

FORESTRY



APPSC

Andra Pradesh PSC

STATE FOREST SERVICE

2026

Detailed
Syllabus Based
study material

+

Linkage of
Concepts with
PYQs

+

Infused with
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Maps

Module - 3

- © Forest Protection
- © Forest Utilization
- © Forest Economics
- © Forest Legislation
- © Forest Planning & Management
(Only FSO, not in RFO syllabus)

MPPSC STATE FOREST SERVICE



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Selections in**

Assistant Conservator of Forest (ACF) 2024



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Assistant Conservator of Forest (ACF) 2023

GENERAL FORESTRY

MODULE – 3



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Module - 3

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PAPER ANALYSIS

SYLLABUS

GF – II | UNIT – II : FOREST PROTECTION

◆ Injuries to forest - *abiotic and biotic destructive agencies*, insect — pests and disease, effects of air pollution on forests and forest dieback. ◆ Susceptibility of forests to damage, nature of damage, cause, prevention, protective measures and benefits due to chemical and biological control. ◆ General forest protection against fire, equipment and methods, controlled use of fire, *economic and environmental costs*; ◆ *Timber salvage operations* after natural disasters. ◆ Role of afforestation and forest regeneration in absorption of CO₂. ◆ Rotational and controlled grazing, different methods of control against grazing and browsing animals; ◆ Effect of wild animals on forest regeneration, ◆ Human impacts : Forest encroachment, poaching, grazing, live fencing, theft, shifting cultivation and control

GF – II | UNIT – III : FOREST UTILIZATION

◆ Traditional and improved/modern tools used in logging, wood seasoning, wood/timber preservation, ◆ Logging-transport methods, ◆ Physical properties of wood and their importance in the identification of timber species. ◆ Uses of important MFP/NTFP species available in the forests of A.P. ◆ List of plants known to be *antidotes of snake and scorpion poisoning*

GF – II | UNIT – VI : FOREST ECONOMICS, FOREST LEGISLATION AND ADMINISTRATION

◆ **Forest economics** – fundamental principles, cost-benefit analyses; estimation of demand and supply; ◆ **Forest economics** – investment planning, depreciation, working capital, types of costs viz., gross, fixed, variable, marginal & opportunity costs., ◆ Methods employed for investment calculations such as Net surplus method, payoff time method, present value or capital value method, internal interest method, and capital cost method. ◆ **Forest Legislation**-History of forest development; the essence of Indian Forest Policy of 1894, 1952 and 1990. National Forest Policy -1988. ◆ **Forest laws**, necessity; general principles, AP Forest Act-1967; Forest Conservation Act-1980; Wildlife Protection Act-1972 and their amendments; Application of Indian Penal Code to Forestry. ◆ **Forest Administration** : Indian Forest Service, AP State Forest Service, AP State Forest Subordinate Services, AP Forest Department structure and activities

GF – II | UNIT – VIII : FOREST MANAGEMENT & WORKING PLAN

◆ Forest planning, evaluation and monitoring tools and approaches for integrated planning.

TOPIC-WISE QUESTION SUMMARY

Topic	FRO 2018	FSO 2019	ACF 2022	RFO 2022	FRO 2025 Pre	FRO 2025 Mains	FSO 2025 Pre	FSO 2025 Mains	Total
Forest Protection	9	13	11	13	5	17	16	5	89
Forest Utilization (Wood Science + NTFP)	6	3	37	21	4	25	11	4	111
Forest Economics	4	–	–	2	–	2	–	–	8
Forest Legislation (Policy + Acts)	9	15	1	17	5	16	1	5	69
Forest Management + Working Plan	–	–	8	–	–	4	–	1	13
Forest Administration	–	–	–	1	–	–	1	1	3
Total	28	31	57	54	14	64	29	16	293

1. FOREST PROTECTION

► PROTECTION AGAINST HUMAN

1. Branch of forestry which is concerned with the activities directed towards the prevention and control of damage to forests by man, animals, insects, fungi, injurious plants and adverse climatic factors [APPSC FRO (Mains) 2025]
 - (a) Forest Ecology
 - (b) Silviculture
 - (c) Forest protection
 - (d) Forest biology
2. The term 'forest degradation' refers to [APPSC (RFO) 2022]
 - (a) the process of natural forest recovery after disturbance
 - (b) the reduction in forest area due to urbanisation
 - (c) the decline in forest health and productivity over time
 - (d) the intentional planting of fast-growing tree species
3. The fragmentation of forest ecosystems due to human activities can lead to [APPSC (RFO) 2022]
 - (a) Increased species diversity
 - (b) Enhanced gene flow between fragmented areas
 - (c) Decreased habitat quality and loss of biodiversity
 - (d) Improved ecosystem resilience and stability
4. Alternation and destruction of natural habitats is the key human activity that leads to [APPSC (ACF) 2022]
 - (a) Pollution of the environment
 - (b) Hunting of valuable wildlife products
 - (c) Introduction of alien species
 - (d) The extinction of wildlife
5. Which of the following statement is false in relation to deforestation ? [APPSC Forest Section Officers (Pre) 2025]
 - (a) Urbanization
 - (b) More biodiversity
 - (c) Expansion of agriculture
 - (d) Timber purpose
6. What is a common environmental problem associated with the construction of large dams ? [APPSC FRO (Mains) 2025]
 - (a) Increased biodiversity
 - (b) Reduction in greenhouse gas emissions
 - (c) Submergence of forests and wildlife habitats
 - (d) Improved groundwater recharge
7. What is poaching ? [APPSC Forest Section Officers (Pre) 2025]
 - (a) Protecting animals
 - (b) Making medicine
 - (c) Illegal hunting of wild animals
 - (d) All of these
8. Which of the following is NOT a man-made disaster in India? [APPSC (RFO) 2018]
 - (a) Boat capsizing
 - (b) Forest fire
 - (c) Building collapse
 - (d) Cyclones
9. Shifting cultivation is locally called _____ in Malaysia [APPSC (ACF) 2022]
 - (a) Hanumo
 - (b) Ladang
 - (c) Karen
 - (d) Milpa
10. Which layer of the forest typically experiences the most intense burning during a fire? [APPSC (RFO) 2022]
 - (a) Canopy
 - (b) Understory
 - (c) Tree roots
 - (d) Forest floor
11. Forest fire spreading slowly over the ground with low flame is calledfire. [APPSC (Forest Section Officers) 2019]
 - (a) Ground
 - (b) Crown
 - (c) Creeping
 - (d) Surface
12. Which type of forest fire burns the organic material beneath the forest floor, including humus and peat ? [APPSC FRO (Mains) 2025]
 - (a) Surface fire
 - (b) Ground fire
 - (c) Crown fire
 - (d) Subsurface fire
13. Fire triangle consists of which of the following? [APPSC (RFO) 2018]
 - (a) Biotic factor, ignition and temperature
 - (b) Hazard, oxygen and biotic factor
 - (c) Fuel, biotic factor and oxygen
 - (d) Fuel, oxygen and temperature
14. Which forest type in India is most susceptible to severe fires ? [APPSC FRO (Mains) 2025]
 - (a) Evergreen forests
 - (b) Semi-evergreen forests
 - (c) Montane temperate forests
 - (d) Dry deciduous forests
15. In moist teak forests, adverse effect on natural regeneration of teak is due to [APPSC (ACF) 2022]
 - (a) Indiscriminate use of weedicides
 - (b) Poor management of trees
 - (c) Indiscriminate tree felling
 - (d) Indiscriminate fire protection
16. Which of the following is a natural method of preventing forest fires? [APPSC (RFO) 2022]
 - (a) Controlled burning
 - (b) Smokey bear campaigns
 - (c) Fire-fighting helicopters
 - (d) Fire-resistant tree species
17. Controlled burning in a forests is [APPSC (Forest Section Officers) 2019]
 - (a) Integrated control
 - (b) Biological control
 - (c) Silvicultural operation
 - (d) Chemical control

18. What is the most effective way to prevent human-caused forest fires? [APPSC (RFO) 2022]
- Enforcing strict penalties for arson
 - Promoting fire safety education
 - Increasing forest patrols
 - Planting fire-resistant tree species
19. Which one is a traditional method of firefighting in forests? [APPSC Forest Section Officers (Pre) 2025]
- Fire alert system
 - Mobile squads
 - Communication devices
 - Counter fire
20. Which one is a modern method of firefighting in forests? [APPSC Forest Section Officers (Pre) 2025]
- Controlled burning
 - Fire terracing
 - Fire watchers
 - Fire alert system
21. Which sensors are used by Forest Survey of India to identify forest fire in India? [APPSC (ACF) 2022]
- High Resolution Infra-Red Radiation Sounder and Suomi-National Polar-orbiting Partnership - Visible Infrared Imaging Radiometer Suite
 - Moderate Resolution Imaging Spectro-radiometer and Suomi-National Polar orbiting Partnership - Visible Infrared Imaging Radiometer Suite
 - High Resolution Optical Imager and Moderate Resolution Imaging Spectroradiometer
 - High Resolution Optical Imager and High Resolution Infra-Red Radiation Sounder
22. What are the names of the satellite-based modules used for near real-time monitoring of forest fires by the Forest Survey of India? [APPSC (RFO) 2018]
- MODIS and SNPP-VIIRS

- MODIS and SNPP-VIIRS
 - LISS III and MODIS
 - LISS III and SNPP-VIIRS
23. The real time forest fires are visualized through which sensors used by Vana Agni Portal? [APPSC FRO (Mains) 2025]
- MODIS
 - SNPP-VIIRS
 - Both (1) and (2)
 - None of these
24. What is the spatial resolution of LISS III sensor? [APPSC (ACF) 2022]
- 24 m
 - 80 m
 - 30 m
 - 10 m
- **PROTECTION AGAINST ANIMALS**
25. The animals dwelling in _____ ecosystem show gregariousness, keen sight and swift running. [APPSC (Forest Section Officers) 2019]
- Aquatic
 - Grassland
 - Desert
 - Forest
26. The grasslands found in Argentina are called: [APPSC (RFO) 2018]
- Savannas
 - Prairies
 - Steppes
 - Pampas
27. Dhadabgao and Sankarnarayan (1973) classified the grasslands of India broadly into [APPSC (ACF) 2022]
- 4 types
 - 5 types
 - 6 types
 - 7 types
28. What is the primary factor responsible for the formation of grasslands? [APPSC (RFO) 2022]
- High annual precipitation
 - Rich soil with high organic content
 - Extreme temperature fluctuations

- Insufficient rainfall to support tree growth
29. The anthropogenic activity that poses a threat to grassland ecosystems is [APPSC (RFO) 2022]
- Planting more trees to increase biodiversity
 - Promoting controlled grazing by herbivores
 - Overgrazing by livestock
 - Implementing conservation measures
30. Match column A with column B [APPSC FRO (Pre) 2025]
- | Column A | Column B |
|---------------------------|-------------------------------|
| i. Sehimia-Dichanthium | a. Alpine region |
| ii. Phragmitis-Saccharum | b. Marshy locality |
| iii. Deschampsia-Deyeuxia | c. Black soils |
| iv. Bothriochloa | d. High rainfall paddy fields |
- i-c, ii-b, iii-a, iv-d
 - i-a, ii-d, iii-b, iv-c
 - i-c, ii-a, iii-b, iv-d
 - i-a, ii-b, iii-c, iv-d
31. What is the primary benefit of rotational grazing? [APPSC (RFO) 2022]
- Increased forage production
 - Increased animal reproduction
 - Reduced infectious disease in animals
 - Improved soil texture
32. Which of the following statements is true about rotational grazing? [APPSC (RFO) 2022]
- It requires large amount of land.
 - It leads to overgrazing of certain areas.
 - It can help control parasites in livestock.
 - It is not suitable for maximising forage utilisation

- (d) 1998
- 268.** In which year, the Andhra Pradesh Forest Act come into force? [APPSC (Forest Section Officers) 2019]
- (a) 1977
(b) 1967
(c) 1958
(d) 1972
- 269.** What does Section 28 of the Andhra Pradesh Forest Act, 1967, state? [APPSC FRO (Pre) 2025]
- (a) Power to issue notification reserving tree
(b) Power to close forest against pasture
(c) Power to declare protected forest to cease to be protected forest
(d) Power to declare reserved forest as no longer reserved
- 270.** As per the Andhra Pradesh Forest (Amendment) Act, 2016, which of the following is classified as a 'scheduled tree'? [APPSC FRO (Mains) 2025]
- (a) Teak (*Tectona grandis*)
(b) Rosewood (*Dalbergia latifolia*)
(c) Red Sanders (*Pterocarpus santalinus*)
(d) Sandalwood (*Santalum album*)
- 271.** As per the A.P. Forest Act, 1967 (Amendment), a private persons possessing Red Sanders Wood above what quantity (in kgs) must inform their stocks to the concerned divisional Forest Officer within 180 days? [APPSC Forest Section Officers (Mains) 2025]
- (a) 5 kgs
(b) 10 kgs
(c) 20 kgs
(d) 25 kgs
- 272.** What is 'Cognizable Offence'? [APPSC FRO (Mains) 2025]
- (a) An offence where Police must get Court permission to arrest
(b) An offence that is only punishable with a fine

- (c) An offence where Police can arrest without prior approval
(d) A civil wrong
- 273.** What is a 'Non-Bailable Offence'? [APPSC FRO (Mains) 2025]
- (a) An offence where bail is automatically granted
(b) An offence where bail is not a right but can be granted by a Court
(c) An offence that does not require a trial
(d) A minor crime
- 274.** Who is considered a 'Public Servant' under IPC? [APPSC FRO (Mains) 2025]
- (a) A person lawfully authorized to discharge public duties on behalf of the Government
(b) Only officials who hold elected positions in Government
(c) Only Police Officers and Judges
(d) Any person working in a Government office, regardless of duties
- 275.** What is the act of stopping a person, restraining their movement, and detaining them with valid legal authority called? [APPSC FRO (Mains) 2025]
- (a) Custody
(b) Detention
(c) Conviction
(d) Arrest
- 276.** What is the legal notice issued by a Court ordering an individual to appear or produce a document at a specified time and place? [APPSC FRO (Mains) 2025]
- (a) Summon
(b) Bail
(c) Charge
(d) Warrant
- 277.** As per Evidence Act, what does "evidence" include? [APPSC FRO (Mains) 2025]
- (a) Both oral statements and documentary evidence, including electronic records

- (b) Only oral statements made by witnesses
(c) Only documents produced before the Court
(d) Only physical objects related to the case

5. FOREST MANAGEMENT + WORKING PLAN

- 278.** In the regeneration category, woody shoot which has been browsed is represented by which of the following symbols? [APPSC (ACF) 2022]
- (a) W⁺
(b) W⁻
(c) U
(d) W
- 279.** A felling area, usually one of an annual series, is called _____. [APPSC (ACF) 2022]
- (a) Compartment
(b) Coupe
(c) Cutting section
(d) Periodic block
- 280.** The minimum diameter at breast height at which trees are considered suitable for exploitation is [APPSC (ACF) 2022]
- (a) Felling diameter
(b) Tradable diameter
(c) Exploitable diameter
(d) Selective diameter
- 281.** The sum (by number or volume) of all the trees growing in a forest or a specified part of it is [APPSC (ACF) 2022]
- (a) Yield
(b) Growing stock
(c) Number of trees
(d) Crop volume
- 282.** The rotation under which a species yields the maximum material of a specified size or suitability for economic conversion or for special use is called as [APPSC (ACF) 2022]
- (a) Rotation of maximum volume production
(b) Technical rotation

FOREST PROTECTION

INTRODUCTION

1.1 FOREST DISASTERS

HAZARD : A dangerous event, natural or man-induced, that could cause injuries, loss of life, damage of property, livelihood, or environment in a definite area. Events may be –

- **Natural**, e.g., Tsunami, Volcanic eruption, Earthquake, etc.
- **Man-induced**, e.g., Pollution, Flood, Drought, etc.

DISASTER : When a *natural* or *human-induced event* causes *widespread human loss*, accompanied by loss of livelihood, property, and the environment *in a definite area*.

- Means that an event becomes a disaster only when it happens at such a wide scale that the forest ecosystem is unable to cope with it, causing complete disruption of the normal functioning of the forest ecosystem.

[A **forest disaster** is a large-scale event that causes significant damage to a forest ecosystem]

TYPES OF FOREST DISASTERS

Based on speed

- Slow onset : Takes months/Years – Drought, Environmental / Forest degradation.
- Rapid onset : Triggered instantaneous – Cyclone, Landslide, Forest fire, etc.

Based on the agency

- Natural : Tsunami, Cyclones
- Man-induced : Forest fire

Based on the area of damage

- Climatic disasters : Drought, Flood in the Low lying area, Cyclone, Hail storm, Heatwave
- Geological disasters : Landslides, Volcanic eruptions, etc.
- Hydrological disasters : Tsunami, Limnic eruptions, etc.
- Man-induced : Forest fire, Heavy metal poisoning, etc.



Mt. Merapi volcano erupts, Indonesia, March 2023



Bhopal gas tragedy



The U.S. military used **Agent Orange**, a herbicide and defoliant, during the Vietnam War from 1962 to 1971.

PROTECTION AGAINST INJURIES BY MAN

On the one hand, man is responsible for the establishment and cultivation of new forests, as well as the regeneration and sustainable management of natural forests in a scientific manner. However, on the other hand, man is also the primary cause of damage and destruction to these forests. Due to human activities, numerous forests around the world have already vanished, and some continue to be destroyed even today

KINDS OF DAMAGES BY MAN (ANTHROPOGENIC)

- Deforestation
- Shifting cultivation
- Illicit felling and illicit removal of forest produce
- Forest fire
- Encroachment
- Defective management
- Other damages, such as lopping, removal of leaf litter, removal of flowers and fruits, poaching, environmental pollution, etc.

10.1 | DEFORESTATION

DEFINITION : Deforestation is defined as the *removal of tree crops* from a piece of land *without the intention of reforesting*. The damaging or removal of forest vegetation to such an extent that it failed to support its natural flora and fauna.

CAUSES OF DEFORESTATION

- Diversion of forest land for non-forestry purposes – like river valley projects, *Dams, Roads, Communication Lines, Railway Tracks, Mining*, etc. which have done a lot of damage to the forests. Since independence about. [Major causes = Expansion of Agriculture land]
Example : Establishment of fruit belts in hills, *i.e.*, Chamba-Mussoorie fruit belt of UP govt during the 1960s clear large area of deodar-oak forest of Shivalik and lesser.

About **7.5 million hectares** of forest land has been diverted for non-forestry uses since independence, of which approximately **4.5 million ha** was diverted between 1950-1980 and **2.8 million hectares** from 1980 to 2000. The central government admitted that *in 2019, 11500 hectares of forest land had been diverted in 22 states.*

- Forest Fire : both natural and accidental. In 2016, about a 4500-hectare area was burnt in Uttarakhand due to a forest fire. The fire in Australia (2020) destroyed 18.6 million hectares of land and killed nearly three billion terrestrial vertebrates.

PROTECTION AGAINST INJURIES BY ANIMALS

Animals cause damage to forests through grazing, browsing, debarking, trampling of plantations, and new growth.

Domestic animals often enter the forest to graze, which can have significant negative impacts on both the forest and its wild inhabitants. One major concern is the potential spread of diseases from domestic animals to wild animals. Additionally, domestic animals can inadvertently introduce new weed species by carrying the seeds on their bodies.

3.1 GRAZING

Grazing refers to feeding leaves and twigs of plants such as grasses and herbs.

Grazing Animals : Cow, Buffalo, etc.

SIGNIFICANCE

- The backbone of the rural economy by providing milk, food, meat, and workforce.
- Contribute 6 % of GDP and 25 % of agricultural GDP.

GRAZING PATTERN

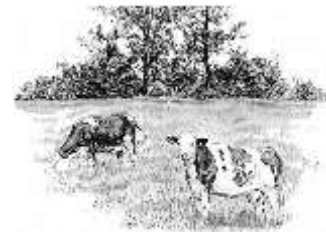
- (1) **Migratory grazing** : In this grazing, animals move from a higher to a lower altitude in winter seasons to avoid cool weather conditions uphill and go back to hills in summer (*i.e.*, Bakarwals in HP, Van Gujjar in JK).

🦅 **Kharak** system in Uttarakhand, **Gol** system in Rajasthan,

- (2) **24 hour grazing** : In this, livestock remains inside the forest throughout the day. After the end of the designated period, animals are captured again for domestic use.
- (3) **Day grazing** : Here, animals are allowed inside the forest in the daytime for grazing. In the nighttime, livestock is returned back to cattle sheds located near the human settlements.
- (4) **Penning and stall feeding** : In this kind, fodder is collected from the forest and fed to the cattle in the cattle shed itself. Animals are not allowed to go out of the cattle shed.

► GRAZING SYSTEM

- (1) **Continuous grazing** : In this grazing, the area subjected is *allowed for grazing throughout the year* without any control or regulation measures. This is not advisable because *continuous grazing*



Grazing



Browsing :

[Goat, Elephant, Camel, etc.]

PROTECTION AGAINST INJURIES BY INSECTS

Insects are a significant threat to forests as they cause a lot of damage. They can harm plants at any stage of growth, from the time the seeds are planted until the final product is ready. Some insects like weevils and moths can even attack the seeds before they are collected. The deterioration of seeds due to insect infestation can continue during storage as well.

4.1 HARMFUL POLYPHAGOUS INSECTS

- Termites (White ant)** : Species - *Odontotermis* obesus & *Microtermis* mycophagus
 - Order : Isoptera
 - Harmful stage : ~~Larvae~~ / ~~Pupae~~ / **Adult only** / All
 - Caste responsible for all types of damages : ~~Larvae~~ / **Workers** / **Queen** / **Soldiers**.
 - Termite problems are more serious in *Arid and Semi-arid* conditions/Sandy and Sandy loam soil.
 - Positive Role of Termite in *Nutrient Recycling*
 - Chemical control can be achieved by spraying *Aldrin* and *Chloropyrifos*.
- White Grub or Chaffer Beetle or June Beetle or Cock Chaffer** : It is a *soil-dwelling root feeder polyphagous* larva.
 - Order : Coleoptera
 - Example : *Holotrichia* Consanquinea***
 - Serious Nursery pest of *Teak, Sal, Deodar, Babool, Ber* and *Khejari*.
 - Attackers stage : Grub (Root feeder, attack on seedlings), Adult (Leaf feeder).
- Cut-worm (*Agrotis epsilon*)** : The caterpillar is mainly active during the night and cut young shoots near the base to suck sap.
 - It attacks primarily on - *Acacia, Albizzia, Prosopis (AAP), and Eucalyptus*.
- Bark-eating caterpillar (Xyleborous)** : Caterpillars such as the *Inderbela quadrinotata* consume the bark of many species and form shelters around it.
 - Attacks on *Acacia, Albizzia, Prosopis (AAP), and Ziziphus*.



Termite



White grub



Cut-worm



Inderbela quadrinotata

PROTECTION AGAINST INJURIOUS DISEASES

Branch of forestry that deals with the diseases of forest species & timber : Forest Pathology

Causes of diseases

- Parasitic or infectious
- Non-infectious : by adverse weather

Types of diseases

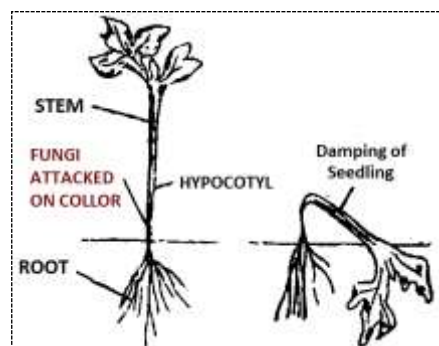
- Endemic : in a particular locality, i.e., Monkey fever
- Epidemic : India/Indian Sub-continent level
- Pandemic : Continent or global level, i.e., Malaria, COVID-19.

5.2 DAMPING OFF

Damping-off is the most widespread and serious forest nursery disease in India as well as the world. It primarily affects *conifer seedlings* growing in a temperate climate, though it also attacks *broad-leaved seedlings* as well—results of large-scale mortality in forest nurseries = upset plantation activity.

► MORTALITY OCCURS AT 3 STAGES OF SEEDLING GROWTH

- (1) **Pre-emergence blight** : The seedlings are killed even before they emerge above the ground level. As a result, very few seedlings are able to come up above the ground and this is wrongly attributed to the poor quality of seeds. It is difficult to estimate the loss due to pre-emergence blight unless the killed seedlings have been dug up from the soil.
- (2) **Post-emergence blight** : The seedlings may be killed after emergence from the ground as a result of rotting of tissues at the base (*Hypocotyl*) or roots, or Both.
- (3) **Root rot** : Pathogenic fungi may attack the roots of older seedlings. Usually, it affects succulent root tips resulting in poor growth performance. However, in extreme cases when prolonged drought and other environmental-biotic stresses followed by these fungal attacks may cause death.



► PATHOGEN : A number of *soil fungi*^{***} may cause this disease.

Usually, they are *soil saprophytes*^{***}, but under favorable conditions, they become pathogenic. Fungi of the genus *Pythium*, *Rhizoctonia*, *Phytophthora* and *Fusarium* are mainly responsible for dumping off. In India, *Rhizoctonia solani* is the most important cause of damping-off in conifer nurseries.

REMAINING TOPICS

6.1 INJURIES TO FOREST BY ABIOTIC AND BIOTIC FACTORS : We have already studied all these in chapters 3 to 6 and 10 of silviculture and chapters 2 and 3 of forest ecology.

Living (Biotic) and Non-living (abiotic) stresses are two categories of environmental factors that can forest vegetation.

Biotic stresses : living organisms such as pests, pathogens, and other organisms that directly affect tree health.

- Insects like beetles, borers, caterpillars, and aphids can attack trees, feeding on leaves, stems, or roots and causing damage.
- Fungal, bacterial, and viral pathogens can infect trees, leading to diseases such as pink disease in Eucalyptus, Teak defoliation.
- Competing vegetation, commonly referred to as weeds, can compete with trees for nutrients, water, and sunlight, potentially affecting tree growth and health.
- Larger organisms like deer, rabbits, or rodents can browse on tree foliage or bark, causing damage or hindering growth.

Abiotic stresses : non-living environmental factors that can impact trees. These stresses are often related to unfavorable physical or chemical conditions. Examples include –

- Extremely high or low temperatures - can affect tree physiology and metabolism, leading to stress or damage.
- Lack of water availability - can cause drought stress in trees, impacting their ability to carry out essential functions and leading to wilting or even death in severe cases.
- Flooding - Excessive water saturation in the soil can suffocate tree roots, causing oxygen deprivation and root damage.
- Salinity - High salt levels in soil or water can be detrimental to tree health by affecting water uptake and causing toxicity symptoms.
- Poor soil quality, such as compacted soil, nutrient deficiencies, or imbalanced pH levels, can limit tree growth and Vigor.
- Pollution: Air pollution, including high levels of ozone, sulfur dioxide, or heavy metals, can negatively impact tree health and vitality

Trees have evolved various responses to cope with both biotic and abiotic stresses. These responses can be categorized into physiological, morphological, and biochemical adaptations.

➡ PHYSIOLOGICAL RESPONSES

- Sunken Stomata to reduce water loss through transpiration.
- Adjusting Leaf Angle to minimize exposure to excessive sunlight, reducing the risk of overheating.

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.



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

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.

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

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

► 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 **free 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.

WOOD PRESERVATION

Wood preservation is the process of *improving the natural durability of wood* through treatment with chemicals that are toxic to insects, fungi, and other decaying agents.

NECESSITY

- To increase the lifespan of wood : Woods uses extend to various sectors of the economy (e.g., telephone poles). However, due to cellulose and moisture, its durability or working lifespan diminishes significantly. Therefore, some forms of treatment are necessary to prevent this.
- To enhance the working ability of wood under specific conditions, we also require a specific type of wood that can function effectively under particular conditions, such as heat or salt stress conditions (marine environment), where normal wood may not work efficiently.
- To avoid frequent replacement of wood.

Durability : The property or ability of wood to remain sound. Usually, it's lost due to fungal attacks, insect attacks, animals, fire hazards, or mechanical wear and tear.

Factors Affecting Durability : Moisture contents in the wood (Provide a base for fungal attack), its hardness (↑↑), deposition of resin and gums (↑↑), and use of wood.

Hardwood + more gum/resin deposition = more durable

Ralph Pearson^{***} : Father of wood preservation. Started scientific studies on wood preservation at FRI in 1908

Sonti Kamesam developed a wood preservative "ASCU" in the 1930s at FRI.

6.1 WOOD PRESERVATIVES

Preservatives are chemical used in preservation, usually poisonous to insect pests. Property of an ideal preservative

- It should be *Highly toxic to fungi*, insects and marine organisms whereas *least toxic to human* beings
- High permanence (*resist to leaching* by water or by any other solvent)
- It should *impregnate the wood easily* (High Penetrability) and retain it permanently
- It should be *neither volatile nor liable to become inactive* after some years (High chemical stability).
- It should be *cheap and available in plenty*
- It should *not increase the inflammability* of wood
- It should *not corrode metals*
- It should be a *colourless, odourless, and paintable* one.
- It should *not affect the strength* of the wood.

MODIFIED TIMBER

7.1 COMPOSITE WOOD

Composite wood is a general term for built-up bonded products consisting either *wholly of natural wood or of wood in combination with metals, plastics, etc.*

Various processes and methods have been developed, most of them in recent years in building larger pieces from relatively small pieces or in treating and modifying wood by means of pressure, heat, and chemicals.

TYPES OF COMPOSITE WOOD

- Plywood
- Laminated wood
- Core boards
- Sandwich boards
- Fibreboards
- Particleboards

- **PLYWOOD** : It is a glued wood construction built up of veneers in such a manner that the *grain of each veneer is at right angles* (called the *cross-bonded construction*) to that of the adjacent veneer in the assembly. The outer faces are called **Faces** and the center one is called **Core**. The number of veneers is always in **Odd Numbers** (usually 3 to 13).



- ✂ Normal sheet size of plywood : **4 Foot × 8 Foot** or **122 cm × 244 cm** [MPPSC Forest (Main) 2022]
- ✂ The minimum number of plies in plywood is = 3 [Karnataka PSC AE 2015]

PLYWOOD (COMPOSITE WOOD) PROPERTIES / ADVANTAGES

- The density of wood/ board is uniform = **Tensile strength is equal in all directions** ***
- All knots, twists, air pockets, bonding defects, and graining issues have been eliminated
- The smooth surface finish makes them ideal for carving and painting.
- There are no dimensional limitations in terms of **Size, Shape, and Thickness** and we can customize them to any required length and width.
- have **high resistance to impact** ***
- Can make them water-resistant, fire, or chemical-proof
- Do not show any swelling, shrinking, or warping properties.
- More durable than natural wood.
- Use wood wastage = environment friendly

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.

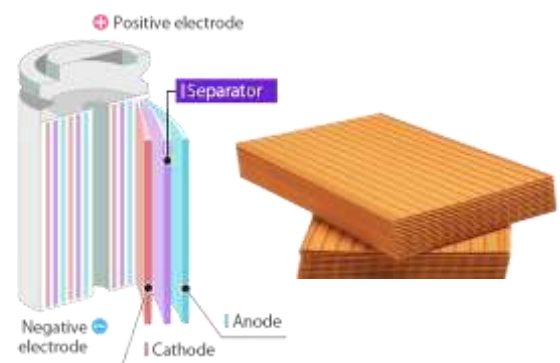
- **Furniture Industry** : The essential qualities required are good colour, handsome grain or figure, non-liability to crack, split, warp or ease of working and finishing.

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*, *Ailanthus 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.



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.

FOREST MARKET

SYLLABUS : Analysis of trends in the national and international market and changes in production and consumption patterns. Assessment and projection of market structures.

- ❖ **MARKET** : an area or place where buying and selling of various goods and commodities taken place.
- ❖ **MARKET STRUCTURE** : The term *structure* refers to something that has organization and dimension (*i.e.*, shape, size and design), and which is evolved for the purpose of performing a function. By the term *market structure*, we refer to *the organizational characteristics of a market including its size, design and manner of operation that affect the nature of competition and pricing, and the operations of business firms.*

COMPONENTS OF MARKET STRUCTURE

1. Concentration of Market Power – means, the element that determining the nature of competition, Conduct & performance of the market. This is measured by the number and size of firms existing in the market. A high degree of market concentration restricts the movement of goods between buyers and sellers at fair and competitive prices, and creates an *oligopoly**** or *oligopsony**** situation in the market.
2. Degree of Product Differentiation - Homogeneous or other nature of the product affects the market structure. If products are homogeneous, the price variations in the market will not be wide. When products are heterogeneous, firms have the tendency to charge different prices for their products.
3. Conditions for entry of Firms in the Market - Sometimes, a few big firms do not allow new firms to enter the market or make their entry difficult by their dominance in the market.
4. Flow of Market Information - A well-organized market intelligence information system helps all the buyers and sellers to freely interact with one another in arriving at prices and striking deals.
5. Degree of Integration - The behavior of an integrated market will be different from that of a market where there is no or less integration either among the firms or of their activities. Firms plan their strategies in respect to the methods to be employed

Monopoly (mono = Single + Poly = Supplier) : a market situation where a specific person or enterprise is the only supplier of a particular commodity.

Oligopoly (some suppliers) - a market situation when there are only a few suppliers (sellers) for the supply of goods or services

Monopsony (Single buyer) - a market situation where a specific person or enterprise is the only buyers of a particular commodity

Oligopsony = few buyer

Perfect (Open) market : a market structure, where a large number of small firms compete against each other. In this scenario, a single firm does not have any significant market power.

FOREST POLICIES

SYLLABUS : History of forest development; Essence of Indian Forest Policy of 1894, 1952 and 1988. National Forest Policy 1988.

1.1 | HISTORY OF FOREST ADMINISTRATION IN INDIA

The history of organized forest administration in India is ancient. Forests have always been integral to Indian civilization — providing food, shelter, and cultural significance. However, formal regulation began with ancient empires that recognized forests as state assets requiring protection and control.

MAURYAN PERIOD (321 – 185 BCE)

- **Chandragupta Maurya** was the first Indian ruler to institutionalize forest management = “first king who made an effort to look after the forest of his kingdom***” by appointing **Kupyadhyaksha**.
- **Kautilya (Chanakya)** in the **Arthashastra** mentioned a specific officer called **Kupyadhyaksha** (*Superintendent of Forests*), Assisted by **Vanpalas** (forest guards).
- Forests were classified into four categories : ♦ **Royal forests** – reserved for the king’s hunting and recreation. ♦ **State forests** – reserved for government use. ♦ **Brahmadeya forests** – donated to Brahmins/Monks and for Sacred groves. ♦ **Public forests** – open for common use.
- **Focus** : regulation of produce (timber, ivory, honey), wildlife protection, and revenue collection.

GUPTA PERIOD (4TH – 6TH CENTURY CE)

- Forest management became **localized**; control passed to **village communities**.
- Timber and medicinal plants were key trade goods.

COLONIAL PERIOD (BRITISH RULE)

The **modern forest administration** in India began under the **British**, whose priorities were revenue extraction and timber supply for railways, navy, and industries.

Charter on Indian Forests (1855) – Lord Dalhousie

In the early period of British rule, forest use was guided by the **laissez-faire economic ideas** of thinkers like **Adam Smith** and **David Ricardo**. This meant minimal government interference, free trade, and open access to natural resources. As a result, private timber merchants freely exploited forests, especially in **Malabar, Bengal, and Burma**, leading to rapid and unregulated cutting of valuable timber.

Reasons for the Charter

- **Change in Economic Philosophy** : Earlier British policy followed **laissez-faire** ideas of **Adam Smith** and **David Ricardo**, meaning : ♦ Minimum government control, ♦ Free trade and free use of resources, ♦

CHAPTER 2

FOREST ACTS

Forest Law, Indian Forest Act (1927, 2002, 2006), Forest Conservation Act (1980) and amendments. Indian Forest Act 2019 (Amendment) – Bamboo freed from forest produce.

- [Wild Life](#) Protection Act (1972) and its Amendments.
- [Environment](#) Protection Act 1986
- [Biodiversity](#) Act 2002,
- [Forest Right](#) Act 2006 for tribal
- [AP Forest Act](#) 1967

Laws are a body of principles recognized and applied by the state in the administration of justice.

Forest Law : All principles, regulations, or acts that govern the forest and its related activities either inside or outside of the forest.

- Law is a generic term, whereas 'Acts' pertains to a specific situation.
- Forest law is a **Special law** [CGPSC Assistant Professor 2019; MPPSC (ACF/RFO) 2020; Nagaland PSC CTE 2017,2021]

Forest Policy : policy is a purposeful course of action, undertaken by an organisation that deals with the uses and management of forest resources.

Forest Law	Forest Policy
Laws or 'Acts' are related to regulating and governing a particular situation or act. If you violate it you will be punished.	The policy is a guiding principle and is related to our future Goal where we want to go. If someone violates it, there is a provision for punishment.
Passed by Parliament	By Executive decision, no need to go through parliament

2.1 INDIAN FOREST ACT (1927)

- ▶ 21st September 1927
- ▶ Act to consolidate the law relating to forests, the transit of forest produces and the duty leviable on timber and other forest produce.

Original Act [MP 2020]

- Chapter = 13***
- Sections = 86***

Chapter : 1 Preliminary	Section 1 : This act may be called the Indian Forest Act of 1927 Extent – Whole India. Section 2 : Definitions –
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Chapter 2 : General power of central government	Section 3 : Power of central government to take measures to protect and improve environment Section 4 : Appointment of officers and their powers and functions Section 6 : Central Government may, by notification in the Official Gazette, make rules with respect to control of environmental pollution.
Chapter 3 : Prevention, control, and abatement of environmental Pollution	Section 7 : Persons carrying on industry operation, etc., not to allow emission or discharge of environmental pollutants in excess of the standards Section 10 : Powers of entry and inspection Section 12 : Environmental laboratories Section 13* : Appointment of Govt. Analyst by Central govt. Section 16 : offences by companies Section 17 : offences by govt department
Chapter 4 : Miscellaneous	Section 25 : Power to make the rule

► Environmental protection rule (**19 November 1986**)

2.6 ANDHRA PRADESH FOREST ACT 1967

An Act to consolidate and amend the law relating to the protection and management of forests in the State of Andhra Pradesh. Enacted by the Legislature of Andhra Pradesh in the Eighteenth Year of the Republic of India

Came into force : **15 April 1967***

Total : Chapters = 10 (+ Chapter IIIA) | Sections = 72

[1] Short title, commencement and application	1) This Act may be called the Andhra Pradesh Forest Act, 1967. 2) It extends to the whole of the State of Andhra Pradesh. 3) It shall come into force on such date as the State Government may, by notification in the Andhra Pradesh Gazette, appoint – 15.04.1967
[2] Definitions	(a) 'Cattle' includes cows, oxen, elephants, camels, buffaloes, horses, mules, asses, pigs, sheep, goats and such other animals as the Government may notify. (b) 'Divisional Forest Officer' means the forest officer in independent charge of a forest division. (c) 'Forest Officer' means any person appointed by the Government – Chief Conservator ... Ranger, Forester, Forest Guard, Forest Watcher, Thanadar, Checking Officer or Plantation Watcher; but does not include a Forest Settlement Officer. (d) 'Forest produce' includes timber, bamboos, charcoal, rubber, catechu, wood-oil, resin, lac, mahua flowers & seeds, myrobalans, tumki leaves, rousa grass, Rauwolfia serpentina, <i>adda leaves</i> (whether found in a forest or not) + "<i>gum</i>" (added 1977). (e) 'Red sanders wood' means wood of "<i>Pterocarpus santalinus</i>" including chips, dust or powder. (f) 'Sandalwood' means wood of "<i>Santalum album</i>" including chips, dust or powder.

FORESTRY MANAGEMENT

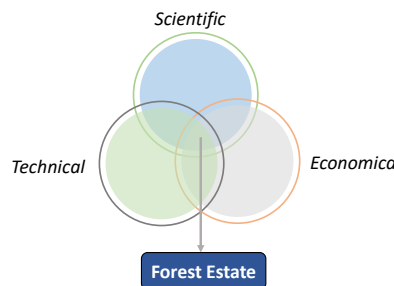
[INTRODUCTION]

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

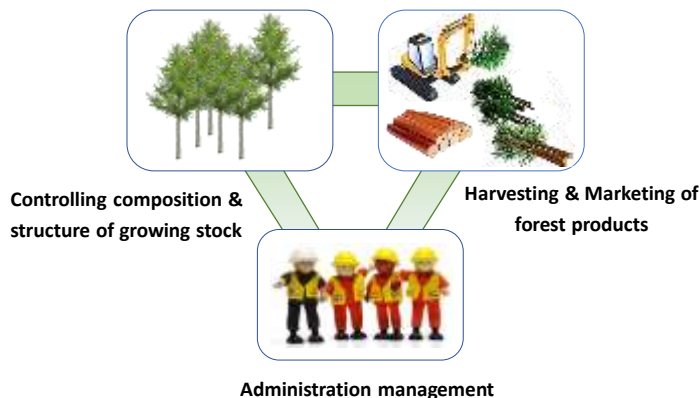
The **practical application** of the **scientific, technical, and economic principles** of forest estate for the achievement of **certain objectives**.

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.



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

Chapter Outline

- 1.1 Definition
- 1.2 Scope
- 1.3 Goals & Objectives of Forest management
 - General objectives
 - Special objectives
- 1.4 Principles of forest management
- 1.5 Peculiarities of forest management
- 1.6 Private forest

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

1.3 GOALS & OBJECTIVES OF FOREST MANAGEMENT

A **goal** is a long-term aim, derived from forest policies to achieve sustainable forest resources development. Only one goal should be determined and defined for any particular forest management unit. Whereas, **Objectives** are measurable activities, or outputs, which state-specific results to be achieved during a specified period of time. Several objectives may be determined and defined in a forest management plan.

The primary objective of good management is to provide maximum benefits to the greatest number of people of all time.

► GENERAL OBJECTIVES

- Fulfill the bonafide requirements of the local community, Wildlife, and Forest ecosystem.
- Maintaining and raising the productive capacity and integrity of the forest ecosystem to regenerate naturally by ensuring the availability of seed sources of all species and minimizing the soil disturbance over the entire production system.
- Promoting the protective role of the forest, like controlling soil erosion, and carbon sequestration, preventing flooding, and providing habitat facilities to the Local flora & fauna (forest genetic resources). Mitigating the impacts of climate change
- Regulation of Silvicultural & felling operations in such a way as to bring the forest to a condition of as near normality as possible. Attainment of the normal forest is one of the principal objects of forest policies.
- Commercially sustainable – As a basic principle of sustainable tropical forest management, all operations comprising a balanced program of activities need to be financially supportable from revenue earned from sales of forest products, primarily from log harvesting.
- Community participation – to improve the livelihoods of rural communities.

► SPECIAL OBJECTIVES

- Fulfill the special industrial demand, *i.e.*, Chir-pine forests for resin industries and poplar plantation in the *Tarai* area for the paper industry.
- Private sector participation in forest management, especially in logging, transportation, and processing sectors.
- Urban forestry : encourages natural scenic beauty as well as the issue of air pollution in urban areas (*i.e.*, Delhi).
- Wasteland management : protection, soil & water conservation, and afforestation practices in badly eroded areas (*i.e.*, Chambal ravines), Abandoned open-pit mines, preventing desertification under watershed management.

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

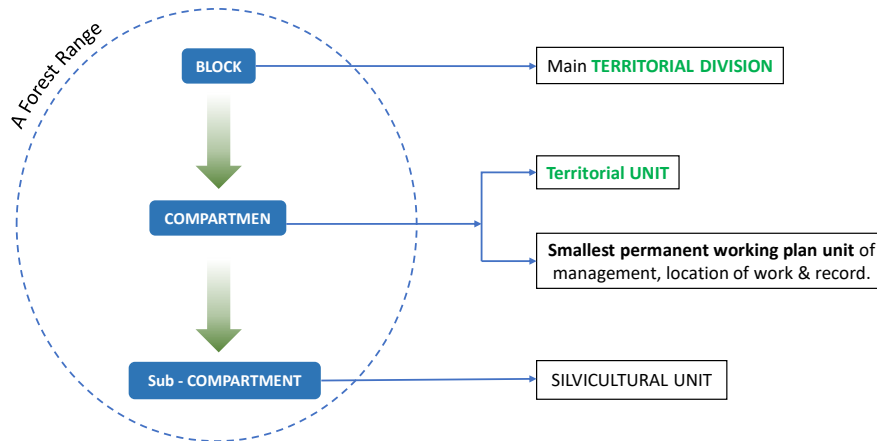
2.1 Territorial Classification

- ✿ Block
- ✿ Compartment
- ✿ Sub-compartment

2.2 Administrative classification

2.3 Silvicultural classification

- ✿ Working circle
- ✿ Felling series
- ✿ section
- ✿ Annual coupe



► **Sub-compartment** : A compartment may be temporarily or permanently divided into sub-compartments if it contains quite a variety of forest types and is not suitable for a uniform inventory and silvicultural treatment, which then form the Silvicultural Units of management

- The sub-division may be revoked when the crops have been brought into a condition where they do not require different treatments.
- Definition : *A sub-division of a compartment, sometimes temporary, where because of particular characteristics an area of forest has a special description and requires separate silvicultural treatment.*
- Use small letters – a, b, c, etc. for their name

FOREST MANAGEMENT BY COMPARTMENT

The first step towards managing a forest area is to divide it into suitable management units or compartments. These compartments should be based on tree associations, soil, topography and site productivity. The biophysical features within the compartment should be homogeneous so that they can be easily managed.

ADVANTAGES / REQUIREMENTS

- After dividing the forest into compartments, the 2nd step in management is to assess and evaluate each compartment, its growing stock and its potential to provide goods and services. This assessment helps the manager to choose the best areas to concentrate his labour and capital for the best returns [Priorities].
- Tarai forests offer wildlife, recreation, and cleaner water, as well as timber, pulpwood, and fuelwood. These goods and services are often complementary, and they can be produced together. For example, a continuous program of thinning to produce bitter-size timber would provide additional fodder and edge effects for wildlife, and would temporarily reduce water loss through transpiration and increase stream flow [Multiple uses].
- Simple compartmentalization of the forest is enabling the owner to easily schedule work, keep records, and choose a few of them to work. It can also serve as a basis for the planning of rotation and cutting cycles. Compartments work as a tool here, as the owner is able to visualize both the end and the beginning of the job [Working plan].
- Compartmentalization also preserves local diversity [Diversity].

TYPES OF COMPARTMENTS

SUSTAINABLE YIELD

[EVEN FLOW]

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 at its full capacity without harming the productivity of forest crops or soil is called sustainable yield.

ADVANTAGES OF SUSTAINABLE YIELD

- It helps in easy budgeting and tax assessment and provides a fixed and consistent source of revenue for the state/Forest department.
- Helps to recruit permanent & fully employed staff, local labour, and Contractors. Therefore, they will not be periodically over or underworked.
- In addition, it enables the establishment of permanent infrastructure and the hiring of skilled workers
- Assured & continuous supply of wood = increase the confidence of wood using industry = will boost their market development.

DISADVANTAGES/LIMITATIONS OF SUSTAINABLE YIELD

- Sustainable means rigid and stable supply, which will not help a growing economy like India.
- Practically, it is very difficult to obtain a sustainable yield from a natural forest due to the very high probability of natural incidences like insect-pest attacks, drought, frost, forest fire, El-Nino, etc.
- Rapidly changing timber demand, the introduction of new competitive products in the markets, and the changing socio-cultural values do not ensure that if we start growing teak today for 80 rotations, its demand will remain stable or will collapse after 80 years.
- Sustainable yield = inelastic felling = Fixed Annual yield. In that case, we cannot cut and sell timber during high market demand and increasing prices and *vice versa*. Therefore, it fails to work as a price moderator.

3.2 INCREASING or PROGRESSIVE YIELD

The concept proposed by Hartig^{***}

[Concepts/Principle] The concept of progressive yield involves increasing the productivity of forest soil and of crops by changing the crop composition and replacing inferior species with more valuable superior species

INCREMENT

5.1 INTRODUCTION

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 10th 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 m³/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 10th to 15th 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 Outline

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

- 6.1 Growing stock
- 6.2 Age class & Age Gradation
- 6.3 Normal Forest

YIELD REGULATION

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

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

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

WORKING PLAN

Let's suppose we wanted to initiate a commercial forest enterprise, similar to agriculture. In that case, systematic planning would be necessary, starting from site preparation and regrowth of vegetation to the final felling and marketing of the harvested products. Since a forest crop is not a seasonal or annual crop like wheat, and its rotation can be less than 40 to 50 years, in addition to production, we also consider other aspects such as protective measures, socio-economic development for tribals, and wildlife conservation. To achieve these goals, we require a brief yet detailed, fact-based plan that can effectively manage, regulate, control, and direct our operations for at least the next 10 to 15 years.

NEED

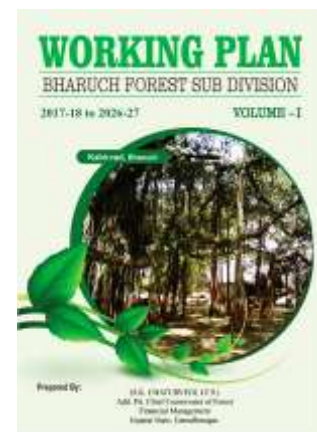
- It is common for foresters/IFoS officers to get transferred after 2/3 years (± promoted, retired, or die); then who would remember which treatment they have already given to the local stand and which is not?
- Forests are also facing high biotic pressure, soil erosion, climate change, and fire incidences. 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 could affect our continuity of operation, whether the officer was transferred, promoted, retired or died.

► **DEFINITION** : A working plan is "*a written scheme of management aiming at the continuity of policy and action besides control treatment of a forest*".

► **OBJECTIVES**

Chapter Outline



Working plan works as a tool for scientific forest management

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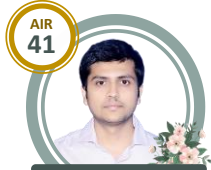
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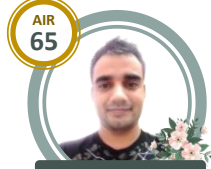
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