, when the demand and price of timber rose sharply. As timber became more expensive, industries and policymakers began exploring the use of *alternative raw materials to reduce production costs* and ensure a steady supply for industrial applications.

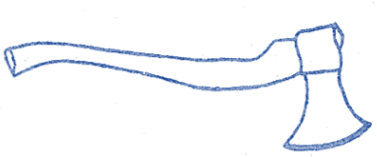
Post Independence Period

After independence, India faced an acute shortage of timber due to rising demand and limited supply. The escalating prices of wood made it necessary for the Government of India to emphasize efficiency in harvesting and conversion, with a strong focus on reducing wastage. On the recommendations of **Dr. A. Huber** and **Mr. A. Koroleff**, a specialized **Logging Branch** was established at the ***Forest Research Institute*** (FRI), Dehradun in 1957 to promote research and training in modern logging practices. Soon after, in **1958–59**, a **Logging Training Centre** was set up at **Batote** in Jammu and Kashmir under the guidance of **H.G. Winkelmann**, aimed at imparting practical skills to foresters in advanced tools and mechanized logging operations.

1.3 IMPLEMENTS USED IN FELLING & CONVERSION

The process of felling and conversion of timber relies on a wide range of tools and implements, each designed for specific functions.

- ***Axes*** : It consists of two parts - A ***metal head*** and a ***wooden handle***.
  - Head : 2.5 to 3 kg weight metallic body with an eye or hole in it and *25 to 30 cm long**** *Curved* Cutting edge. Curved edge helps prevent the *shooting of splinters**** during cutting
  - Wooden handle : *India = Round* (Advantages – Easily replaced on the spot, Disadvantage – liable to slide around the eye); *Europe + America = Oval shape*.
    - Length = 70 to 120 cm (*Standard length = 90 cm*)
  - Uses : *Felling***, Trimming, *Splitting*** and *Grubbing of timber***



- ***Bill hook*** : often used for *felling bamboo***, *Small poles***, Clearing and chopping of brush growth underneath.

- ***Cant-Hook*** : work as a *lever**** for *rolling, stopping, and turning logs****
- ***Saws*** : Most usual implements for felling and conversion.

  Types of Saw – (a) Crosscut Saw, (b) *Bow saw*** or *one man saw***, (c) Pruning saw, (d) Band saw (Power saw, having *Endless blade***), (e) Jigsaw (Scroll saw).

Cross-cut saw

Power saw

Band saw

CHAPTER 2

TIMBER TRANSPORTATION & STORAGE

2.1 TIMBER TRANSPORTATION

► TYPES

Based on the Distance of transportation

- *Minor* or *Off -road* transport : for a short distance
- *Major* transportation : for long-distance

Medium of transportation

- *Land* transport, *i.e.,* by road
- *Water* transport, *i.e.,* by river, canals or coastal routes
- *Overhead* transportation, *i.e.,* By ropeway, chopper

► CHOICE OF METHODS OF TRANSPORTATION

- Cost of transportation and labour requirements
- Damages or losses to the products during this
- Volume of timber available in Local area + Size of Market & Sawmill
- Topography + Available transportation facilities, *i.e.,* Land, Water, Air

TRANSPORTATION by **LAND**

- Human-powered transport is generally used in hilly or difficult terrain for small to medium-sized timber over short distances. Although this method is costlier due to high labour input, it causes the least damage to the wood as well as to the forest floor.
- Animal-assisted : Mules, Elephants, Camels, etc.
- Bullock carts
- Dragging
- Rolling
- Sliding
- Motorized methods : Trucks and Trackers

TRANSPORTATION by **WATER**

The oldest and cheapest mode of transportation, particularly in the *Forest* area. Widely practiced in the Himalayan region, Peninsular India, Eastern & Western Ghats.

Types : (1) Floating, (2) Rafting and Boom, and (3) Wet slide

CHAPTER 3

TIMBER DEFECTS

Defects in timber can occur naturally or as a result of various environmental and processing factors. These defects can affect the strength, appearance, and overall quality of the wood.

DEFECTS DUE TO INSECT ATTACKS

- ***Borer Holes*** : Caused by wood-boring insects, marine borer, Birds, etc.

DEFECTS DUE TO FUNGAL ATTACKS

- ***Rot or decay*** : when fungi feed both soft and heartwood, *i.e.*, White rot, Brown rot, red rot, etc.

The fungi group that digests/Attacks on	Type of rot
Cellulose, but not lignin	Brown rot
Both Cellulose and lignin (All components of cell wall)	White rot
Cellulose in the secondary cell wall makes it brittle	Soft rot

Note **:** *Dry rot* – Decomposition of *felled timber* caused by the action of *various fungi* (Lack of proper ventilation). *Wet rot* – Decay of timber caused by *alternate wetting and drying* [RPSC AE 2013; Nagaland PSC CTSE 2017].

- ***Stain*** : When fungi attack and feed sapwood portion only, where food material is stored, it causes stains (markings). This activity only affects the sapwood, leaving the heartwood unaffected. As a result, the strength of the wood remains unchanged; however, the colour will be changed.

Soft – rot

Wood Stain

DEFECTS DUE TO NATURAL DEFECTS (GENETIC)

- ***Fluted stem*** : Common example – *Teak****
- ***Tapering*** :
- ***Pith***** : The presence of a large or eccentric pith is considered a defect in timber, as it weakens the structure and reduces strength.

CHAPTER 4

WOOD PROPERTIES

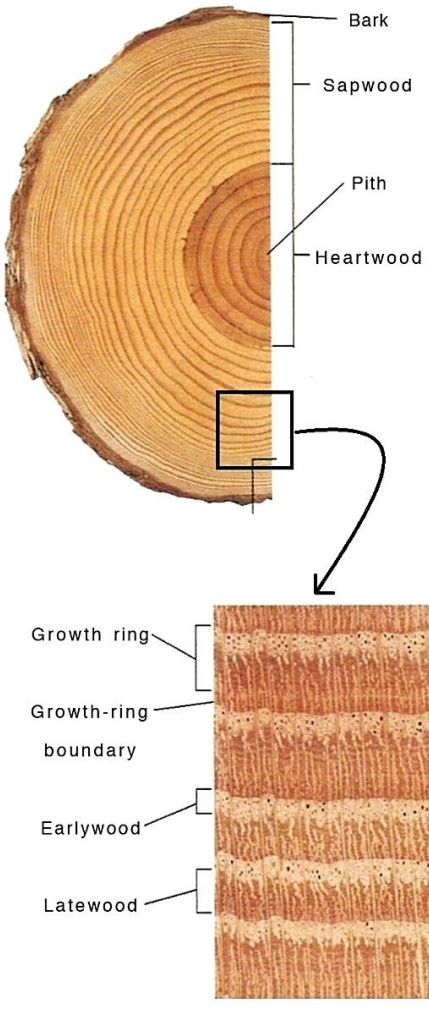
WOOD PROPERTIES

Gross structural	*Minute structural*	*Gross physical*	*Mechanical*	*Chemical properties*

GROSS STRUCTURAL

Gross structural means what we can easily identify when we see a timber (log) through the naked eyes

- Bark
- Pith
- Sapwood & heartwood
- Growth rings or Annual rings
- Spring and Autumn wood
- Grains & Textures



- ***Bark*** : the *outermost part* of the timber. The outer part is usually dead and has diagnostic value (Species identification).
- ***Pith*** : The pith is a *small*, *soft* *central tissue**** that *plays a role in storage during early growth* but loses functional value in mature wood.
- ***Sapwood*** & ***Heartwood*** : *Sapwood (Alburnum)* is the *Lighter, younger outer portion* of a tree trunk. Composed mostly of living cells and, as its name implies, is for the conduction of sap (liquids), and storing food.

  Heartwood (Duramen) is the *central dark part* of the wood that has become heavier and darker due to the deposition of gum, resin, oil, and chemicals.

Sapwood (Alburnum)	*Heartwood (Duramen)*
It forms the outer wood part	It forms the central wood part
It is light–coloured	It is dark–coloured
Lighter in weight	Heavier /Denser
It contains living cells	Dead cells

CHAPTER

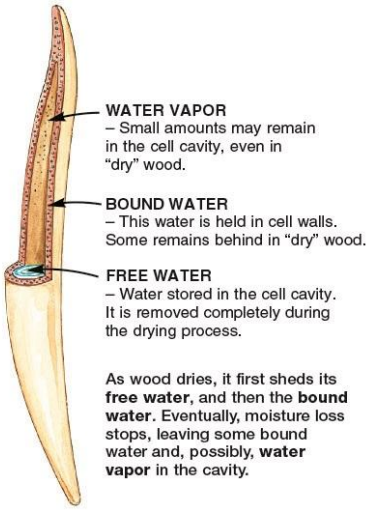
5

WOOD SEASONING

Seasoning refers to the process of *removing excess moisture*[***] that is presented in timber in its green state. Green timber typically contains moisture content ranging from *50 to 200%.* In well-seasoned timber, *10 to 12 % (as per ISI code)*. [For doors and windows, the recommended moisture content for wood is between *10 – 20%.*]

► HOW WATER IS HELD IN WOOD

- ***Free water***[***] : held by capillary action inside the free space in the cells and fibres
- ***Bound water*** : Absorbed by the chemical substance of cell walls.
- ***Water vapours***



► DETERMINATION OF MOISTURE CONTENT IN WOOD

$$\text{Moisture Content} = \frac{wet\ weight - oven\ dry\ weight}{oven\ dry\ weight} \times 100$$

► OBJECTS OF SEASONING *(Advantages)*

- To reduce the risk of fungal and insect attacks
- To reduce weight = ↓ transportation cost
- To avoid seasoning defects like shakes, splits, and cracks = *More dimensional stability*[***]
- To secure proper penetration of preservatives.
- To make timber fit to receive **painting** and **polishing**.
- Controlling the drying rate and regulating it within limits so that the wood seasons with the least possible damage.

► FACTORS AFFECTING THE SEASONING PROCESS

- Temperature, Humidity, and Air Circulation
- Nature of woods and its staking pattern
- Adopted Seasoning methods
- Market/Industrial requirements & Size
- Availability of required infrastructure

Fibre Saturation Point (FSP ~ 30%).
Shrinkage starts **below FSP**; above it only frees water is lost.

5.2 SEASONING DEFECTS

➢ ***Shrinking & Swelling*** : Occur as the wood changes its moisture content in response to both daily and seasonal fluctuations in the relative humidity of the atmosphere, *i.e.,* when the air is humid, wood absorbs moisture and swells; when the air is dry, wood loses moisture and shrinks.

CHAPTER

8

NON-TIMBER FOREST PRODUCES (NTFP)

► **TIMBER** : Major timber species are Teak, Sal, *Albizia lebbeck, Adina cordifolia, Cedrus deodara, Dalbergia latifolia, Dalbergia sissoo, Gmelina arborea, Hardwickia binata*.....and many more.

► **INDUSTRIAL WOOD**

- Pulp and paper : Bamboos, Eucalyptus, Casuarina
- Plywood : Teak, Rosewood, Terminalia
- Packing cases : Dinus spp., Silver oak, Fir,
- Matchwood : Ailanthus, Simaruba, Bombax
- Toys : Adina, Redsanders, rose wood

Non-Timber Forest Product (NTFP)*** covers all forest products "***other than Major Forest Products***" which consist of timber, small wood, and fuelwood. It specifically includes grass, fruit, leaves, bark, animal, and mineral products found in the forest and collected therefrom.

The minor forest products of commercial importance may be divided into the following classes.

- Fibers and Flosses
- Grasses, Bamboos, and Canes
- Distillation and Extraction Products, including Grass Oils.
- Oil Seeds
- Tans and Dyes
- Gums, Resins, and oleo-Resins
- Animal, Mineral, and Miscellaneous Products.
- Drugs, Spices, Edible Products, and Poisons.

8.1 FIBERS

Fibres are ***Sclerenchyma Cells****** (elongated cells with thick walls) that are components of both the xylem and phloem. If its source is phloem (*Bast tissue*), then it is known as ***Soft Fibre*** and if the source is the surface of the stem or leaf which is known as ***Hard Fibre*** (Surface fibre). Method of fibre extracting from one another = ***Retting******

FIBRES FROM STEMS (Means, from Bast Tissue)

- *Sterculia villosa* (udal) - Yields a course, strong, whitish-pink fibre.
- *Hardwickia binata* (Anjan)**** - Fibre obtained from young shoots (branches), which are red in colour and used in rope making.

- *Bauhinia vahlii* : A gigantic size climber.
- *Acacia leucophloea* (Hiwar)*** : from its ***bark*** - which is used for fishing nets
- *Crotalaria juncea* (*Sunn Hemp*) : Substitute for true hemp
- *Colotropis gigantea**** (Asclepiadaceae) : fibres from its bark are mainly used for ropes and stuffing, tensile strength lower than cotton (not higher).
- *Boehmeria nivea**** : *Rhea* or *Ramie Fiber****
- *Cannabis sativa****
- *Grewia optiva*** : A medium-sized Himalayan shrub, the bark of which is extracted to obtain strong white fibre, is utilized in rope making.

Coir** = *Cocos nucifera* (Coconut) = from ***Mesocarp***

FIBERS FROM LEAVES

- *Caryota urens*** (Indian *S*ago-palm) : yields *Kittul Fibre*** + used by fishermen in preparing their nets and fishing lines.
- *Musa textilis* *:* indigenous in the Philippines but cultivated in India. Fibres are known as *Manilla Hemp* (Addon : *Musa Paradisiaca*)
- *Pandanus tectorius* : a common shrub in the tidal forests of Sunder bans, Andaman's + W. coast
- *Agave Americana**** + *A. Sisalana* : obtained fiber is known as *Sisal Fibers****

FIBERS FROM ROOTS

- *Butea monosperma* (Palas) : From *Young roots**** + Bark
- *Pandanus odoratissimus* : The roots of the plant are fibrous and are used by *basket makers* for binding purposes, *Paint brushes* and toothbrushes.

8.2 FLOSSES

- ***Ceiba pentandra*** (kapok) : The floss from this tree is known as silk cotton or kapok + used extensively for stuffing purposes. Found in the Western Ghats and South India.
- ***Bombax ceiba*** (semul) : The floss from this tree is known as ***Indian kapok****
- ***Cochlospermum religiosum*** : tree, known as *yellow silk cotton**** tree. Used as a substitute for Indian or Java kapok for stuffing mattresses, pillows, cushions, and for life-saving belts.
- ***Calotropis procera*** : *Akund**** floss
- ***Salix daphnoides*** and ***Populus ciliata***.

8.3 IMPORTANT GRASSES

- *Eulaliopsis binata* (Bhabhar / Baib grass) : Sub Himalayan region. Uses : *Paper & ropes making****
- *Saccharum munja* (Munj) : River beds, Pan-India distribution. Fibbers were obtained from the leaf sheath. Uses : Thatching & Ropemaking.
- *Saccharum spontaneoum* (Ekra) : key species in riverbank stabilization. Growing prominently in WB + Asham. *Ekra Mud Walls**** built up with mud plaster over this grass + rope
- *Viteveria zizanioides* (Khus khus) : *Aromatic Long Fibrous Roots**** "Khus-Khus" mats + ornament baskets
- *Thatching Grasses* : *Imperata cylindrica*, Munj, Ekra, etc.

CHAPTER 9

ETHNOBOTANY

ETHNOBOTANY

ETHNO	BOTANY
Means - people, culture, beliefs, aesthetic knowledge as well as practices.	Study of plants

Ethnobotany is the "*study of how people of a particular culture or region utilized indigenous (native) plants knowledge through the ages*"

- **Ethnobotany** is the study of plants used by aboriginal and primitive people
- Ethnobotany term given by ***John W. Harshberger*** (1895)
- Father of ethnobotany in India : Dr. S.K. Jain.
- "Soma"rush = Ephedra

IMPORTANT MEDICINAL PLANTS

Medicinal plants constitute a vital component of India's **Non-Timber Forest Products (NTFPs)**. They not only support traditional healthcare systems but also contribute significantly to tribal livelihoods and the herbal pharmaceutical industry. Their importance lies in:

- Providing a **major share of NTFP-based income** in states like Madhya Pradesh and Chhattisgarh.
- Serving as the backbone of **indigenous knowledge systems and tribal healthcare**.
- Acting as raw material for **Ayurvedic**, **Siddha**, **Sowa Rigpa** and **modern allopathic medicines**.

***Abelmoschus moschatus* (Musk dana)**

- Area : Tropical regions, plant resembles ladyfinger (*Bhindi*).
- Part used : Seeds.
- Uses : Taken with milk; cures itching and snake bite.

***Abrus precatorius* (Ratti, Gunja)**

- Area : Chambal ravines, climbing shrub.
- Parts used : Leaves, roots (decoction).
- Uses : Cough, cold, colic pain, induces abortion.

***Achyranthes aspera* (Apamarg)**

- Parts used : Green stem & root collar.
- Uses : Used as toothbrush; prevents tooth decay, cures pyorrhoea.

***Annona squamosa* (Sharifa, Sitaphal / Custard apple)**

- Parts used : Seeds, fruits, leaves.
- Uses : Insecticidal, fish poison, removes lice

***Stevia rebaudiana* (Stevia)**

- Parts used : Leaves.
- Uses : Natural sugar substitute, safe for diabetics.

CHAPTER 10 USES OF WOOD

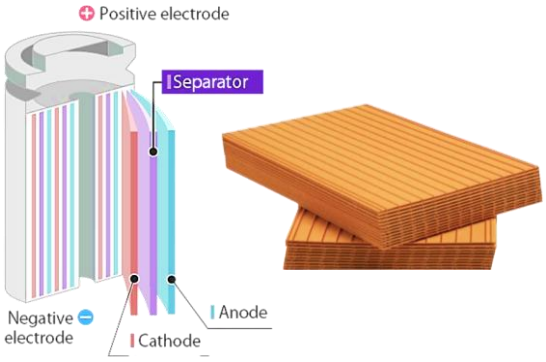
- **Aircraft Industry** : requires light wood with straight fibres and great strength, *i.e.*, *Picea sitchensis*, *Picea smithiana****, *Ochroma pyramedelis**** (Balsa = *Lightest wood*)***, etc.

- **Agriculture Implements** : only the strongest, hardest wood can be suitable to hold pressure developed during uses in bullock carts, Plough, handles, etc. With this, species also must be locally available.

  Example : Babool (*Acacia nilotica*), *Xylia xylocarpa*, *Anogeissus latifolia*, etc.

- **Battery Separators** : wood should be light, sufficiently strong, straight grain, and especially free from volatile acids, tannins and resinous material so it couldn't affect electrolytes.

  Examples : *Conifers**** – *Abies pindrow*, deodar, pines, spruce, etc.



- **Boat and Shipbuilding** : should be strong, elastic, durable and free from defects to stand the enormous strains and marine environment. With this, it should be light in weight and corrosion-resistant

  Examples : Teak*** (*Best ship building timber****)
  Ochroma pyramidalis (Balsa) and *Bombax ceiba* for life-saving apparatus.

The *Beypore Uru* is a traditional dhow that was built in Beypore, India, with a legacy that dates back to the 11th century. Made from pure Malabar teak and coir, these vessels have been used for generations to facilitate trade, and are renowned for their unique design and skilled craftsmanship.

- **Furniture Industry** : The essential qualities required are good colour, handsome grain or figure, non-liability to crack, split, warp or ease of working and finishing.

  Examples : Teak (*Tectona grandis*), Rosewood (*Dalbergia latifolia*), Siris (*Albizia spp*.).

- **Matchwood Industry** : required wood should have straightness of grain, good fissility, strength, good white color, freedom from knots, easily peelable, and capacity to absorb paraffin

  Examples : *Boswellia serrata**** (Salai), *Populus tremula*, *Ailenthus excelsa****, *Bombax ceiba**** (Semul, mainly planted in North India for the matchwood industry)* etc.

- **Packaging Industry** : would be light, free from knots and should have straight fibres to provide excellent packaging with not increasing packaging weights. Examples : Conifers.

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.

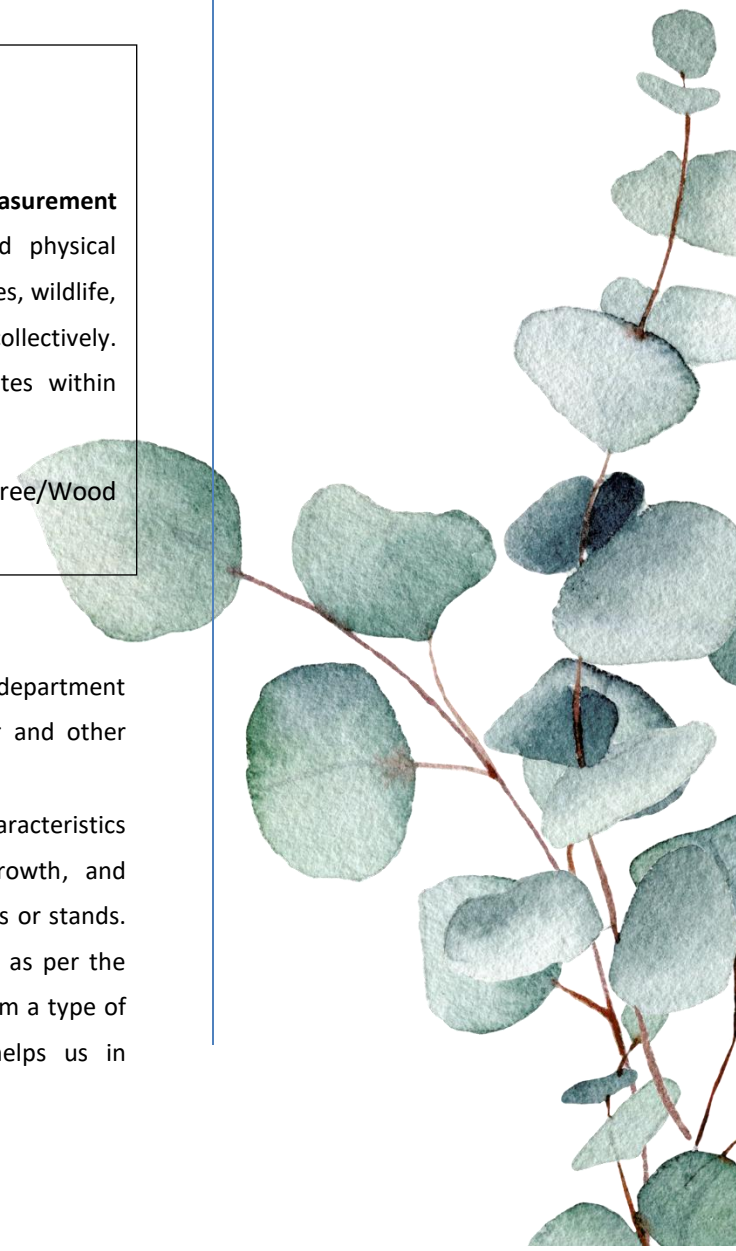
Similarly, Dendrometry : Dendron (Greek word) = tree/Wood
+ Metrum (Latin) = measure

► **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).

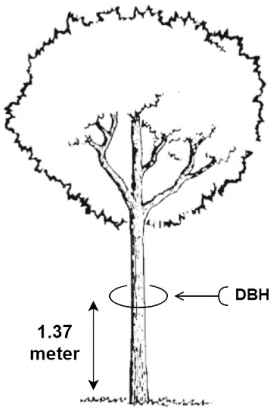
In India***, Burma, S. Africa, USA & other British colonies	In UK, Europe & FAO***
BH = 1.37 m (4 feet 6 Inches)	BH = 1.30 m (4 feet 3 Inch)***

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

3

HEIGHT MEASUREMENT

3.1 BASIC TERMINOLOGY

- **TREE HEIGHT** : the straight line distance from the ground level to the tip of the leading shoot.
- **CROWN POINT** : Crown Point is the position of the first crown forming living or dead branch.
- **BOLE HEIGHT** : The distance between ground level and Crown Point.
  - *Commercial bole height* : the height of bole up to which it is usually fit for timber utilization.
  - *Standard Timber Bole Height* : The height of the bole from the ground level to the point where diameter over bark is 20cm (in case of Timber) or 10 cm (for pulpwood).
- **CROWN LENGTH** : The vertical measurement of the crown of the tree from the tip to the point halfway between the lower green branches forming green crown all round and the lowest green branch on the bole.

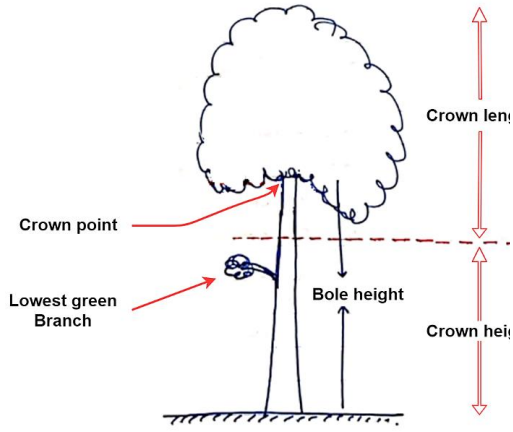


Figure 3.1 : Various terminology

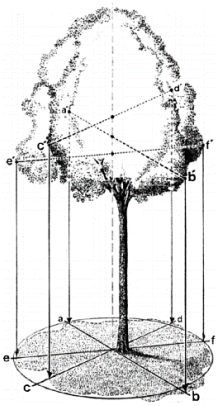


Figure 3.2: Horizontal crown projection

Chapter Outline

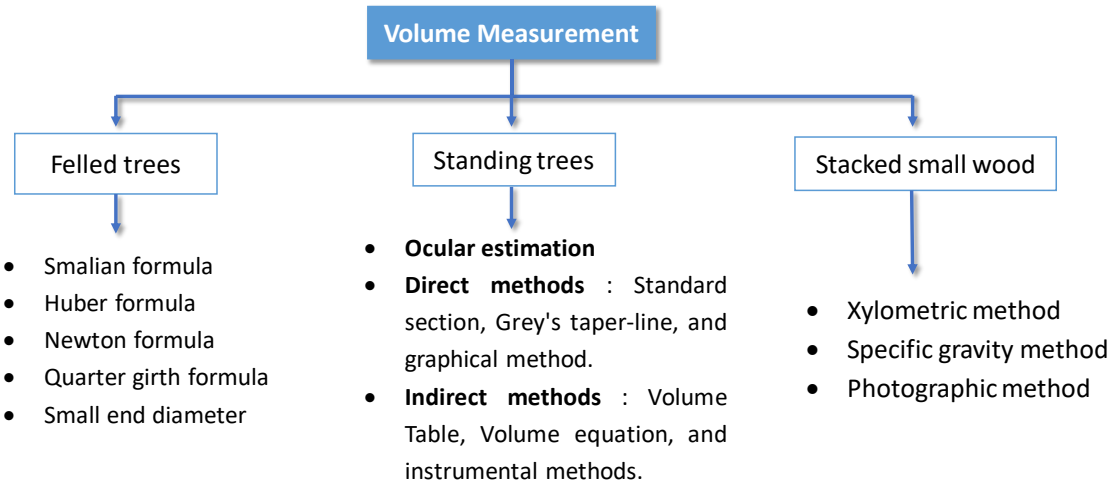
CHAPTER 5

VOLUME MEASUREMENT

We now reach our targeted chapter which discusses volume measurement under the following sub-headings –

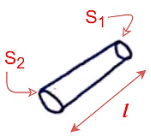
- Volume calculation of both – Felled and Standing tree.
- Volume measurement of fuelwood stocks and billets
- Volume table
- Related terminology

5.1 VOLUME CALCULATION



5.1.1 VOLUME MEASUREMENT OF FELLED TREES

As we know, the shape of felled log volume may be – Cylindrical, Paraboloid, Cone, or Neiloid, and they may be scatted on the ground or stocked during measurement.

SN	Method	Point of measurement	The volume of a frustum of solid	Applicability	Remarks
1.	***Smalian's*** formula		$V = \frac{S_1 + S_2}{2} \times l$ *l = Log length* *S = Cross-section area*	For solids of *Paraboloid* shape.	Only ends diameter are required.

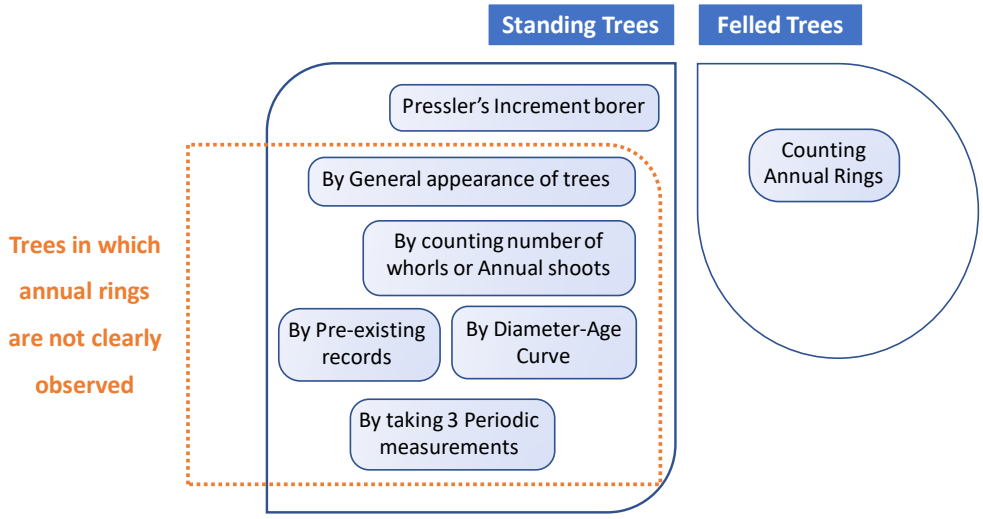
CHAPTER 7

AGE CALCULATION

► WHY DID WE REQUIRE TO ESTIMATE AGE ?

- To estimate the rate of forest wood capital formation.
- To determine the time required for particular volume formation

► METHODS



7.2 CALCULATING AGE OF STANDING TREE

► **From existing records** : in the case of trees raised by plantation, the records of the year of such operations are very helpful in finding the age of trees.

► **From general appearance** : the age of a standing tree can also be found by ocular estimation, but it requires the skill of a high level.

- *Size and shape of the crown* – in some species size and shape of the crown changed with increasing age, *i.e.*, *Pinus roxburghii* has a conical crown in the early stage, and it became rounded as the tree grows older.

Figure : A record board of plantation work. Which give us information about the species sown or planted, year and time of planting, method of planting and various given treatments.

- Younger has a high *tapering rate* while older have low tapering + *Size of the stem*.

CHAPTER 12

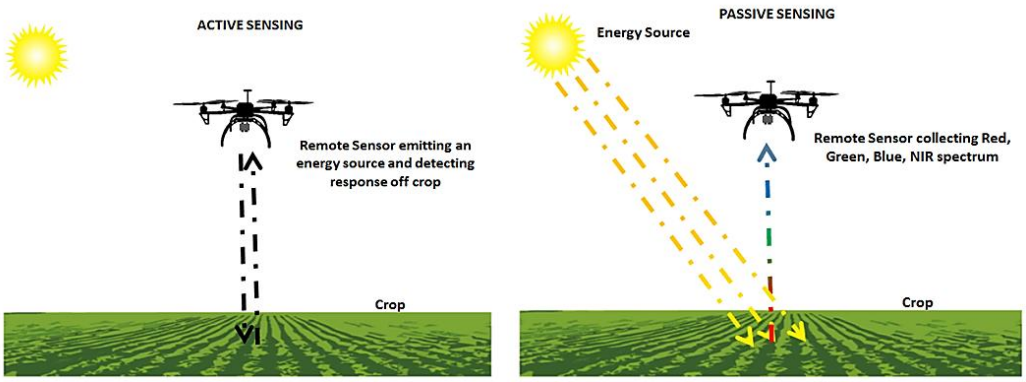
REMOTE SENSING
[INTRODUCTION]

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

12.1 TYPES OF REMOTE SENSING

► **Classification based on source of energy**

- Active remote sensing : Sensors emit their own energy, then analyze the reflected or scattered energy to gather information about the target. Examples include RADAR, LiDAR, and SONAR.
- Passive remote sensing : Passive sensors, such as microwave radiometers, do not emit energy to collect information but rely on natural energy sources like sunlight and thermal radiation to detect a target.



► **Based on platform**

- Ground borne platform : Platforms are used on the surface of the earth.
- Aerial or airborne remote sensing : The most common method, by using airplanes, balloons, drones etc.
- Space remote sensing – by using satellite-based sensors, *i.e.,* LANDSAT

► **Classification based on the region of the electromagnetic spectrum**

- Optical remote sensing
- *Microwave* remote sensing
- *Infra-red* remote sensing
- *Thermal* remote sensing
- LiDAR
- SONAR

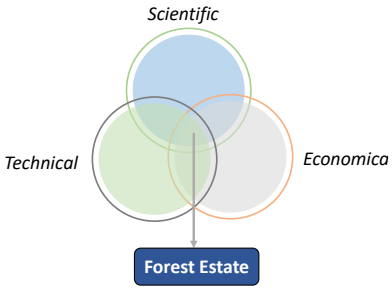
CHAPTER 1

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

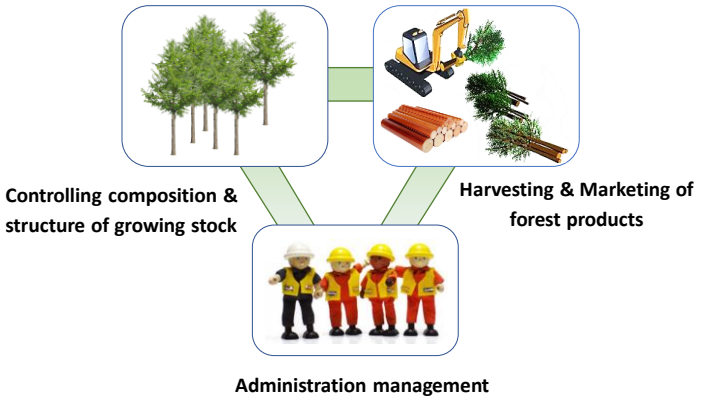
The *practical application* of the *scientific, technical,* and *economic principles* of forest estate for the achievement of *certain objectives*.



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 2

FOREST ORGANIZATION

In 1806 the government of Madras appointed Captain Watson as the first conservator of forest, which laid the foundation of modern-day forest administration. It was further strengthened with the establishment of the Indian Forest Service in 1867. For a *Better Description*, *Administration*, *Management*, and *Record-Keeping*, forest administration is generally divided into 3 major categories. These categories are –

A. Territorial classification or system
B. Administrative (or Organizational) structure
C. Management (or Silvicultural) classification

2.1 TERRITORIAL CLASSIFICATION

At range level, a forest area is divided into Blocks, Compartments, and Sub-Compartments based on its executive and protective functions.

- Forest **Block** : In general, A forest range is divided into 15 to 30 blocks, which are the *main territorial divisions*. A block usually has a distinct *clear-cut boundary* all around marked by numbered pillars and *has its Local proper name*, *i.e.*, Haldwani block.
- **Compartment** : A forest block is divided into several compartments, which are the permanently defined forest territorial Units for the purposes of administration and record.
  - A compartment is a ***permanent***, ***recognized geographic*** *unit of forest land* forming on the basis for planning, prescription, monitoring, and permanent record of all forest operations.
  - Use Arabic numbers 1, 2, 3, etc. for their naming
  - It is the **smallest permanent working plan unit** of management, Its Boundaries are chosen carefully on the ground and marked on the map. The boundaries are formed either by natural features such as ridges, valley bottoms, streams or artificial fire lines, etc.
  - The average size of the compartment : 100-500 hac., depending upon the aim and intensity of forest management.

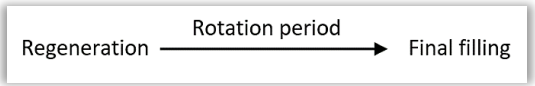
Chapter Outline

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

- Crop growth rate varies with site quality and species.

Chapter Outline

CHAPTER 5

INCREMENT

5.1 INTRODUCTION

Chapter Outline

An increase in growth (or volume) of a tree or crop during a given period is called an increment. This increment means an increase in plant diameter, height, or basal area but remember; this does not mean an increase in the price of timber due to changes in monetary value or demand-supply fluctuations

TYPES OF INCREMENT

- **Current Annual Increment (CAI)** : The increment in the volume or size of a forest crop during a particular year, for example, in the 10^{th} year of growth.
- **Mean Annual Increment (MAI)** : MAI is the total annual increment up to a given age divided by that age is our MAI, *i.e.*, MAI in the volume of Teak plantation up to 30 years is 30 m^3/hac/year.
- **Periodic Annual Increment (PAI)** : An average annual increment for any given short period of time, such as height growth in a teak plantation in the 10^{th} to 15^{th} year of growth, is 0.5 meter per year.
- **Final Mean Annual Increment** : Mean annual increment at rotation.
- **Quality increment** : When a tree/crop's price rises per unit volume because of a change in the quality or a specific property of the wood, and not because of changes in demand and supply (money value), *i.e.*, The price of a 30-year-old sandalwood tree is much higher than that of a 20-year-old tree, not because of its increase in volume, but because hardwood formation increases with age and this hardwood is the source of sandalwood oil.
- **Price increment** : The increment in price, independently of quality increment, resulting from fluctuations in the market value in general and the demand and supply position in particular.

CHAPTER 6

IMPORTANT TERMINOLOGY

6.1 GROWING STOCK

Growing Stock is the sum (Number or volume) of a total of trees growing in a forest or a specific part of it, which has more than a certain diameter at breast height (DBH).

Figure : Growing stock also known as **Forest Capital**

The concept of growing stock is relative, and what one can include in it and what cannot depend upon one's views and objects of forest management. I mean, if our object of forest management is the production of timber, then we count trees of specific diameter only (above specific DBH). If our forest management objectives are carbon capturing and storage, we estimate all above-ground and underground biomass in growing stock; it includes all trees, climbers, stumps, leaf litter, underground roots, etc.

IMPORTANCE OF GROWING STOCK

Periodic estimation of the growing stock is essential for developing national policies and strategies for the sustainable use of forest resources.

- Provides information about (i) the volume of wood available inside forests, (ii) Current Forest carbon storage and carbon sinking potential, (iii) the tangible economic value of forests. This will help in forest certification, carbon trading, and fulfilling our INDC's obligations (2.5 to 3 billion tonnes of carbon sink storage.
- It provides information about site productivity, species composition, and the value of our existing forest resources.

Chapter Outline

CHAPTER 8

COMMUNITY FOREST MANAGEMENT

Chapter outline

Joint Forest Management (JFM) is an approach and program initiated by the ***National Forest Policy of 1988***. Under this, the state forest departments support local forest-dwelling and forest fringe communities to protect and manage forests by sharing the costs and benefits of the forests with them. Communities organise themselves into a JFM Committee to preserve and manage nearby forests, guided by locally prepared guidelines and micro-plans.

JFM is a *participation of the local community* in the management of forest.

8.1 HISTORICAL BACKGROUND

In **1931**, ***Van Panchayats*** in Uttarakhand started participating in forest management, as the remote Himalayan region where creating hardness to the forest department because of the poor Cost-benefit ratio.

Later, the Forest Department of ***West Bengal*** successfully started a pilot project in the ***Arbari**** ***village*** (hilly area) during **1971–72**, and it was a major success.

Followed by Haryana and Odisha, but all these (WB, HR, Odisha, etc.) were pilot projects or individual efforts of some dedicated forest officers and had no forest policy or legal back-ups.

Other similar efforts, *i.e.*, Forest Cooperatives in the Madras Presidency (the 1900s) and cooperative Forest Societies in Kangra (1940s, earlier Punjab, now Himachal Pradesh). Woodlots on panchayat lands under Social Forestry (the 1980s - with Revenue sharing agreements).

The actual initiative by MoEFCC on JFM started with the ***National Forest policy – 1988**** on its past experiences, followed by the ***Guideline of 1990**** to utilize forest wealth to improve local livelihoods. This guideline explains how the forest committee was formed, its powers & functioning, NWFP sharing %, etc. *This guideline forms the basic foundation of JFM in India. That's why most Academicians consider this as the year of initiation of JFM in India*.

Success stories

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Forestry Comprehensive Course

Swastic Yaduvanshi

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Vidyanshu Shekhar Jha

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Shashank Bhardwaj

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Prachi Gupta

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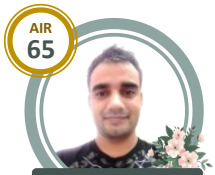

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Forestry Comprehensive Course

Akanksha Puwar

Forestry Comprehensive Course

Yogesh Rajoriya

Forestry Comprehensive Course

G Prashanth

Forestry Comprehensive Course | Test Series

Kanishak Aggarwal

Forestry Comprehensive Course

Shashi Shekhar

Forestry Comprehensive Course

Vinay Budanur

Forestry Comprehensive Course

Shraddhesh Chandra

Forestry Comprehensive Course | Test Series

Kaore Shreerang Deepak

Forestry Comprehensive Course | Test Series

Javed Ahmad Khan

Forestry Comprehensive Course

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