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2024

UPSC

INDIAN FOREST SERVICE

TOOLKIT

The Ultimate Guide to Success

Module - 4

- Forest Management
- Yield Regulation
- Working Plan
- Forest Mensuration
- Remote sensing

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FOREST MANAGEMENT & WORKING PLAN

Paper - 2 | Section - A

EDITION : 2024

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SYLLABUS

FOREST MANAGEMENT AND MANAGEMENT SYSTEMS : Objective, principles, and techniques; The 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; Management of forest plantations, commercial forests, and forest cover monitoring. Approaches viz., (i) site-specific planning, (ii) strategic planning, (iii) Approval, sanction, and expenditure. (iv) Monitoring (v) Reporting and governance; Regulation of yield

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.

MARKS DISTRIBUTION

Year	2023	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
Conceptual part **[Part-I]**	53	20	33	~41	43	75	48	30	50	~90	35
Yield regulation **[Part-II]**	×	×	15	15	10	8	15	×	15	33	8
Working Plan **[Part-III]**	39	35	33	15	~15	23	23	10	15	10	~13
Total	**92**	**55**	**79**	**65**	**61**	**104**	**86**	**40**	**80**	**106**	**71**

Module - 4

CONTENTS

INDIAN FOREST SERVICE (IFoS) PYQs [2008 to 2023]

[Part-I] PRINCIPLES & CONCEPTS

2023	• What are the objectives and principles of forest management? [8 M]. • Describe the methods for assessment of growing stock [15 M]. • What is village forest committee? Explain its role in forest management [*Linked* Q | 10 M]. • Describe the role of MAI (Mean Annual Increment) and CAI (Current Annual Increment) to decide rotation of a forest stand [15 M]. • Describe the importance of forest management. How will it be operated in forest plantations? [15 M].
2022	• What is the *purpose of classifying forests* ? How are the *forests classified for silvicultural management*? [*Linked* Q | 8 M] • *Define Forest Management* and write *its Objectives*. Discuss in brief the *major activities related to forest management* [15 m] • Explain the *salvage operations* for plantation trees after natural disasters [*Linked* Q | 10 M].
2021	• "Forestry enterprise is *peculiar* compared to other enterprises" Justify (8 m). • Define *working circle*. Mention different *types of working circles* generally constituted in India. Explain *Biodiversity working circle* (10 m). • Define *rotation of maximum volume production*. Explain the methods for fixing up of rotation of maximum volume production with the help of a neat diagram (15 m).
2020	• What are the *key decision parameters* in an *uneven-aged forest management* (8m). • How does collaborative forest management ensure *community and household resilience*? (8 m) [*Linked* Q : JFM + Social Forestry] • What are the recommended practices *for strategic harvest planning***?** (8m). • What are the *factors that affect* a *stand structure*? Describe in brief the DBH distribution in even, uneven, and Multi-aged normal forest stands (15 m) • What are the *Socio-ecological implications* of *modifying rotation lengths* in forestry? (10 m).
2019	• Explain the role of **Normal Series of Age Gradation** and **Age Class** in forest management (8 m). • Describe the method for calculation of **Normal Growing Stock** with the help of yield table (15 m). • What is **Progressive Yield** ? How is annual yield obtained in a forest worked with periodic block method? (15 m) [*Linked* Q : Yield regulation] • What is Compartment*?* why is its study and description required when making a working plan ? (15 m)
2018	• What is **Sustained Yield** ? Mention the positive and negative aspects related to sustained

	yield (8m). • What is **Growing Stock**? How is normal growing stock calculated in **Clear Felling System** based on final MAI? (15 m). • Define **Rotation**. Explain different types of rotation with special reference to ecological, industrial, and economical benefits (10 m). • What is **Increment** ? Discuss different types of increments. Discuss the graphical relationship between current annual increment and mean annual increment (15 m). • Define forest management. Give its objectives. How does the attitude of the owner put impact on the management of forests? (15 m). • How is the rotation of any particular species at any particular locality practically decided? (10 m).
2017	• Describe the different formulae used in forest trees for determining **Increment Percent** in diameter and volume (15 m). • Write about the concept of **Normal Forest** and the kind of abnormalities which affect the normal growing stock (15 m). • How the **Forest Cover** was measured prior to and post 1980's in India? Define the various categories of forest cover (8m). • Some rural communities are opposed to chir pine and advocate removal of chir pine and its replacement with broadleaved multipurpose trees. What is your reaction in this matter? (10 m) [*Linked* Q : JFM + Social forestry]
2016	• What is **Normal Growing Stock** ? Explain the determination of NGS in clear felling system with graphical illustration and numerical examples (10 m). • How do you visualize the concept of **Normal Forest** in Indian context ? describe the effect of silviculturel system on normality (10 m). • What is the **Increment Percent** ? Discuss the relationship between CAI and MAI of a forest stand (10m). • Explain the concept of rotation and its application in regular and irregular forests (10) • Describe the role of **Corporate Social Responsibility** (CSR) towards sustainable forest production through Public-Private Partnership (PPP) approach (10 M) [*Linked* Q : Forest economics]
2015	• **Progressive Yield** concept differs from **Sustainable Yield**. Under the present situation, which would you suggest and why? (15 m). • Discuss how the **Rotation of Minimum Volume Production** differs from the **Silvicultural Rotation** (10 m). • Enumerate the importance of **Forest Survey of India** (FSI) in the forest management system (10 m). • Show by your interpretation, either graphically or theoretically, how the forest yield depends upon the **Growing Stock** (15 m) [*Linked* Q : Working plan]

2014	• Define rotation and describe the various **types of Rotation** prescribed (8m). • With the help of a diagram, discuss the **relationship between MAI and CAI**. What is their role in forest measurements? (10 m). • Define rotation and describe the various **types of Rotation** prescribed (8m). • What are the **Peculiarities** you have observed in **Forest Management** practices? Suggest ways to overcome them (10 m). • With the help of a diagram, discuss the **relationship between MAI and CAI**. What is their role in forest measurements? (10 m). • What are the **Peculiarities** you have observed in **Forest Management** practices ? Suggest ways to overcome them (10 m). • Define **Growing Stock**. Explain the estimation of growing stock and density (10 m). • How enumeration of the **Growing Stock** is done ? describe in brief the various methods of enumeration for preparing a working plan (15 m) [*Linked* Q : Working plan + Forest mensuration] • What is **Stand Density** ? How spacing is used to control stand density ? Discuss (15) [*Linked* Q : Silviculture]
2013	• Describe the **scope and objectives of Forest Management**. What is the impact of restrictions laid down by the Hon'ble Supreme Court on green felling in forests? (10 m). • Define the **rotation** and describe **its various types** used in Indian forestry (20 m). • Describe the compound interest and Schneider's formulae for calculation of **increment percentage** (10 m) [*Linked* Q : Forest mensuration]
2012	• Differentiate between – **CAI and MAI** (4m) • Explain **dynamics of forest vegetation** giving an example of the evolution of Sal Forest in Uttaranchal (10 m).
2011	• Write short notes on – interrelationship between **CAI** and **MAI** (5 m). • Explain the situations under which a **Forest** becomes **Abnormal** (10 m). • Define **Rotation** & discuss different **Types** of **Rotations** giving suitable examples (20).
2010	• Discuss the significance of normality in **sustainable management of forest** (8m). • How is **De-Liocourt's principle** utilized to ensure normality concept in selection forest? (8m). • How do variation in density and quality of a forest influence annual yield estimation? (8m). • How are yield table data used for the assessment of **normal growing stock**? (8m) • What is **working circle** ? How is it decided in working plan exercise ? (8m) [*Linked* Q : Working plan] • Briefly discuss the relative importance of **physical and silvicultural rotations** in respect of existing forest resources of India (8 m). • Explain the components of **compartment description** (10 m) [*Linked* Q : Working plan] • How is the **soil expectation value** helpful for deciding financial rotation ? (10m).

	• What is **intermediate yield** ? How does it differ from final yield ? (10 m). • What is **integrated land use management** ? Give a plan of integrated land use management for 10 ha. of land in the tropics and sub-tropics part of India (10 m).
2009	• Justify the statement "Control of **stand density of desired species** helps in the production of maximum volume" (10 m). • Explain the concept of **normal growing stock** in clear felling system (10 m). • Show the relationship between **Current annual Increment (CAI)** and **Mean Annual Increment (MAI)** of a forest stand (10m). • Describe the **normal forest concept** for commercial plantations (10 m). • Distinguish between **Silvicultural rotation** and **rotation of the maximum volume production** (10 m).
2008	• How is the growing stock estimated in clear felling system ? (20 m).

[Part-II] YIELD REGULATION

2021	• Explain the **French Method (1883)** of yield regulation in irregular forests. What are its advantages and disadvantages? (15 m)
2020	• What are the classical methods for determining the allowable cut? (15 m)
2019	• What is **progressive yield** ? How is annual yield obtained in a forest worked with periodic block method ? (15 m) [*Linked* Q : Principles & Concepts].
2018	• 50 equi-productive coups are to be worked out from 2000 hectares of forest under clear felling system with the following densities : *Area (ha)* – *Densities* 600 – Normal density 400 – 0·75 density 800 – 0·50 density 200 – 0·25 density Find out the number of coupes in different densities. 8
2017	• How a selection forest is managed under the **Felling Series**? Describe with suitable examples/diagrams (15 m) [*Linked* Q : Silviculture System]
2015	• Show by your interpretation, either graphically or theoretically, how the forest yield depends upon the **Growing Stock** (15 m) [*Linked* Q : Principles & Concepts]
2014	• How yield is regulated? Describe the **Von-Mantel's formula** for yield regulation in forests (15 m)

	• Describe the general principle of **yield regulation in Uneven-aged forest** crop (10 m).
2014	• Give a short account on - the management of uneven-aged forests (8 m).
2013	• What is the yield regulation in forest management ? How can the yield regulation by **Judeich method** be used ? (8m).
2011	• How is yield regulated in a forest which is worked under clear felling system ? (10 m) • Discuss **Smythies Safeguarding formula** for annual harvest of timber from a selection forest (20 m)
2010	• Describe the procedure for allotting different **types of periodic blocks** in a forest (10)
2009	• Write short notes on – **Permanent and floating periodic blocks** (5 m)
2008	• How is the yield regulated by **Periodic block method** ? (10 m)

[Part-III] WORKING PLAN

2023	• Differentiate between forest working plan and forest management plan [8 M]. • What are Maps? How are they helpful in the management of forests? [8 M]. • Describe the role of working plan in forest conservation [8 M]. • Describe regeneration survey in natural forest and explain the significance of regeneration stock map [15 M].
2022	• *Maps* play a significant role in working plan preparation. Explain (10 m) • Describe the outline and the components of the *preliminary working plan report* (15 m) • "Working plan is a document of enforce systematic, obligatory and mandatory regulations for continuous management of a given forest". Discuss (10 m)
2021	• "Working plan is a basic prerequisite for the management of forest division" Discuss (8). • What is **forest regeneration survey map**? How is it useful in the management of natural forests? (10 m). • Briefly explain the steps involved in **preparation of working plan** according to national working plan code, 2014 (15 m)
2020	• A well-defined working plan is crucial for the **sustainable management of forests** and **biodiversity**. Write your answer in brief in the light of **National working plan code 2014** (15 m).
2019	• Describe the **significance** of **working plan** and **working scheme** in conserving biodiversity (8 m). • What is Compartment*?* why is its study and description required when making a working

	plan? (15 m) *Linked* Q : Principles & Concepts]
2018	• Define working plan. Discuss objectives and scope of a working plan. Describe salient features of a good working plan (15 m). • What are the **forest stock maps**? Discuss the details shown in stock maps for a working plan report (8m).
2017	• What are the objectives of working plan? How it is helpful for conservation of biodiversity and natural resource conservation of forests? (8 m) • Describe the Various **Kinds of Maps** prepared by the Working Plan Officer. What is their utility and purpose ? (15 m).
2016	• Differentiate **Working Plan** and **Annual Plan** of operations. Suggest the changes needed in the working plan preparation for more effective application in forest management (10 m).
2015	• Maps are an integral part of forest management. Give your perceptions about the kind of maps you consider important for managing a forest circle (15 m).
2014	• How enumeration of the **Growing Stock** is done? describe in brief the various methods of enumeration for preparing a working plan (15 m) [*Linked* Q : Forest mensuration]
2013	• What are the main contributions of Dr. D. Brandis in Indian forestry? Enumerate the various stages of working plan. What is the role of silvicultural system in the working plans ? (8m). • Describe a stock map. Discuss the scheme of recording crop composition (including colouring pattern used) and crop density (8m).
2011	• What is a **regeneration stock map**? How is it prepared? (10 m). • Explain various types of maps prepared by Working Plan Officer (10 m).
2010	• What are the **different regeneration categories** that are observed and recorded during sal regeneration survey ? (8 m). • What is working circle ? How is it decided in working plan exercise ? (8m) [*Linked* Q : Principles & Concepts] • Explain the components of **compartment description** (10 m) [*Linked* Q : Principles & Concepts]
2008	• In what ways does a **Divisional Forest Working Plan** seem to be essential in sustainable forest management (20 m).

SOURCE OF REFERENCE FOR THIS MODULE

- Forest Management by Ram Prakash, IBD Publication, Dehradun (2006 edition)
- Guidelines for the management of tropical forests, Ian Armitage, FAO, 1998.
- Forest Management by Steven P. Grossberg, Nova Science Publishers, inc. New York
- National working plan code 2014, MoEFCC, Govt. of India.

- Forest Ecology and Conservation : A handbook of techniques by Newton A. C., Oxford University press, US (1st Edition, 2007).
- Ecological and Silvicultural strategies for Sustainable Forest Management. Fujimori T, Elsevier (1st Edition, 2001).
- Forest dynamics and Disturbance Regimes : Studies for temperate evergreen-Deciduous forests. Frelich L.E. Cambridge University Press (1st Edition, 2002)
- Ecological Silviculture : Foundations and Applications, by Brian J. Palik, Anthony W. D'amato, Jerry F. Franklin, K. Norman Johnson by Waveland Press (2021).
- The practice of Silviculture : Applied forest ecology, Smith D.M., Larson, B.C., Kelty M.J., Ashton P.M.S., by Wiley Publication. (9th edition, 2014).
- Growing plantation forests, by P.W. West, Springer publication (2006 edition).
- Indian state of forest report 2021, Forest Survey of India, Dehradun.

CHAPTER 1

INTRODUCTION

Chapter outline

1.1 HISTORICAL BACKGROUND

Britishers look over our natural forest resource as a source of timber to feed the growing demand of the British royal navy and industries like railway sleepers, power-supply poles, domestic furniture demands, etc. Therefore, they start managing our forest resources just like agriculture practices over the vast natural area through –

(a) Establishing a monopoly over the production and harvesting of timber resources,

(b) Production should be sustainable in the sense of harvesting an equal amount of wood annually or periodically (and not in the modern sense of sustainability).

(c) Exploiting timber without giving much importance to its negative impact on the wildlife habitat, tribal economy, local watershed, and forest ecology.

To handle this, they compiled the contemporary European knowledge of various subjects of forestry, including silviculture systems and yield regulation, with some modified and original Indian versions in a linear structural format to systematize knowledge that make them easy to train next-generation foresters. That's why we often see this type of outdated content in our Indian academic textbooks.

However, this colonial legacy remained continued till the 1970s. as there were few major changes happening in Indian perspectives.

- Raise of many International and national organizations working on forest and wildlife sectors after the Stockholm conference (1972) on the human environment.
- Legislative changes : like shifting forest and wildlife subjects from the state list to the concurrent list (1976), passing the Wildlife protection act (1972), Water Act (1974), Forest conservation act (1980), Air act (1981), environment protection act (1986), Biodiversity conservation and many more.
- Achieved food security after the success of the green revolution. Therefore, the need to prioritize food production over forestry remains

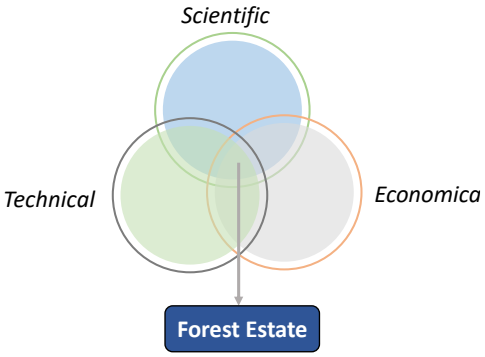
no more.

- Achieved food security after the success of the green revolution. Therefore, the need to prioritize food production over forestry remains no more.
- The emergence of new threats like Global warming and climate change, Deforestation, increasing the destructive effect of exotic species, watershed destruction, flooding issues, etc.
- Policy-related changes like the promotion of Participatory Forest management and forest rights acts.
- Biodiversity conservation and forest genetic resources.

All of these lay down the foundation of our policy shifting from a *production forestry* point of view to *protection forestry*. And 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*.

1.2 DEFINITION

Forest management is the *practical application* of the *scientific*, *technical*, and *economic principles* of forest estate to achieve *certain objectives*.



In the broadest sense, forest management is a process that effectively integrates the biological, social, and economic factors which influence the decisions leading toward the implementation of one or more specified objectives.

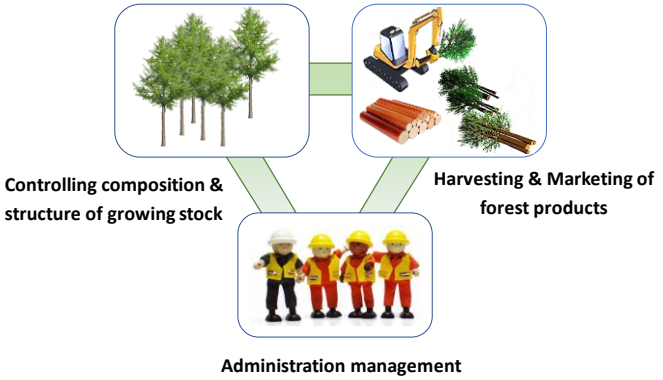
[FAO define - Forest Management deals with the overall administrative, economic, legal, social, technical, and scientific aspects related to natural and planted forests. It implies various degrees of deliberate human intervention, ranging from actions aimed at safeguarding and maintaining the forest ecosystem and its functions to favouring specific socially or economically valuable species or groups of species for the improved production of goods and services].

1.3 SCOPE

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

Harvesting to the marketing of produce : by preparing a proper Logging Plan, adopting suitable transportation methods, Marketing / Auctioning of produced, and Revenue management.

Administration of forest property : Monitoring and control of works, Labour management and their welfare, Economy efficiency.



CHAPTER 2

FOREST ORGANIZATION

Chapter outline

In 1806 the government of Madras appointed Captain Watson as the first conservator of forest, which laid the foundation of modern-day forests 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 areas are 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 geographically** 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.

CHAPTER 3

SUSTAINABLE YIELD
[EVEN FLOW]

Chapter outline

In Europe, forestry emerged as a profession and national forests were created based on the belief that unregulated markets would result in forest devastation. It was believed governments must own or regulate forests to perpetuate timber resources. This belief is still widely held and is the basis for extensive public forest ownership in Europe, India, and elsewhere. The profession of forestry began somewhere in Germany several centuries ago. Before the industrial revolution, forest management practised by professional foresters had spread from Germany to most other parts of Europe and the world.

A common forest management philosophy like the concept of sustained yield, yield regulation, and many other associated ideas emerged in this environment that continues to have a major and most unfortunate impact on forestry today.

3.1 SUSTAINABLE YIELD

[Concepts/Principle] It is the theoretical equilibrium concept, and according to it, a forest should be managed in such a way that the *annual or periodic* (when the period is short) *removal* of mature timber does not exceed the annual or periodic *stock growth* under the *existing environmental conditions*, and at a given *intensity of management*, without *harming its renewable process* and *productivity* of the forest area. In other words, Sustainable yield can be expressed as the allowable cut which may differ slightly from net increment (*i.e.*, gross increment minus natural losses due to fire, wind, epidemics, etc.) depending on the growing stock and distribution of age-classes.

[Definition] The *regular* and *fixed supply* of the desired forest produce with *its full capacity without harming the productivity* of forest crop or soil is called sustainable yield.

MAXIMUM SUSTAINABLE YIELD

The maximum sustainable yield (MSY) is defined as the *highest average yield* one can harvest from the forest over an indefinite period.

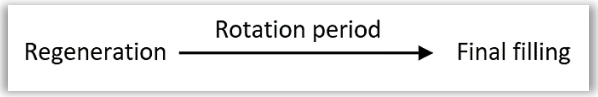
CHAPTER 4

ROTATION [PRODUCTION PERIOD]

Chapter outline

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]**.

Term **rotation** is correctly applied for **regular crop only** (*i.e.,* clear-felling system or plantation), where entire crops of a sizable area felled at a time or periodically (in the shelterwood system). For uneven or irregular forest, term "exploitable age" or "utilizable size/age" is used

ROTATION PERIOD	EXPLOITABLE AGE
The time period is taken by forest crop between its formation and final felling	Age at which tree attains the size required to fulfill the object of management
Applicable : Regular crop ✓	Regular crop ✗
Individual tree ✗	Individual tree ✓

CHAPTER 6

GROWING STOCK

Chapter Outline

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 sustainable use of the forest resources.

(a) 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.

CHAPTER 8

NORMAL FOREST

Chapter Outline

8.1 INTRODUCTION

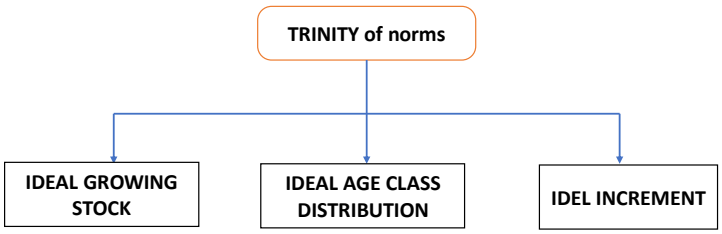
In Forestry, we always aim to get an **Ideal Yield** from a forest coupe, with its *maximum production capability* without harming sustainability – that means – we always want an **Ideal Maximum Sustainable Yield**.

A normal forest is an **ideal condition**, a **purely artificial concept**. This does not mean common or usual, as we normally understand the term. The concept was developed to provide a benchmark for our actual forest. This will enable us to determine where and how much work is needed to meet this ideal standard.

It is based on the principle of sustainability, which is also one of our forest policy objectives.

Definition : The normal forest is a forest that has an **ideal growing stock**, **ideal age class distribution**, and **ideal increment** with annual or periodic removal of produced is equal to the increment without endangering future yield and site quality.

It is based upon three criteria known as the **Trinity of Norms**.



8.2 FACTORS/ATTRIBUTES OF NORMALITY

There are three main factors or criteria for an ideal forest. These are as following :-

- **Normal series of age gradations/age classes** : it represents the presence of trees of all ages from one year old to rotation age in an appropriate quantity.

CHAPTER 10

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.

10.1 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 ?

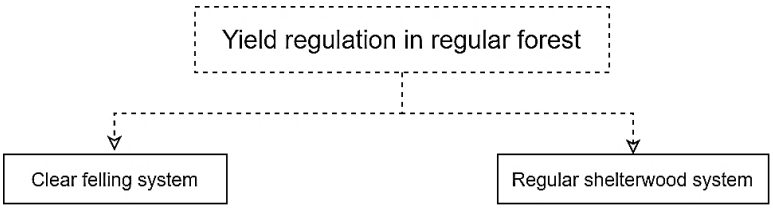
  - Less effective, time-consuming, and too expensive.
  - The majority of aerial remote sensing data is recorded in the black and white spectrum. Because of this, it is virtually impossible to identify invasive species, detect stress on the forest ecosystem, and trees species these days.

CHAPTER 12

YIELD REGULATION IN REGULAR FOREST

Chapter Outline

Even-aged management deals with forests composed of even-aged stands. In such stand, individual trees originate at about the same time, either naturally or artificially. In addition, stands have a specific termination date at which time all remaining trees are cut. This complete harvest is called a *cleat-cut*.



12.1 YIELD REGULATION IN CLEAR-FELLING SYSTEM

- **Annual coupes by gross area** : Under this, a forest area is divided into a number of *equi-extensive* annual coupes. The number of coupes is equal to the rotation age, so we can cut one coupe every year.

  The *simplest and oldest method*. *Suitable for coppice forests and high forests* that are managed under a clear-fell system. Except for the first rotation where crops are usually irregular both in composition and density, this method ensures a sustainable yield from the second rotation onward.

- **Annual coupes by reduced area** : Site quality and crop density may vary from coupe to coupe. Hence, felling of *equi-extensive* annual coupes may not guarantee equal volume of timber every year. In order to achieve this, we adjust the boundaries of an annual coupe in a way to get areas of equal productivity.

ADVANTAGES OF YIELD REGULATION BY AREA

- Easy to apply
- Site preparation and planting can be done economically over large areas, using machinery and fire.

CHAPTER 13

YIELD REGULATION IN IRREGULAR FOREST

Chapter Outline

13.1 INTRODUCTION

Uneven-aged or irregular forests (a) are those forests containing more than two or three distinct age classes or age cohorts. (b) Forest stand consists of trees of all ages. The range of difference is usually more than 20 years and, in the case of long rotation crops, more than 25 % of rotation age.

Uneven-aged management is the process of making decisions to best achieve ownership objectives while maintaining an uneven-aged structure. These objectives might include maintaining constant forest cover, earning more frequent income from the stand, providing a specific type of wildlife habitat or a specific set of plant communities, or studying uneven-aged management techniques.

Advantages of Uneven Forest Management

- Uneven-aged stands have a diverse structure, with small, medium and large trees providing a multi-layered canopy. This forest structure provides habitat for many plant and wildlife species.
- Because the site is always occupied by trees = provides continuous cover on a site, reducing problems with erosion and excessive run-off after heavy rains.
- It provides more frequent cash flow, and, because it typically relies on natural regeneration, it has relatively low investment requirements.
- Many people are offended by the sight of a clearcut. With uneven-aged management, the stand is never clearcut = Socially more acceptable.

Disadvantages

- It does not work well when light demander species are desired. Example Teak, Sal, Chir-pine, etc.
- Uneven-aged management is complex and difficult to maintain.

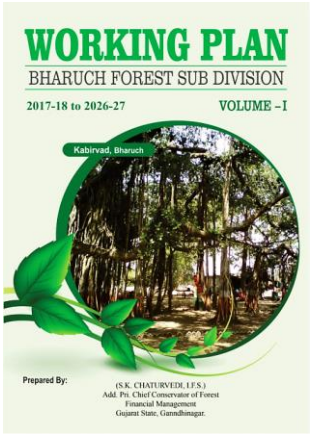
CHAPTER 14

WORKING PLAN [INTRODUCTION]

Chapter Outline

14.1 INTRODUCTION

CONCEPT : Let's suppose we wanted to start a commercial forest enterprise, similar to an agriculture one. In that case, we would need systematic planning for it, right from the preparation of the site and regrowth of the vegetation to the final felling and marketing of the harvested products. Since forest crop is not a seasonal or annual crop like wheat and its rotation can be less than 40/50 years + Apart from this production, we also have other protective, socio-economic development for tribals and wildlife conservation purposes. To accomplish all these goals, we need a brief but detailed fact-based plan that can manage, regulate, control, and direct our operations for at least the next 10 to 15 years.



NEED

- It is common for foresters/IFoS officers to get transfer after 2/3 years (± promoted, retired, or die); then who would remember which treatment they have already given to the local forest stand and which is not?
- Forests are also facing high biotic pressure, soil erosion, climate change, and fire incidences. Therefore, they must also be managed in a certain way (in a sustainable manner) with long-term planning.
- Wildlife is also a component of the forest ecosystem; we cannot leave them or drive them out of the area.
- CAMPA plantation and REDD^{+} type initiatives give much attention to the prevention of forest degradation.

Therefore, we needed a written document to establish a sustainable plan based on ground-based observations, all needed facts, and scientific principles, so no one can affect our continuity of operation, whether officer

CHAPTER 19

IMPORTANCE OF WORKING PLAN

Chapter Outline

19.1 ROLE OF A WORKING PLAN IN FOREST CONSERVATION

The working plan enhances the conservation of forests through the following means -

- It gives information about past management and its result. Accordingly, it facilitates future management by avoiding errors in management, if any.
- It prescribes the management practices according to the site conditions.
- It shows the information on degraded lands. That will helps the afforestation as well as the reforestation program in the correct orientation.
- It gives the information on regeneration status, and thus by this, we can determine which areas require supplementary plantation and which require protection.
- It gives information on forest composition, its distribution, and geographical challenges that can help in managing them more effectively.
- The working plan also gives information about the local people and their demands. Hence, local people are effectively managed, and people's cooperation is enhanced towards the conservation of forests.
- Information on soil, climate, slope, and site quality is helpful for the selection of crops for afforestation as well as conservation program.
- All these favorable points favor the conservation of the forest ecosystem with the help of a working plan

19.2 WORKING PLAN AS A TOOL FOR FOREST MANAGEMENT

As forestry is a long term enterprise, it needs a specific written plan for its management, so a working plan -

- provide a summary of past work and results. This serves as primary data for future planning.

FOREST MENSURATION & REMOTE SENSING

Paper - 2 | Section - A

EDITION : 2024

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Gole ka mandir, Morar, Gwalior (MP) 474005

SYLLABUS

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.

MARKS DISTRIBUTION

Year	2023	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
Forest Mensuration	31	23	0	0	41	40	48	20	46	61	46
Remote Sensing	0	15	15	23	15	10	8	30	15	8	0
Total	**31**	**38**	15	23	56	50	56	50	61	69	46

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Module - 7

CONTENTS

INDIAN FOREST SERVICE (IFoS) PYQs [2008 to 2022]

[Part-I] FOREST MENSURATION

2023	• What is point sampling? How is it used in forest enumeration? [8 M] • Explain briefly the reference point for measurement of diameter and girth of tree species [8 M] • How does the yield table differ from the volume table? Describe the contents of yield table with justifications [15 M]
2022	• Explain (i) Artificial Form Factor, (ii) Absolute Form Factor, (iii) Normal Form Factor, and (iv) Form Quotient (8 Marks) • Describe the tangent method used to calculate height of trees on (i) Level ground, and (ii) Sloping ground (15 Marks)
2021	• NO
2020	• NO
2019	• Explain *Metzger's theory* of tree form and its significance in volume calculation (8m). • Describe the procedure for *estimating* the *volume* of standing and felled tree (8 m). • Explain the *principles of the height measuring instruments* giving suitable examples (10m). • What is *point sampling*? How is it helpful to find out the basal area of a forest? (15)
2018	• What are the precautions required for *diameter measurements* with *calipers*? Discuss the errors that occur due to non-observation of the precautions (15 m). • Define *volume tables* and give their classification (10 m). • Define *forest sampling*. Give advantages of sampling Discuss different types of non-random sampling methods used in forestry (15 m).
2017	• How *volume tables* are classified on the basis of kind of outtum ? Describe briefly (8m) • How the geometrical measurements for calculating *volume yield* are made in (i) Buttressed tree, (ii) Leaning tree on a slope, and (iii) a tree forked at the base? Give a thematic presentation (15 m). • Describe the different formulae used in forest trees for *determining increment percent* in diameter and volume (15 m). • Write a note on kinds of *enumeration* and explain in brief different random sampling techniques used in forest inventories (10 m).
2016	• Discuss the significance of *Stump analysis* in forest mensuration. How does it helps in understanding the past growth of trees ? (10). • *Sampling* has a very important role in forest inventory. Discuss with the help of kinds of sampling (10 m).

<table>
<tr><td>2015</td><td>

Which of the instruments has Wheeler's pentaprism replaced and why? (8m)
How important are the increment borers in forest health and growth analysis ? Does Pressler's borer have any adverse effects on the tree sampled ? Elaborate on the issue (8 m).
How far do taper tables help in measuring the volume of a tree? Discuss their types and methods of preparation (15 m).
Why are sample plots laid out in different forest species? What is their utility and how are they enumerated? (15 m).

</td></tr>
<tr><td>2014</td><td>

What is a stand table ? Give a brief description for preparation of a stand table (8m).
How is stump analysis carried out and what kind of information does it yield ? (8 m).
What is a tree stem form? How is tree stem form calculated and what are its uses in forestry? (15 m).
Differentiate between sample plots and preservation plots. Discuss their role in management (15 m).
"Spiegel Relaskop is an instrument of great use in forestry" justify with reasons. How is the basal area per hectare determined by this instrument ? Explain (15 m).

</td></tr>
<tr><td>2013</td><td>

Differentiate between the graphical method and the regression equation method for the preparation of general volume tables (8m).
Differentiate between Hojer's formula and Behre's formula for tree form (8 m).
Describe the compound interest and Schneider's formulae for calculation of increment percentage (10 m).
Differentiate between random sampling and non-random sampling. Describe different methods of non-random sampling that are used in forest inventories (10 m).
In stem analysis, diameters of 30th ring (as computed on BH section) at different height sections was found as follows :
<table>
<tr><td>Ht. of Section (m)</td><td>01.37</td><td>04.24</td><td>07.24</td><td>10.24</td><td>13.24</td><td>14.74</td></tr>
<tr><td>Diameter (cm)</td><td>29.5</td><td>25.2</td><td>21.0</td><td>16.00</td><td>10.40</td><td>06.60</td></tr>
</table>
The diameter curve of 30th ring cuts the height axis at 18.24 m
(The average seedling takes 10 years to reach 1.37 m)
Calculate the MAI at 40 years of Age of the tree (10 Marks)

</td></tr>
<tr><td>2012</td><td>

What are the items of information available in the volume table in addition to the volume of tree ? Briefly describe them (8 m).
Describe the process of tree height measurement by the Abney level. What are its advantages and disadvantages ? (8 m).
Describe various formulae for calculation of the volume of logs (8 m).
Define Stem analysis and discuss its purpose (8 m).
Describe compound interest formula for calculation of diameter increment percent (8)
Describe the indirect methods for volume estimation of trees (14 m).

</td></tr>
</table>

	• If the *angle of elevation* to the tip of the tree is 30° and 45° respectively, measured from two sides of a ravine, and width of the ravine at the top is 15" m and height of the eye of observer from the ground is 1·5 m, find the height of the tree (8m). • *Calculate values* of – (10 m). (i) Bark thickness; (ii) Log volume OB; (iii) Log volume UB; (iv) Volume of bark, and (v) Bark percentage, for a log with measurements DBH OB = 130 cm, DBH UB = 124 cm and Length = 4·8 m • Discuss the *Metzer's theory* of Stem Form (8 m). • A tree with elliptical c/s when measured at BH by a *calipers* gives two values as 71 cm and 65 cm. Girth of the tree at BH by tape is 1·82 m. Calculate the basal area by three different methods, listing the methods clearly, and discuss which method is the correct one (12 m).
2011	• Describe reference point of *diameter/girth measurement* on a standing tree (10 m). • Explain *principles of height measuring* instruments (10 m). • What is *quarter girth formula*? Why is it preferred for calculation of log volume ? (10). • What is *yield table* ? How contents of yield table is utilized in forestry ? (10 m)
2010	• Comment on the comparative significance of *calliper* and *tape* for d.b.h measurement (8 m). • Explain the principle and use of *Abney's level* (10 m). • Write principle of *Christen hypsometer* and its use (10 m).
2009	• What is the importance of estimating *form factors* of a tree ? Write common formula(e) used to estimate the form factor (10 m). • Write on the importance of *stem analysis* in forest mensuration. How does the stem analysis help in knowing the volume of the stand ? (10 m). • Write the procedure of *measure the height of tree* in the following situation, when - (i) Observer's eye is above the top of the tree. (ii) Observe's eye is below the base of the tree (20 m) • Discuss the concept and use of *Horizontal point sampling* when wedge prism is used (10 m). • What is *Quarter girth formula* ? How is it used in calculating the volume of a log ? (10) • Write the salient differences between *local volume table* and *general volume table* (10)
2008	• Write different methods in brief for estimation of volume of stand (10m) [*Linked* Q : Forest Mensuration].
2007	• What is the importance of estimating *form factor* of a tree? Write common formula used to estimate the form factor (10). • Describe working principles of *Christen's Hypsometer* in tree height measurement (10). • Answer the Following –

	(a) To compute volume of standing trees which parameters are required to be measured? Write instruments used and brief procedure of their handling (20). (b) How the age of the trees can be determined in which annual rings are not clearly observed (10)?

[Part-II] REMOTE SENSING & GIS

2022	• "Application of Remote sensing and GIS helps in continuous forest cover monitoring and efficient forest management activities". Explain with Examples (15 Marks)
2021	• Define Gioinformatics. What are its elements? Explain its role in management and monitoring of forest resources (15m).
2020	• Why should GIS be considered as a 'Pure Science'? (8m) • What are the application of remote sensing in forestry? (15m).
2019	• Describe the role of remote sensing and GIS in monitoring forest resources (15 m).
2018	• Define *remote sensing*. Discuss its *application in forest management* along with GIS applications (10 m).
2017	• What are the applications of *remote sensing* and GIS in the field of forestry and wildlife? (8 m).
2016	• Define *photogrammetry*. Discuss in detail its application in forest management (10). • Thermal *Remote Sensing* has specific application in forest management, Describe (10) • The recent developments in *GIS and Digital Image Processing* make forest cover assessment and mapping more easier and accurate. Explain your views (10).
2015	• Discuss how the microwave *remote sensing* has been found to be more useful in forestry than other satellite imageries (15 m).
2014	• Differentiate between *Geostationary* and *Sun synchronous satellite*; and satellite imagery and remote sensing (8m).
2012	• Estimation of *crown volume* depends on which factors and what are the different geometrical shapes ·of crowns ? Write down the various formulae for measurement of crown volume (10). • What are the advantages and disadvantages of *LANDSAT* images? (8 m).
2011	• How is remote sensing advantageous as compared to ground surveys ? (10 m).
2010	• What are the *pictorial elements* used of interpretation of aerial photo graphs (10 m). • How does the *flying height influence the scale* of aerial photo graphs in hilly areas (10)

2009	• Discuss the features of *EM spectrum* & mention bandwidth spectral range used in remote sensing (10 m). [Similar Question in 2005] • Discuss the features of *EMR* & mention bandwidth spectrum range used in remote sensing
2007	• How is the remote sensing used in monitoring forest cover ? (10 m)

Source of Reference

- Forest mensuration by Chaturvedi AN & Khanna LS, IBD publication Dehradun.
- Forest mensuration by Anthonie VL and Alparslan A, Springer publication.
- Forest mensuration by Kershaw JA et. al, Wiley Blackwell publication (5th edition).
- Forest inventory, Methodology and application by Annika k & Mattis M, Springer publication.
- FAO web portal.
- Remote sensing and GIS by Basudeb Bhatta, Oxford University press (3rd Edition, 2020)
- Websites for for Previous year Papers – FAO, examrace.com, upsc, opsc, hppsc, ukpsc, uppsc and crowd sourcing.

CHAPTER

1

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 dimensions, form, weight, growth, volume, health, and age of trees, individually or collectively.

► **Definition :** Forest mensuration 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.

► **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 assessing the effects of silvicultural treatments on stand growth, its quality, and productivity.
- **For forest management** : To properly manage the forest land at the ecosystem level, we have to know how much wood is standing in the forest, its structure, composition, productivity, carrying capacity, and carbon sequestration. We also need to measure them for carbon trading, *forest certification,* and making a *"zero-carbon" economy* based.
- **For planning** : For the future need of the nation and its industries, *i.e.*, working plan.
- Prediction also is an important aspect of forest measurements. For instance, the weight of a standing tree cannot be measured directly, but it can be predicted using easily measured tree attributes such as diameter at breast height and total tree height.

► **SCOPES**

- For contractors, Sawyers, Transporters, and millers – to know the volume and quantity of timber.
- For a forester – for better wildlife management, estimating the carbon sequencing capacity of the forest.
- Recreational and eco-tourism purposes.

► **ACCURACY-RELATED ISSUES DURING MEASUREMENT** : Accuracy depends upon -

- **Characteristics of trees** : Trees vary widely for their length, shape, stem size, form factor, forking, and buttressing behavior. Therefore, they cause problems during measurement.
- **Varying methods and conditions of felling & conversion** : Even if we have measured them correctly, the actual result values may vary due to poor felting and conversion methods, lack of skilled workforce, location factors, and transportation losses.
- **The market value of the products** : Species whose market demand or prices are high will be measured more accurately and vice versa.
- **Instrumental errors** : Every instrument has its own level of accuracy, and its continuous use also produces distortion, *i.e.*, the length of a metric tape.
- **Personal biases of the treatment** : Work dysfunction, fatigue, and poor experience will also affect the results.

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.

For MCQ Based Exams

- The term mensuration comes from the *Latin* term *mensura*, which means *measure*.
- During Mauryan times, the unit of forest management was *Gorut* (12 km^2)

UNITS OF MEASUREMENTS

As we were a British colony, we used the FPS (foot, pound, second) system of measurement. However, after independence, we introduced the *Weights and Measures Act in 1956**** to adopt the **Metric / French / CGS** (centimeter, gram, second) **system** in general administration, although we were still using the FPS system in forestry. Later, in *October 1962, we adopted this CGS system in the Forestry field**** to synchronize our forestry research data with the world. However, the British system would continue to be apparent in the reference, so we have to study both

► **UNIT OF LENGTH**

British (Feet)	CGS (Meter)
• 12 inch = 1 foot • 3 feet = 1 yard* • 22 yard / 66 feet = 1 Chain* • 10 Chains = 1 furlong • 80 Chains = 1 mile	Millimeter > Centimeter > Decimeter > Meter > Decameter > Hectometre > Kilometer.

CHAPTER 2

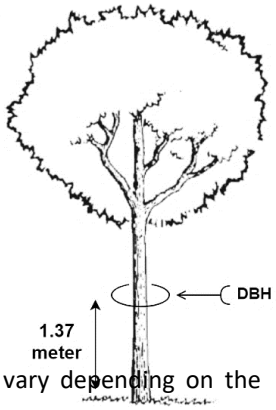
DIAMETER & GIRTH MEASUREMENT

2.1 OBJECTIVES BEHIND DIAMETER/GIRTH MEASUREMENT

- To estimate the quantity of timber, firewood, and other forest produce, *i.e.*, Cubic feet 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**

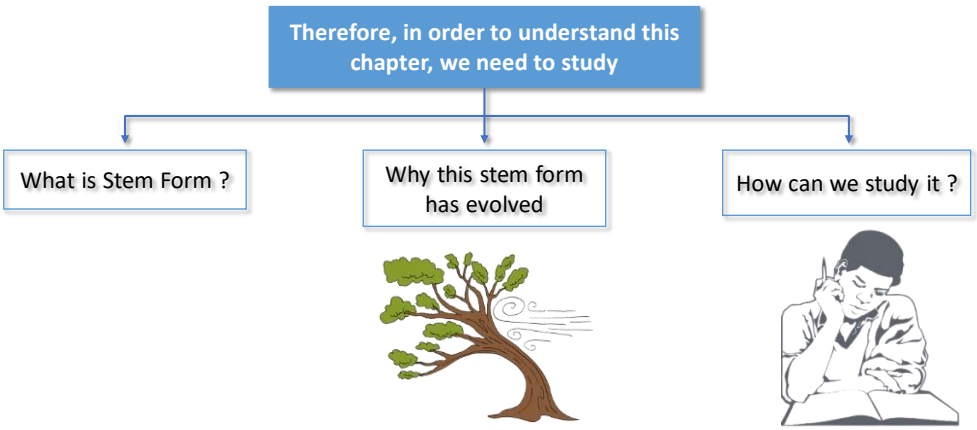
- The bases of the trees are generally covered with grasses, shrubs, and thorns sometimes, so the measurement of Diameter or Girth at the base is usually challenging and requires extra effort to clear these before the measurement.
- Many trees develop root swellings, Buttressing, and fluted stems near the base and may extend to several meters above ground, especially in tropical rainforests. These create difficulties in getting the actual diameter.
- It gives a uniform point of measurement and therefore standardizes diameter measurements of trees overall the world.

CHAPTER

4

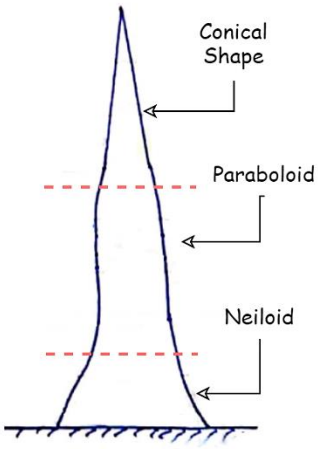
STEM FORM

The primary purpose behind the development of this subject, "Forest mensuration," is to estimate the timber volume of standing tree crops. Whereby a government, manufacturer, or contractor can set its price according to the market value for taxation, royalty, and auction purposes. But, simply multiplying the tree height data by its basal area (diameter) will not give us the actual volume. Why? Because the tree is not a cylinder, its thickness (diameter) continuously decreases from bottom to top. Therefore, we need to consider this rate of tapering to get a real answer.



4.1 STEM FORM

Stem form is the characteristic shape of the tree bole, which is usually tapered from the base to the top. Generally, a stem is divided into three parts – (a) The lower one is neiloid in shape and covers about 10% part, (b) The central section is represented by a paraboloid, and (c) the upper one is a conical section.



Although this general pattern is apparent in both the open-grown and stand-grown trees (In group). The stem profile of the individual tree is affected by its social position within the stand as well as the site, silvicultural treatments, such as stand density, planting espacement and fertilizer, and genetic parameters.

Note : **Tapering** is the rate of decrease in the diameter of a tree or a log per unit increase in height from the base. For practical purposes, it is expressed in centimetre per meter stem length

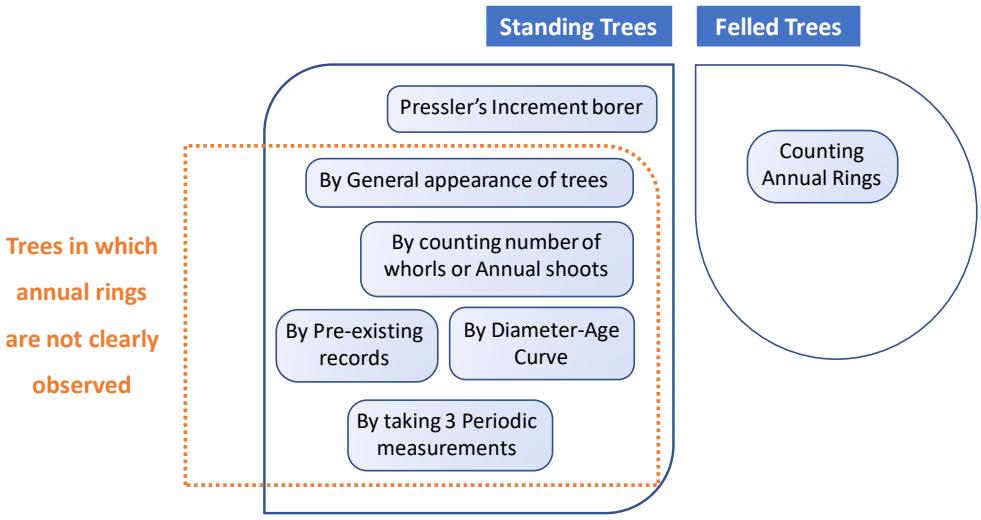
CHAPTER 7

AGE OF TREES

► **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*.
- *Colour and condition of barks* – in Shorea robusta, younger trees have rough, crooked and darker bark than the old one which has lighter and smooth bark.

CHAPTER

13

APPLICATION OF REMOTE SENSING

► **FOREST MANAGEMENT :** The main application of photo interpretation to forestry involves (i) preparation of a base map, identification of tree species, (ii) quantitative measurements about the density of trees in a given.

- Forest classification
- Forest certification
- Mapping stand structure, susceptibility and vulnerability.
- Wildlife management : habitat pattern and fragmentation analysis.
- Forest hydrology and watershed management –
- Monitoring Wetland Dynamics
- Carbon Cycle modelling for forest and terrestrial ecosystem.

► **MONITORING INVASIVE SPECIES** : The spectral information acquired by multispectral and hyperspectral sensors onboard satellites or aircraft has made it possible to –

- Papped and analyzed the abundance, distribution, and impact of invasive species on the local vegetation.
- Determine how they occupied the habitat.
- Determine the level of compositional changes in native ecosystems and prediction of what possible future dispersal at local, regional, and national levels.

Through analyzing key environmental parameters such as light, water, and temperature, with remotely detectable biophysical properties (Phenology) like – *Parthenium hysterophorus*, *Lantana camera*, *Argemone mexicana,* and *water hyacinth,* etc. shows a significant spectral variation (variation in leaf shedding, flowering & fruiting time, etc.), water blooming detection in wetland and coastal areas, etc.

Foresters and ecologists are now well aware of the problems caused by the invasive species into natural areas like displace native species, disrupt nutrient and fire cycles, and cause changes in the pattern of plant succession. So, they searching for answers to what types of biophysical traits make a superior invader and what types of communities are more susceptible to invasion. Ultimately, the goal of invasion research is to develop a unified and comprehensive framework that allows them (foresters, ecologists & conservation biologists) to make accurate predictions on the potential invaders even before their introductions and on the types of communities that are more vulnerable to invasions.

<u>Challenges</u>

- Mapping accuracy of our sensors.
- It is generally known that most understory invasive species are hard to detect and mapped by remote sensing since they could be completely hidden by the overstory canopy. However, there might be a temporal window

Congratulations

To all our successful candidates in

INDIAN FOREST SERVICE (IFOS) 2023

1 AIR

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Forestry Comprehensive Course

3 AIR

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Forestry Comprehensive Course

5 AIR

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6 AIR

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Forestry Comprehensive Course

10 AIR

Shashank Bhardwaj

Forestry Comprehensive Course + Test Series

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Ankan Bohra

Forestry Comprehensive Course

16 AIR

Prachi Gupta

Forestry Comprehensive Course

17 AIR

Raj Patoliya

Forestry Comprehensive Course + Test Series

23 AIR

Vineet Kumar

Forestry Comprehensive Course

27 AIR

Jatin Babu S

Forestry Comprehensive Course

28 AIR

Gaurav Saharan

Test Series

37 AIR

Yash Singhal

Forestry Comprehensive Course

41 AIR

Nitish Pratik

Forestry Comprehensive Course

50 AIR

VAASANTHI P.

Test Series

54 AIR

Sourabh Kumar Jat

Forestry Comprehensive Course

56 AIR

Ekam Singh

Forestry Comprehensive Course + Test Series

57 AIR

Kunal Mishra

Forestry Comprehensive Course

58 AIR

Atul Tiwari

Forestry Comprehensive Course

60 AIR

Aman Gupta

Forestry Comprehensive Course + Test Series

61 AIR

Sanket Adhao

Forestry Comprehensive Course

63 AIR

Preeti Yadav

Forestry Comprehensive Course

65 AIR

Nihal Chand

Forestry Comprehensive Course + Test Series

66 AIR

Shashikumar S. L.

Forestry Comprehensive Course

67 AIR

Dhino Purushothaman

Forestry Comprehensive Course

68 AIR

Diwakar Swaroop

Forestry Comprehensive Course

72 AIR

Rajesh Kumar

Forestry Comprehensive Course

74 AIR

Krishna Chaitanya

Forestry Comprehensive Course

75 AIR

Harveer Singh Jagarwar

Forestry Comprehensive Course

76 AIR

Akash Dhanaji Kadam

Forestry Comprehensive Course

78 AIR

Himanshu Dwivedi

Forestry Comprehensive Course

80 AIR

Sumit Dhayal

Forestry Comprehensive Course

82 AIR

Priyadarshini

Forestry Comprehensive Course + Test Series

91 AIR

Sucheet Balkal

Forestry Comprehensive Course

93 AIR

Harshad Hinge

Test Series

96 AIR

Maharshi Kumar

Forestry Comprehensive Course

97 AIR

Akash Kumar

Forestry Comprehensive Course

104 AIR

P R Sarbajit

Forestry Comprehensive Course

105 AIR

Pawan K. Meena

Forestry Comprehensive Course

110 AIR

Keshav Prasoon

Forestry Comprehensive Course + Test Series

111 AIR

Nagabhushana S

Forestry Comprehensive Course

113 AIR

Shewale Vyankatesh G.

Forestry Comprehensive Course

123 AIR

Chandra Bhushan

Forestry Comprehensive Course

127 AIR

Shubham Kanoujia

Forestry Comprehensive Course + Test Series

128 AIR

Harsh Verma

Forestry Comprehensive Course + Test Series

134 AIR

Gaugin Gyanendra Singh

Forestry Comprehensive Course

64 Out of 147 Total Selections in

Indian Forest Service (IFoS) 2023