

2026

APPSC ANDHRA PRADESH STATE FOREST SERVICE



Module - I

Single-Source Solution for **Forestry Optional**

This study material not only covers the entire syllabus and previous years' questions in a structured, topic-wise manner but also includes several emerging and important areas that are not explicitly mentioned in the **APPSC RFO/FSO 2025** examination syllabus but from which questions are likely to be asked.

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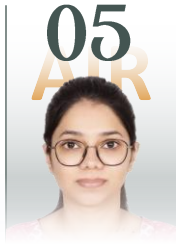


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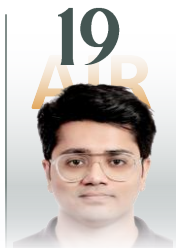
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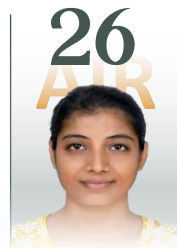
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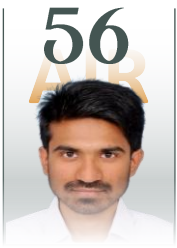
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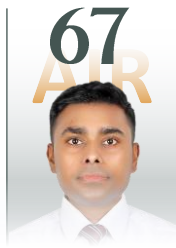
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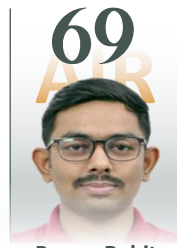
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APPSC
FOREST RANGER (FRO) / FOREST SECTION OFFICER (FSO)

FORESTRY

MODULE – 1



EDITION : 2026

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SYLLABUS

- ❖ **Forest Resources** : Use and over-exploitation, deforestation, important case studies. Timber extraction, mining, dams and their effects on forests and tribal people.
- ❖ **General Silvicultural Principles** — ecological and physiological factors influencing vegetation, natural and artificial regeneration of forests, methods of propagation, grafting techniques; site factors.
- Nursery & Planting Techniques** — nursery beds, polybags and maintenance, water budgeting, grading and hardening of seedlings, special approaches, establishment and tending
- ❖ **Silviculture of the Following Economically Important Species** grown in Andhra Pradesh such as –
 (1) *Acacia nilotica* (2) *Azadirachta indica*, (3) *Dendrocalamus strictus*, (4) *Casuarina equisetifolia*, (5) *Dalbergia sisoo*, (6) *Emblia officinalis*, (7) *Eucalyptus* spp., (8) *Gmelina arborea*, (9) *Pterocarpus marsupium*, (10) *Pterocarpus santalinus* (11) *Santalum album* (12) *Tectona grandis*, (13) *Melia dubia* and (14) *Leucaena leucocephala*.

PYQ ANALYSIS.

Exam	General Forestry	AP State Special	Silviculture	Mangroves & Cold Desert	Tree Species	Total
APPSC FRO 2018	27	1	38	1	7	74
APPSC FSO 2019	10	1	30	–	3	44
APPSC FRO 2022	21	2	30	1	–	54
APPSC ACF 2022	17	4	47	1	6	75
APPSC FRO Pre 2025	6	–	9	1	2	18
APPSC FRO (Main) 2025	12	5	53	3	11	84
APPSC FSO Screening 2025	4	3	16	1	1	25
APPSC FSO Main 2025	5	6	22	1	8	42
Total	102	22	245	9	38	416

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TABLE OF CONTENTS

	Syllabus	ii
	PYQ Summery	iv – xxix
Part – I : General Forestry		
1	General Forestry	1 – 27
2	Andhra Pradesh : State special	28 – 34
Part – II : Silviculture		
1	Forest, Forestry & Silviculture	35 – 45
2	Locality Factors	46 – 48
3	Climatic Factors	49 – 65
4	Edaphic Factors	66 – 76
5	Physiographic Factors	77 – 82
6	Biotic Factors	83 – 87
7	Influence of Forest on their environment	88 – 94
8	Tree's Structure and Growth forms	95 – 100
9	Crop Morphology	101 – 108
10	Forest Succession	109 – 117
11	Forest Types in India	118 – 125
12	Natural Regeneration	126 – 135
13	Artificial Regeneration	136 – 140
14	Choice of Species	141 – 148
15	Seed Supply	149 – 161
16	Forest Nursery	162 – 174
17	Vegetative Propagation	175 – 182
18	Sowing and Planting	183 – 193
19	Maintenance of Plantation	194 – 195
20	Tending operations	196 – 210
21	Plantation Forestry	211 – 214
Part – III : Mangroves & Cold desert		
1	Mangroves	215 – 221
2	Cold desert	222 – 224
Part – IV : Tree Species		
24	State-specific	225 – 238

PYQs

1. GENERAL FORESTRY

► HISTORICAL BACKGROUND

1. The first forest act of India that was passed during the British rule in the year [APPSC FRO 2022; APPSC FRO (Pre) 2025]
- (a) 1799
 - (b) 1865
 - (c) 1947
 - (d) 1946

2. Social Forestry programme was launched in [APPSC FRO 2022]
- (a) Seventh five-year plan
 - (b) Sixth five-year plan
 - (c) Fifth five-year plan
 - (d) Eighth five-year plan

► ACTS & POLICIES

3. The Concurrent List includes which of the following? [APPSC FSO 2019]
- (a) Forests
 - (b) Protection of wild animals and birds.
 - (c) All of the given options
 - (d) Prevention of cruelty to animals.
4. Forests are included in the Concurrent List in the (Seventh Schedule) of the Constitution of India. This means that [APPSC FRO 2022]
- (a) Only the central government of India can enact the forest laws
 - (b) Forests are a state subject so state legislation can enact the laws
 - (c) Both, the Centre and States are competent to enact laws for forest conservation and use in India

- (d) The Centre can enact the laws and a State has to implement it
5. Forest and wildlife were brought under concurrent list as per [APPSC FRO (Main) 2025]
- (a) 42nd Amendment
 - (b) 40th Amendment
 - (c) 44th Amendment
 - (d) 48th Amendment
6. What does Article 48A of the Indian Constitution deal with? [APPSC FRO (Main) 2025]
- (a) Protection of monuments
 - (b) Protection and improvement of the environment, forests and wildlife
 - (c) Promotion of international peace
 - (d) Right to Education
7. Forest conservation act and Forest (Conservation) Amendment Bill were passed in the year [APPSC FRO 2022]
- (a) 1927 and 2001
 - (b) 1857 and 1947
 - (c) 1980 and 2023
 - (d) 1865 and 2000
8. Which category of land is exempted from the Forest Conservation Act, 1980 for constructing strategic linear projects of national importance or security? [APPSC FRO (Main) 2025]
- (a) Land within 50 km of international borders
 - (b) Land within 100 km of international borders
 - (c) Land within 25 km of international borders
 - (d) Land within 10 km of international borders
9. What is the main purpose of the Forest Conservation Act, 1980 ? [APPSC FRO (Main) 2025]
- (a) To expand forest cover
 - (b) To prevent deforestation and regulate the diversion of forest land for non-forest purposes
 - (c) To promote commercial forestry
 - (d) To recognize the rights of forest dwellers
10. Which of the following litigations in the Honourable Supreme Court of India proved to be a landmark in forest conservation? [APPSC FRO 2018]
- (a) Godavarman Thirumulpad v/s Union of India
 - (b) MC Mehta v/s Union of India
 - (c) TC Mehta v/s Union of India
 - (d) EC Richards v/s Forest Ranger Officer, Mettupalayam
11. What is the primary objective of CAMPA in India ? [APPSC FRO (Main) 2025]
- (a) To promote urban development projects
 - (b) To manage funds for compensatory afforestation
 - (c) To regulate pollution control measures
 - (d) To oversee wildlife conservation exclusively
12. Which year the Forest Rights Act was enacted? [APPSC FSO 2019]
- (a) 2002
 - (b) 2004
 - (c) 2006
 - (d) 2008
13. Which legislation in India recognizes the rights of forest-dwelling

- communities to land and other resources? [APPSC FRO (Main) 2025]
- Wildlife Protection Act, 1972
 - Forest Conservation Act, 1980
 - Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006
 - Environmental Protection Act, 1986
14. The policies and guidelines of the Joint Forest Management are enunciated in [APPSC FRO 2018]
- The National Forest Policy of 1952
 - The National Forest Policy of 1988
 - The Forest (Conservation) Act, 1972
 - The Biodiversity Act, 2002
15. Identify the correct option from among the following, that specifies the area to be kept under forest cover in India as per the 'National Forest Policy 1988'. [APPSC FRO 2022]
- One-fourth of the total land area of the country is under forest or tree cover, in which the hills and in mountainous regions should aim to maintain one-third of the area under such cover.
 - 37% of total land area of the country under forest or tree cover in which the hills and in mountainous regions should aim to maintain 75% of the area under such cover.
 - One-third of the total land area of the country under forest or tree cover in which the hills and in mountainous regions should aim to maintain two-third of the area under such cover.
 - 37% of total land area of the country under forest or tree cover in which the hills and in mountainous regions should aim to maintain 50% of the area under such cover
16. According to the National Forest Policy forest area in comparison to the total geographical area should be [APPSC FSO (Main) 2025]
- 1/3rd
 - 1/5th
 - 1/4th
 - 1/6th
17. What is the principal aim of the National Forest Policy, 1988? [APPSC FRO (Main) 2025]
- Revenue generation from forests
 - Ensuring environmental stability and ecological balance
 - Expansion of agricultural lands
 - Increasing timber production
18. In which year was the National Agroforestry Policy launched in India? [APPSC FRO 2018]
- 2013
 - 2014
 - 2017
 - 2018
19. Which of the following is the latest National Working Plan Code? [APPSC FRO 2018]
- 2012
 - 2014
 - 2011
 - 2009
20. Which of the following missions is NOT under the National Action Plan on Climate Change? [APPSC FRO 2018]
- Sustainable Habitat
 - Water Mission
 - Green India
 - Green GDP
21. Hazardous waste (Management & handling) rules came into existence in the year _____. [APPSC FSO 2019]
- 1988
 - 1989
 - 1987
 - 1990
22. The Protection of Plant Varieties and Farmers' Rights Act was enacted by the Parliament of India in [APPSC FRO 2018]
- 2000
 - 2001
 - 2002
 - 2003
23. In which year was the Biological Diversity Act enacted in India? [APPSC FSO (Main) 2025]
- 2000
 - 2002
 - 2010
 - 2017
24. Which Act is aimed at the protection and improvement of the environment? [APPSC FSO Screening 2025]
- Wildlife (Protection) Amendment Act, 2022
 - Biological Diversity Act, 2002
 - Wildlife Protection Act, 1972
 - Environment Protection Act, 1986
25. Which of the following statements is/are correct? [APPSC FRO (Pre) 2025]
- Statement I:** The Ministry of Environment and Forests (MoEF) was established in 1985, marking a significant step in India's commitment to sustainable development and environmental governance.
- Statement II:** The National Environment Policy, along with the Water (Prevention and Control of Pollution) Act and the Air (Prevention and Control of Pollution) Act, has provided a robust regulatory framework, ensuring flawless enforcement and public compliance across all sectors.
- Both statements are correct, and Statement II is the correct explanation of Statement I.
 - Both statements are correct, but Statement II is not the correct explanation of Statement I.
 - Statement I is correct, but Statement II is incorrect.

- (d) Statement I is incorrect, but Statement II is correct.
26. The National Green Tribunal Act was enacted in the year _____. [APPSC FSO 2019]
- (a) 2000
(b) 2012
(c) 2010
(d) 1998
27. Where is the principal bench of the National Green Tribunal situated? [APPSC FRO 2018]
- (a) Pune
(b) Bhopal
(c) New Delhi
(d) Kolkata
- **NATIONAL COMMISSION ON AGRICULTURE**
28. The National Commission on Agriculture was founded in August 1970 under the Ministry of Agriculture. It released its final report in fifteen parts in 1976 under _____. It has _____ chapters in _____ parts [APPSC FRO 2022]
- (a) NR Mirdha; 65; 16
(b) T Murthy; 69; 15
(c) NR Mirdha; 69; 15
(d) T Murthy; 65; 16
29. The term social forestry was first used in 1976 in India by [APPSC FRO 2018]
- (a) the National Commission on Agriculture
(b) the National Commission on Horticulture
(c) the National Commission on Forestry
(d) the National Commission on Silviculture
30. Which of the following statements related to the objective of the National Agricultural Policy 1976, to facilitate the establishment of a

prosperous egalitarian rural society is/are correct? [APPSC FRO 2022]

A) Adequate supply of goods and services to sustain a rising standard of living.

B) Sufficient employment and income opportunities for the masses.

Option

(a) Both statements A and B are correct

(b) Only statement A is correct

(c) Only statement B is correct

(d) Neither statement A nor B is correct

31. Main elements of the National Agricultural Policy 1976 include [APPSC FRO 2022]

A) Reordering of the agrarian structure should not get high priority

B) Extensive utilisation of land

C) Personal cultivation to ensure adequate attention to land, and for increased productivity and production should be discouraged.

D) Efforts should be made to detect all surplus land for distribution to the landless and marginal farmers, with priority being given to the landless particularly Harijan, tribal and backward communities.

Choose the correct option below

(a) All the statements are correct

(b) Only statement D is correct

(c) Statements B, C and D are correct

(d) Only statement A is correct

32. Main elements for animal husbandry in National Agricultural Policy 1976 include [APPSC FRO 2022]

A) For improving the productivity of cattle and buffaloes scientific methods of breeding should be adopted.

B) Adequate feeds and fodders resources should be provided.

C) Animal health cover should not be given priority.

D) Animal management practices should be given less priority.

Choose the correct statements

(a) Statements A and D are correct

(b) Statements C and D are correct

(c) Statements B and C are correct

(d) Statements A and B are correct

33. Which of the following statements endorses the focus of National Agricultural Policy 1976 on forestry sector? [APPSC FRO 2022]

A) To meet the requirements of goods, i.e., industrial wood for forest-based industries, defence, communications, and other public purposes.

B) To provide small timber, fuelwood, and fodder for the rural community.

C) To ignore for the time being, the present and future demands for protective and recreative functions of the forests.

D) To clearly indicate the inter-relationship of forest economy with rural and tribal economy.

E) Employment, rights of user and involvement of the local people should not be the priority

Options

(a) Statements A, B and D are correct

(b) Statements A, B and E are correct

(c) Statements C, E and D are correct

(d) Statements B, C and E are correct

- **INTERNATIONAL CONVENTIONS & ORGANISATIONS**

34. The United Nations Conference on the Human Environment was held in which year? [APPSC FRO 2018]

(a) 1971

(b) 1972

(c) 1981

Institute of Disaster Management (NIDM) achieve the status of a statutory organisation and become responsible for planning and promoting training and research in the area of disaster management in India? [APPSC FRO (Pre) 2025]

- (a) 1995
- (b) 1999
- (c) 2005
- (d) 2011

98. Which of the following is a primary cause of riverine flooding in low lying areas? [APPSC FRO (Pre) 2025]

- (a) Tsunami
- (b) Earthquake
- (c) Prolonged heavy rainfall
- (d) Deforestation

99. Recent Wayanad disaster in India was caused by [APPSC FSO Screening 2025]

- (a) Volcanic eruption
- (b) Landslide
- (c) Low temperature
- (d) Gas leak

2. AP = STATE SPECIAL

100. Dipterocarpus retusus, an important timber plant, is the state tree of [APPSC FRO 2018]

- (a) Assam
- (b) Arunachal Pradesh
- (c) Meghalaya
- (d) Tripura

► AP FOREST STATISTICS (ISFR)

101. According to India State of Forest Report (ISFR) 2021 given by the Forest Survey of India, the recorded forest area of Andhra Pradesh is [APPSC ACF 2022]

- (a) 37,258 km²
- (b) 36,258 km²
- (c) 35,258 km²
- (d) 38,258 km²

102. As per the ISFR 2021, the forest cover of Andhra Pradesh is _____ of the

total geographical area of the country [APPSC ACF 2022] (Deleted)

- (a) 0.1828
- (b) 0.1645
- (c) 0.195
- (d) 0.172

► FOREST TYPES IN AP

103. As per the ISFR 2021, which of the following forest types has the **maximum area / Predominant / dominant** in Andhra Pradesh? [APPSC ACF 2022; APPSC FSO Main 2025; APPSC FRO (Main) 2025]

- (a) Dry deciduous scrub forests
- (b) Southern thorn forests
- (c) Southern moist mixed deciduous forests
- (d) Southern dry mixed deciduous forests

104. The vegetation in the Rayalaseema region is primarily [APPSC FSO (Main) 2025]

- (a) Thorn scrub
- (b) Evergreen forest
- (c) Grasslands
- (d) Wetlands

105. Red Sanders is endemic to which region of India and has high demand in the international market? [APPSC FSO (Main) 2025]

- (a) Western Ghats
- (b) Southern Part of Eastern Ghats
- (c) Himalayas
- (d) Aravalli Hills

► AP PROTECTED AREAS & WILDLIFE

106. State bird of Andhra Pradesh is [APPSC ACF 2022]

- (a) Psittacula krameri
- (b) Coracias garrulus
- (c) Coracias benghalensis
- (d) Psittacula himalayana

107. Which is the first gazetted biosphere reserve in Andhra Pradesh, known for its endemic species and Eastern Ghats ecosystem? [APPSC FSO (Main) 2025]

- (a) Coringa Wildlife Sanctuary
- (b) Seshachalam Biosphere Reserve
- (c) Pulicat Bird Sanctuary
- (d) Papikonda National Park

108. Name of the Biosphere Reserve in Andhra Pradesh [APPSC FRO (Main) 2025]

- (a) Marripakala Biosphere Reserve
- (b) Seshachalam Biosphere Reserve
- (c) Papikonda Biosphere Reserve
- (d) Kambalakonda Biosphere Reserve

109. Which type of forest is found in the Coringa Wildlife Sanctuary? [APPSC FRO (Main) 2025]

- (a) Evergreen Forest
- (b) Tropical Dry Deciduous Forest
- (c) Mangrove Forest
- (d) Semi-evergreen Forests

110. Naupada Coastal and Marine Biodiversity Area (ICMBA) is located in which district of Andhra Pradesh? [APPSC FSO (Main) 2025]

- (a) Vizianagaram
- (b) Visakhapatnam
- (c) Srikakulam
- (d) Alluri Sitharama Raju

111. Which of the following is a Ramsar wetland site in Andhra Pradesh? [APPSC FRO (Main) 2025]

- (a) Kolleru Wildlife Sanctuary
- (b) Pulicat Wildlife Sanctuary
- (c) Nelapattu Wildlife Sanctuary
- (d) None of the above

112. Sri **Lankamalleswara** Wildlife Sanctuary is habitat for which of the critically endangered species? [APPSC FSO (Main) 2025]

- (a) Great Indian Bustard
- (b) Jerdon's Courser
- (c) Blue Jay
- (d) Peafowl

113. The **Lankamala** Wildlife Sanctuary is home to which rare species? [APPSC FRO (Main) 2025]

- (a) Great Indian Bustard
- (b) Olive Ridley Turtle
- (c) Jerdon's Courser

(d) Indian Peafowl

► **AP ACTS, INSTITUTIONS & FOREST PRODUCE**

114. In which year, Andhra Pradesh Forest Act come into force? [APPSC FSO 2019]

- (a) 1977
- (b) 1967
- (c) 1958
- (d) 1972

115. Andhra Pradesh Water, Land Trees Act, 2002 (APWALTA) came into force on [APPSC FRO 2022]

- (a) 15th June 2002
- (b) 19th April 2002
- (c) 15th June 2004
- (d) 6th November 2002

116. Which of the following statements is true about **Girijan Cooperative Corporation**? [APPSC FRO 2022]

- (a) It is the marketing wing of Andhra Pradesh Forest Department.
- (b) It is the main purchaser of Bamboo from Andhra Pradesh Forest Department.
- (c) It pays royalty to the Andhra Pradesh Forest Department for the collection and sale of non-timber forest products.
- (d) It has full right to collect and sale non-timber forest products in Andhra Pradesh

117. In Andhra Pradesh, which organization is primarily responsible for collecting and selling the majority of Minor Forest Produce (MFP) items? [APPSC FSO Screening 2025]

- (a) Forest Department
- (b) Girijan Cooperative Corporation
- (c) Ministry of Micro, Small and Medium Enterprises
- (d) Municipal Administration and Urban Development Department

118. Country liquor in Andhra Pradesh is brewed from the flowers of [APPSC FSO Screening 2025]

- (a) Tendu/Kendu
- (b) Mahua
- (c) Jidichettu
- (d) Sal

3. SILVICULTURE

► **FOREST, FORESTRY & SILVICULTURE**

119. A virgin forest is a _____ forest [APPSC ACF 2022]

- (a) Man-made
- (b) Social
- (c) Natural
- (d) Recreational

120. The various species which form a forest crop and their proportion in it is called [APPSC ACF 2022]

- (a) Composition
- (b) Selection
- (c) Yield
- (d) Development

121. _____ is a species of inferior quality or size, of relatively little Silvicultural value or importance, associated with the principal species [APPSC FSO 2019]

- (a) Accessory species
- (b) Lesser species
- (c) Mediocre species
- (d) Auxiliary species

122. The sum (by number or volume) of all the trees growing in a forest, or a specified part of it is [APPSC FRO 2018; APPSC ACF 2022]

- (a) Yield
- (b) Growing stock
- (c) Number of trees
- (d) Crop volume

123. Silviculture originated in which continent? [APPSC FRO 2018]

- (a) Asia
- (b) Europe
- (c) North America
- (d) South America

124. The branch of forestry that deals with theory and practice of raising forest crops is [APPSC FSO (Main) 2025]

Or

The art and science of cultivating forests crops [APPSC FRO (Main) 2025]

Or

Which branch of forestry deals with the establishment, development, care and reproduction of forest crops especially timber? [APPSC FSO (Main) 2025]

- (a) Forest utilization
- (b) Agroforestry
- (c) Silviculture
- (d) Forest protection

125. Certain aspects of theory and practice of raising forest crops, methods of raising tree crops, their growth and after care up to the time of final harvesting is referred as [APPSC FSO (Main) 2025] ■ **Similar: Q128, Q130, Q131**

- (a) Forest Mensuration
- (b) Forest Management
- (c) Forest Utilization
- (d) Silviculture

126. The practice of forestry in all its aspects on farm and village lands, generally more or less integrated with other farm operations, is called [APPSC ACF 2022]

- (a) Village forestry
- (b) Community forestry
- (c) Farm forestry
- (d) Social forestry

127. The scope of social forestry does not include which type of forestry? [APPSC FRO 2018]

- (a) Farm Forestry
- (b) Community Woodlots
- (c) Community Reserve
- (d) Extension Forestry

128. Forestry aimed at producing flow of protection and recreation benefits to the community [APPSC FSO (Main) 2025]

- (a) Agro forestry

- (c) *Sapium sebiferum*
 (d) *Madhuca indica*

359. Which of the following plants does NOT yield bio-diesel? [APPSC FRO 2018]

- (a) *Simarouba glauca*
 (b) *Pongamia pinnata*
 (c) *Calophyllum inophyllum*
 (d) *Xylia Xylocarpa*

360. Which of the following is a second-generation biofuel feedstock? [APPSC FRO 2018]

- (a) Sugarcane
 (b) Sugar beet
 (c) Corn
 (d) Woodchips

4. MANGROVES + COLD DESERT

► MANGROVES

361. *Rhizophora* species are characteristic of which kind of forest type? [APPSC FRO 2018]

- (a) Grassland
 (b) Alpine forest
 (c) Mangrove
 (d) Tropical rainforest

362. Which Indian biome is best known for its salt-tolerant trees and aquatic biodiversity ? [APPSC FRO (Main) 2025]

- (a) Deciduous Forests
 (b) Grasslands
 (c) Mangroves
 (d) Alpine Meadows

363. _____, located in the northern Bay of Bengal, is the world's largest single patch of mangrove forests. It is spread over approximately 10,000 km² in Bangladesh and India [APPSC FRO 2022]

- (a) Oceania
 (b) Thar
 (c) Sundarbans
 (d) Swamp of Bengal

364. Which place is known as "Mangrove Genetic Paradise" of world ? [APPSC

FRO (Main) 2025]

- (a) Bhitarkanika
 (b) Coringa
 (c) Sundarbans
 (d) Australian Great Barrier

365. Which root modification helps in respiration in mangrove plants ? [APPSC FRO (Main) 2025]

- (a) Prop roots
 (b) Stilt roots
 (c) Nodular roots
 (d) Pneumatophores

366. The type of germination where the seed germinates inside the fruit while still attached to the parent tree is called [APPSC ACF 2022]

- (a) Hypogeal
 (b) Epigeal
 (c) Vivipary
 (d) Advance

367. Which of the following options is correct regarding the Assertion (A) and Reason (R)? [APPSC FRO (Pre) 2025]

Assertion (A): In estuaries, halophytic plants are adapted to deal with salt water spray and salt water on their roots.

Reason (R): In some halophytes, filters in the roots remove the salt from the water that the plant absorbs.

- (a) Both A and R are true, and R is the correct explanation of A.
 (b) Both A and R are true, but R is not the correct explanation of A
 (c) A is true, but R is false.
 (d) A is false, but R is true.

368. Salt-tolerant plants are called [APPSC FSO Screening 2025]

- (a) Glycophytes
 (b) Heliophytes
 (c) Halophytes
 (d) None of the above

► COLD DESERT

369. Which wild animal is typical of India's cold desert region ? [APPSC FSO (Main) 2025]

- (a) Lion
 (b) Snow leopard
 (c) Tiger
 (d) Bear

5. TREE SPECIES

► ACACIA NILOTICA

370. Arabica gum is extracted from which species and is mainly used for ? [APPSC FSO (Main) 2025]

- (a) *Azadirachta indica*
 (b) *Santalum album*
 (c) *Tectona grandis*
 (d) *Acacia nilotica*

► DENDROCALAMUS STRICTUS (BAMBOO)

371. Bamboos belong to which plant family [APPSC FRO 2018]

- (a) Myrtaceae
 (b) Moraceae
 (c) Poaceae
 (d) Fabaceae

372. What is the scientific family of bamboo ? [APPSC FRO (Main) 2025]

- (a) Fabaceae
 (b) Moraceae
 (c) Rutaceae
 (d) Graminae

373. _____ is described as "wood of the poor" in India, "friend of the people" in China and "brother" in Vietnam [APPSC FSO 2019]

- (a) Teak
 (b) Acacia
 (c) Casuarina
 (d) Bamboo

374. The following tree is propagated through rhizomes [APPSC FSO (Main) 2025]

- (a) Bamboo
 (b) Teak
 (c) Eucalyptus
 (d) Terminalia

375. Which industry consumes a major proportion of bamboo ? [APPSC FSO (Main) 2025]

- (a) *Fusarium moniliformae*
- (b) *Fusarium oxysporum*
- (c) *Rhizoctonia solani*
- (d) Phytoplasma

393. In sandal, spike disease is caused by: [APPSC FRO (Pre) 2025]

- (a) Bacteria
- (b) MLO
- (c) Virus
- (d) Fungi

394. Name the disease that affected Sandalwood plantations in Kerala. [APPSC FRO (Main) 2025]

- (a) Leaf spot
- (b) Root rot
- (c) Leaf blight
- (d) Spike disease

► **TECTONA GRANDIS (TEAK)**

395. The oldest teak plantation in the world is located in which state of India? [APPSC FRO 2018]

- (a) Tamil Nadu
- (b) Andhra Pradesh
- (c) Karnataka
- (d) Kerala

396. Which tree species of India was heavily exploited during the early British period (1750 - 1900) for Royal Navy ship building activities? [APPSC FRO 2018]

- (a) *Terminalia tomentosa*
- (b) *Dipterocarpus macrocarpus*
- (c) *Tectona grandis*
- (d) *Azadirachta indica*

397. Which tree species of India was heavily exploited during the early British period (1750- 1900) for Royal Navy ship building activities? [APPSC FRO 2018]

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- (b) *Dipterocarpus macrocarpus*
- (c) *Tectona grandis*
- (d) *Azadirachta indica*

398. Identify the forests in which teak is the dominant species [APPSC ACF 2022]

- (a) Tropical evergreen forests
- (b) Tropical thorn forests and scrubs
- (c) Tropical deciduous forests
- (d) Mangrove forests

399. In moist teak forests, adverse effects on the natural regeneration of teak are due to [APPSC ACF 2022]

- (a) Indiscriminate use of weedicides
- (b) Poor management of trees
- (c) Indiscriminate tree felling
- (d) Indiscriminate fire protection

400. Which soil type is most suitable for *Tectona grandis* growth ? [APPSC FRO (Main) 2025]

- (a) Saline and alkaline soils
- (b) Sandy desert soils
- (c) Lateritic and well-drained alluvial soils
- (d) Waterlogged clayey soils

401. Which biocontrol agent has been used in India to manage the teak defoliator (*Hyblaea puera*) ? [APPSC FRO (Main) 2025]

- (a) *Trichogramma* spp.
- (b) Tobacco Mosaic Virus
- (c) *Bacillus thuringiensis*
- (d) *Beauveria bassiana*

► **LEUCAENA LEUCOCEPHALA**

402. Which of the following tree species is classified into four broad types, namely, Hawaiian, Salvador, Peru and Cunningham? [APPSC ACF 2022]

- (a) *Populus deltoides*

- (b) *Leucaena leucocephala*
- (c) *Dalbergia sisoo*
- (d) *Eucalyptus globulus*

► **OTHER SPECIES**

403. The flame-of-the-forest is the common name of which of the following tree species? [APPSC FRO 2018]

- (a) *Bombax ceiba*
- (b) *Phanerapurplea*
- (c) *Butea monosperma*
- (d) *Lagerstroemia lanceolata*

404. Tendu leaves, used for making beedis, are obtained from which tree ? [APPSC FRO (Main) 2025]

- (a) *Diospyros melanoxylon*
- (b) *Azadirachta indica*
- (c) *Tectona grandis*
- (d) *Mangifera indica*

405. Which is the major host of lac insect ? [APPSC FRO (Main) 2025]

- (a) *Butea monosperma*
- (b) *Ziziphus mauritiana*
- (c) *Scheuchera oleosa*
- (d) All of the above

406. Kath (Catechu) is prepared from which tree species ? [APPSC FRO (Main) 2025]

- (a) *Acacia nilotica* (Babul)
- (b) *Acacia chundra* (Khair)
- (c) *Azadirachta indica* (Neem)
- (d) *Ficus religiosa* (Peepal)

407. The National Tree of India is [APPSC FSO Screening 2025]

- (a) *Ficus benghalensis*
- (b) *Ficus elastica*
- (c) *Ficus religiosa*
- (d) *Ficus racemosa*



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Congratulations

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Rank – 1
Shashank Jain

Comprehensive Forestry
Course + CIGP



Rank – 3
Jyoti Thakur

Comprehensive Forestry
Course + CIGP



Rank – 4
Shivam Gautam

Comprehensive Interview
Guidance Programme



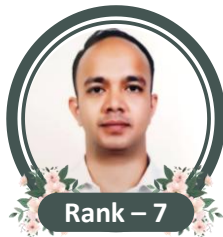
Rank – 5
Nitin Patel

Comprehensive Forestry
Course + CIGP



Rank – 6
Ravi Kumar

Comprehensive Interview
Guidance Programme + Test Series



Rank – 7
Ankur Gupta

Comprehensive Forestry
Course



Rank – 8
Deependra Lodhi

Comprehensive Interview
Guidance Programme



Rank – 9
Kapil Chauhan

Comprehensive Forestry
Course



Rank – 10
Alok Kumar Jhariya

Comprehensive Forestry
Course + CIGP



Rank – 11
Tarun Chouhan

Comprehensive Interview
Guidance Programme + Test Series



Rank – 12
Raghvendra Thakur

Comprehensive Forestry
Course + CIGP

11 Out of **12** Total
Selections in

Assistant Conservator of Forest (ACF) – 2023

GENERAL FORESTRY

Our religious texts, such as the **Vedas**, **Aranyakas** (Aranya means “forest” in Sanskrit), **Upanishads**, and **Smritis**, contain many references to the use and management of forests. These texts also highlight the importance of sustainable use and conservation of forest resources.

According to Vedic tradition, a village was considered complete only when different types of forests or sacred groves—such as **Mahavan**, **Shrivan**, and **Tapovan**—were protected and maintained within and around the village.



In the **Vishnu Purana**—one of the **18 Mahapuranas**—there is a description of **13 types of forests** found in different regions of ancient India. Some of these include – ♦ **Angireya** Vana (Bengal and Assam), ♦ **Prachya** Vana (Bihar, Uttar Pradesh, Nepal), ♦ **Naimisharanya** (Central Uttar Pradesh), ♦ **Panchanada** Vana (Punjab and Jammu & Kashmir), ♦ **Aparantaka** Vana (Wester coast), ♦ **Dandakaranya** Vana, ♦ **Kalinga** Vana, ♦ **Saurashtra** Vana, ♦ **Kalesha** Vana (south of the Narmada River), ♦ **Vaman** Vana (near Gwalior), ♦ **Dasarnaka** Vana (around Bhopal, Sagar, Damoh), ♦ **Mahakantaka** Vana (Kalahandi, Koraput, and Bastar districts in Odisha and Chhattisgarh), and ♦ **Karusha** Vana (Baghelkhand and Bundelkhand regions).

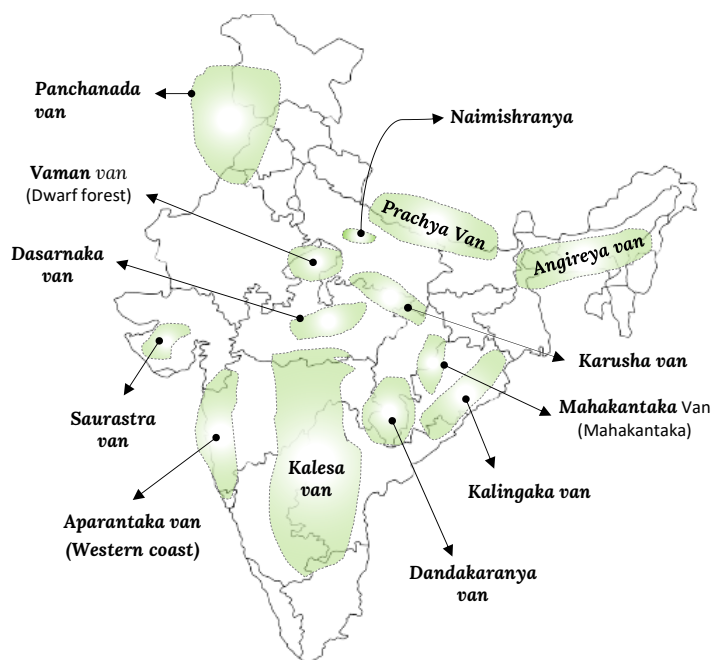
These forests were broadly classified into two main types—

- (a) **Kunjar Vana***** – **Elephant forests**, characterized by dense vegetation that provides shelter and sustenance for wild elephants.

Chapter Outline

- 1.1 Historical background
- 1.2 Forestry & Wildlife after independence
- 1.3 MoEFCC & Its Sub-ordinated bodies
- 1.4 Forestry Education system
- 1.5 Forest Survey of India
- 1.6 FAO & Its State of the world forest report
- 1.7 Forest types in India
- 1.8 Forest & wildlife related acts, policies & missions
- 1.9 Wildlife projects
- 1.10 National & International days & years
- 1.11 International Organizations
- 1.12 Superlatives in Forestry
- 1.13 Remarks

(b) **Kantak Vana***** – **Thorny scrub forests**, consisting of arid or semi-arid vegetation.



Mahāvan (Great Natural Forest)

A large natural forest that provided a protected habitat for plants and animals. It can be compared with present-day **protected forests**, where human interference is kept to a minimum and natural ecosystems are allowed to remain largely undisturbed.

Shrīvan (Forest of Prosperity)

A managed forest meant to meet the needs of local communities. Villagers could sustainably collect fuelwood, fodder, medicinal herbs, timber, and other forest products without causing serious damage to the forest ecosystem.

Tapovan (Forest for Penance)

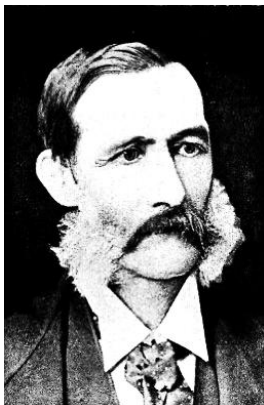
A sacred forest or grove reserved for sages, meditation, and spiritual activities. Plants and animals in such areas were given special protection, and activities that could harm them were generally restricted.

- **MAURYA PERIOD** : When **Chandragupta Maurya** came to power around 300 BC, he recognised the importance of forests. He appointed a **Kupyadhyaksha***** (head of the forest department) to manage and supervise the forests with the help of several **van-pals** (forest guards). According to Kautilya's Arthashastra, during this period, the king generally divided the forests into four Bhag (parts) : ♦ One part was reserved for the king for hunting and personal use. ♦ The second part was reserved for the State, i.e., Magadh. ♦ The third part was kept for donation purposes, mainly for Monks and Brahmins. ♦ The fourth part was meant for public use.
- **GUPTA PERIOD** : During the Gupta period, **Brahmadeya** land grants encouraged the expansion of agriculture into some forest and uncultivated areas, leading to forest clearance. The Gupta rulers also came into conflict with the **Atavika Rajyas***** (forest kingdoms) of Central India, many of which were brought under Gupta control.

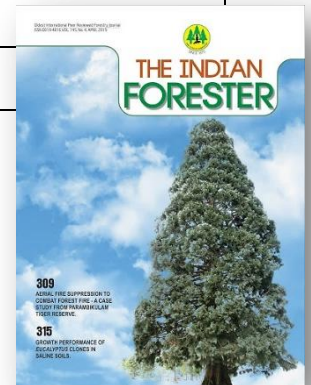
► DURING COLONIAL RULE

1790	Eucalyptus*** = introduced in 1790 by Tipu Sultan, around his summer palace at Nandi Hills (then known as Nandi-Durga). Later historical accounts claim that he planted around 16 species, possibly using seeds obtained through his French allies. <u>Our own world</u> During the 1930s, a few old and decaying Eucalyptus trees were reportedly found in the Nandi Hills region. Annual-ring counts suggested that some of these trees could possibly date back to around 1780–1800. However, this evidence did not establish who planted these trees, how they reached Nandi Hills, or how many species were originally introduced. Interestingly, neither the accounts of British troops operating in the region nor contemporary British records provide any description of the Eucalyptus at Nandi Hills during Tipu Sultan's period, including
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	records from the period when Nandi Hills came under British control in 1792. Later, D. Nanjundappa (1957), in “A Note on Eucalyptus Plantations in Old Mysore State”, reported around 10 Eucalyptus species growing in the region, which had been planted during the preceding 30–40 years. However, when modern Indian forestry literature began reproducing these accounts, the number of species gradually increased from 10 to 14 and eventually to 16, along with the story linking their introduction to Tipu Sultan and his French allies and their planting around his summer palace. How and when these additional details became part of the narrative remains unclear. As evidence, there is nothing beyond this literary account—no surviving trees, no these 16 species names, no any even sample or image evidence. Later, when FAO start publishing resources on forestry, the story acquired an almost unquestionable status. Once published under the FAO name, it began to be treated almost like an “Qur’anic word”—something not to be questioned—and was repeatedly reproduced in subsequent literature. The most striking point is that the British colonisation of Australia began in January 1788. The maritime transmission of Eucalyptus seeds from the remote shores of New South Wales to the landlocked heights of Nandi Hills in South India within a mere two years, therefore, presents a profound chronometric and logistical anomaly.
1806	Captain Watson*** was appointed as the first Conservator of Forests*** by the Government of Madras. His main responsibility was to <u>preserve and enhance the production of teak and other timber species suitable for shipbuilding</u>. With the help of “Native Agents”, Watson established almost complete government control over timber production in the Malabar and Travancore regions. This helped the government to obtain large quantities of timber at a low cost. This system continued until 1823, when the post of Conservator was abolished on the recommendations of Thomas Munro. ✎ Watson was thus the first person in India to be officially designated as a 'Conservator of Forests'
1842	Following the directives of the Court of Directors, the Madras Government initiated Teak plantation work in Nilambur through H.V. Conolly, the then Collector of Malabar. Conolly was authorized to appoint a Sub-Conservator of Forests under his direct supervision, with a monthly salary of ₹150. In 1844, Chathu Menon was appointed as the Sub-Conservator. He introduced pioneering methods such as pre-sowing seed treatment and Sapling transplantation—techniques that, with minor modifications, are still in use today. ✎ Oldest teak plantation of the world = Nilambur [Recently received GI-Tag] ✎ In honour of H.V. Conolly’s contributions, the plantation area is named Conolly’s Plot. ✎ This effort is recognized as the beginning of plantation forestry in India.
1843	Captain Cotton of the Madras Engineers successfully introduced Eucalyptus globulus at Wellington (Madras).
1847	Gibson's appointment as the Conservator of Forests by the Bombay Presidency laid the foundation for the organized forest services in India.
1856	Cleghorn was appointed as the 1st “Regular” Conservator of Forests in the Madras Presidency in 1856, marking a significant step in the institutionalization of forest management in India. Unlike earlier appointments, Cleghorn's role was exclusively dedicated to forest conservation, with no additional responsibilities—hence the term

	"Regular" Conservator. He also initiated Eucalyptus plantations in Udhagamandalam (Ootacamund), which later played a major role in plantation forestry. ✍ Brandis began his forestry career as a Superintendent in Burma (Pegu) in 1856 before moving to a pan-India role in 1864 (1st IGF). Appointed by Dalhousie.
1863	The Taungya system, introduced by Dr. Brandis in Burma in 1856. The first taungya plantations in India were raised in North Bengal in 1863, followed by further trials at Sylhet in Assam in 1886 and Coorg in 1890. However, taungya cultivation was not adopted on a regular scale until 1911, when it was used for raising plantations of Shorea robusta (Sal) in North Bengal. Following its success, the system was extended to plantations of Tectona grandis (teak) in 1912. The practice gradually spread to other regions. In 1923, the taungya system was adopted in the Gorakhpur Division of Uttar Pradesh for regenerating <i>failed Sal coppice coupes</i>. The results were highly successful, and taungya subsequently became a standard method for the regeneration of sal in the lower alluvial forests. Consequently, dependence on conventional coppice regeneration was gradually reduced. The system was also used extensively in parts of Madhya Pradesh and Maharashtra, particularly in the Berar region, for raising plantations of babul.
1864	The then governor-general John Lawrence*** created the Indian Forest Department and appointed Dietrich Brandis as its Inspector General for Forests (IGF)***. This marks the beginning of scientific forestry in India***. ✍ 1st IGF of India = Brandis*** ✍ Forest department set up = 1864*** ✍ Scientific forestry started in India = in 1864*** About Dietrich Brandis • German • Father of Tropical forestry + Father of Indian Forestry*** • Appointed as Superintendent of Forest in Pegu province, Burma, by Lord Dalhousie (Joining date 16.1.1856). • IGF : Appointed on 1st April 1864, served until 1881 (Retired). At the request of the Madras Government, he continued for an additional <i>two years in an advisory role</i>, before finally returning to Europe in 1883. • Books : The forest flora of North-west and Central India (1874), Forest Entomology (1882), Indian Trees (1906). 
1865	Indian Forest Act [Passed by Governor-general of India in council] • Define Forest as = Any such land covered with trees, brushwood or jungle • Come into operation : 1st May 1865.
1866	The Changa-Manga fuelwood plantation was established to supply fuel and timber resources for the steam engines used in the North-Western Railway network. It is located in

	present-day Punjab, Pakistan .
1867	Imperial Forest Service (IFoS) started.
1875	The establishment of The Indian Forester journal was the outcome of a resolution passed at the 1st Forestry Conference held at Allahabad in January 1874, under the leadership of Dr. Dietrich Brandis, the then Inspector General of Forests. Attended by forest and civil servants from across British India, with key contributors including Baden-Powell, Gamble, Schlich and Smythies. ✂ The initiative was supported by several dedicated foresters, including Dr. W. Schlich, who served as the first honorary editor. ✂ The 1st issue was published in 1875 by Dr. Schlich and Baden-Powell, marking a significant milestone in the formal documentation and dissemination of forestry knowledge in India.
1878	- Central Forest school at Dehradun started [1st Director = F. Bailey] - Indian Forest Act, 1878 : 1st time classified Indian forests into –Reserved Forests (Chapter 2), Village Forests (chapter 3), and Protected forest (Chapter 4),
1879	Elephants Preservation Act passed.
1881	Brandis retired from the service and William Schlich became the 2nd Inspector General of the Forest (IGF) [In some books, it is given as 1883].
1883	Bombay Natural History Society (BNHS) *** started, Mumbai * [Its logo = Hornbill *]
1890	Botanical Survey of India (BSI) was established in 1890*** - Under the direction of Sir George King***, who had been the Superintendent of the Royal Botanic Garden, Sibpur (Calcutta). - King was appointed the first ex-officio Director (Honorary Director) of BSI, making him both the founder and inaugural head of the organization. - Headquarters : Kolkata (formerly Calcutta).
1890	Dr. John Augustus Voelcker (a German) was a consulting chemist to the Royal Agricultural Society of England. At the request of the Government of India, he began a study on the problems of Indian agriculture. In 1893, he submitted his report titled "Improvement of Indian Agriculture", which included a dedicated chapter on forests (Chapter 8, titled "Wood"). This report played a key role in laying the foundation for the Forest Policy of 1894. ✂ The First Forest policy of India came in = 1894***
1894	The 1st working plan for the Nilambur Forest Division (1896–1905) was prepared. The first planned working of forests in India is generally traced to 1837, when Mr. U. V. Munro, Superintendent of Forests in Travancore, estimated the number of teak trees fit for felling. He assessed approximately 1,00,000 teak trees on the basis of personal observation,



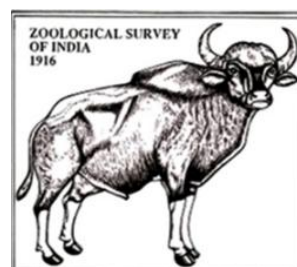
	existing stock and anticipated yield. This introduced the basic idea of regulating and forecasting forest yield. Current form of Working Plan was subsequently developed through the work of Dietrich Brandis, and formally codified through W. E. D'Arcy's "Preparation of Forest Working-Plans in India" (1891).
1898	Vedanthangal ^{***} declared as the 1st Wildlife Sanctuary in India
1906	The Imperial Forest Research Institute , now known as the Forest Research Institute (FRI) , was established in 5 June 1906 at Dehradun . Initially, it operated out of the Imperial Forest School building, and later, from 1914 to 1929 , it functioned from a building at Chandbagh (currently the site of Doon School). In 1929 , the institute moved into its newly constructed building, which was inaugurated by Lord Irwin , the then Governor-General of India . 1st President : E. Wilmont - FRI became deemed university : 1991 
1914	Board of Forestry set up
1926	1st World Forestry Congress in Rome, Italy.
1927	Indian Forest Act ^{***}
1935	Under the Government of India Act, 1935 , the subjects of Forests and Wildlife were transferred from the Central List to the State List .
1936	Hailey National Park was established in 1936 ^{***} in the Tarai area of Uttarakhand, which later (in 1957) was renamed, Corbett National Park. The 1st national park of India was set up in : 1936^{***}

1.2 FORESTRY & WILDLIFE AFTER INDEPENDENCE

1948	Central Board of Forestry ^{***} Created
1949	M.D. Chaturvedi — 1 st Indian Inspector General of Forest (IGF)   M.D. Chaturvedi (1 st Indian IGF) C.R. Rangnathan 2nd IGF
1950	Van Mahotsav is an annual pan-Indian tree planting festival ^{***} , which was launched in 1950 ^{***} by (Kanaiyalal Maneklal Munshi) K. M. Munshi ^{***} , the then Union Minister for Agriculture and Food , to create enthusiasm in the minds of the population for the

1950	conservation of forests and planting of trees. It is observed in the 1st week of July^{***}. The main objectives of the planting of trees during Van Mahotsav are – — Provide fuel — Increase the production of fruits and add to the potential food resources of the country. — Help creation of shelter-belts around agricultural fields to increase their productivity. — Provide fodder leaves for cattle to relieve the intensity of grazing over reserved forests. — Provide shade and ornamental trees for the landscape. — Provide small poles and timber for agricultural implements, house construction, and fencing. — Help conservation of soil and prevent further deterioration of soil fertility. — Inculcate tree consciousness and love of trees among the people. — Popularize the planting and tending of trees in farms, villages, municipal and public lands for their aesthetic, economic and protective needs.																
1952	– The 2nd National Forest Policy came up with the target of bringing 33 % of the Geographical area under forest cover. – The Indian Board of Wildlife (IBWL) was set up under the Chairmanship^{***} of the Minister of Agriculture^{***} [At that time, the forest was a department under the Ministry of Agriculture].																
1954	– 4th World Forestry Conference held in Dehradun <table border="1"> <thead> <tr> <th>World forestry congress</th><th>Year</th><th>Place</th></tr> </thead> <tbody> <tr> <td>1st</td><td>1926</td><td>Rome, Italy</td></tr> <tr> <td>3rd</td><td>1949</td><td>Helsinki, Finland</td></tr> <tr> <td>4th</td><td>1954</td><td>Dehradun</td></tr> <tr> <td>15th</td><td>2022</td><td>Seoul, South Korea</td></tr> </tbody> </table> Generally been held at about six-year^{***} intervals	World forestry congress	Year	Place	1 st	1926	Rome, Italy	3 rd	1949	Helsinki, Finland	4 th	1954	Dehradun	15 th	2022	Seoul, South Korea	A Magazine published by Food and Agriculture Organization (FAO), Rome, Italy is UnaSylva.
World forestry congress	Year	Place															
1 st	1926	Rome, Italy															
3 rd	1949	Helsinki, Finland															
4 th	1954	Dehradun															
15 th	2022	Seoul, South Korea															
1960	– Prevention of Cruelty to Animals Act^{***} passed ✎ Animal welfare board : Chennai (1962) ----> Ballabgarh (Haryana). ✎ 28 Members @ 3 Years.																
1965	A centre called the Pre-Investment Survey of Forest Resources (PISFR) was established in FRI (Dehradun) building as a joint project of the FAO, the Government of India, and the UNDP. Based on the recommendations of the National Commission on Agriculture (NCA) Report, 1976, this centre was reorganized and upgraded to form the Forest Survey of India (FSI) in 1981.																

- In **1916**, to promote the scientific study of India's rich faunal resources.
- Logo : **Indian Bison (Bos gaurus)**
- **Number of Regional Centres : 16**
 - **Estuarine** Biology Regional Centre, Gopalpur, Ganjam, **Orissa**.
 - **Freshwater** Biology Regional Centrem Hyderabad, Telangana.
 - **Central Zone** Regional Centre, **Jabalpur**
- **Work** : Survey and Monitoring of Faunal Diversity. Assessment of Threatened and Endemic Species. Maintain **Red Data Book (Animals)**.



National Green Tribunal (NGT)

- **National Environment Tribunal^{***} @ 1995** under **National Environment Tribunal Act, 1995**.
 - Mandate : to hear cases involving environmental damage and award relief.
- **National Environment Appellate Authority (NEAA) @ 1997** via **National Environment Appellate Authority Act, 1997** = to hear appeals against environmental clearances issued under the EPA, 1986.
- **National Green Tribunal (NGT)^{***} : Founded in 2010^{***}** under the **National Green Tribunal Act, 2010**; operates under MoEFCC.
 - **Nature** : **Statutory^{***}**, **Quasi-Judicial^{***}** body for expeditious resolution of environmental disputes.
 - Main Office : **New Delhi^{***}** | Regional branches : **Bhopal^{***}**, Pune, **Kolkata^{***}**, and Chennai.
 - ✍ AP = Under Chennai.
 - **Procedural ethos** : ♦ Applies **sustainable development**, **precautionary**, and **Polluter Pays^{***}** principles in its decisions. ♦ Governed by **principles of natural justice^{***}** —not strictly bound by the Civil Procedure or Indian Evidence Act.

CENTRAL ZOO AUTHORITY (CZA)

The concept of Zoo was started in Egypt way back in 2500 BC, where animals such as monkey, antelopes and mongoose were kept as pets.



- In India, the **1st zoo**, known as the **Indian Natural History Project**, was established in **1803** at **Barrackpore**, near **Kolkata**. It was later transferred in 1875 to the newly established and larger **Alipore Zoological Garden**, Kolkata.
- The **1st private zoo** in India, the **Marble Palace Zoo**, was established at **Kolkata** in **1854** by Raja Rajendra Mullick Bahadur.
- In 1855, **Arignar Anna Zoological Park** (or **Madras Zoo**) was established in **Chennai**. Although its official website claims it to be the first zoo in India, this claim is factually inaccurate.
- In 1952, the Indian Board for Wildlife (IBWL) decided to develop modern zoo facilities in the national capital for public awareness, education and wildlife conservation, which paved the way for the establishment of the **National Zoological Park, New Delhi** in **1955**. In the following year (1953), a **Zoo Wing** of the **IBWL** was constituted to strengthen zoo administration and management.
- Wildlife (Prot) Amendment act, 1991 = **Central Zoo Authority (CZA)** was established in **1992** as a **statutory body** for regulating, coordinating and improving the scientific management of zoos in India.
- The **National Zoo Policy, 1998**

Source : Biodiversity : Perception, Peril & preservation, 3rd edition (2023), PHI Publication, New Delhi

- **Wildlife Crime Control Bureau (WCCB)** : on the recommendation of **Tiger Task Force**, under Wildlife Protection (Amend) Act **2006^{***}**, notify in June **2007**

- **HQ : New Delhi,**
- A specialized agency to combat organized wildlife crime.

- The **National Museum of Natural History** was established in **New Delhi** in **1972**, on the occasion of the **25th anniversary of India's Independence**. The objective was to create a museum that would showcase the country's rich **flora, fauna, and mineral wealth**. The museum was formally **inaugurated in 1978**.

1.4 FORESTRY EDUCATION SYSTEM

Background

- In 1878, the Establishment of a "**Forest School**" in **Dehradun**. Which was later renamed **Imperial Forest School** in 1884.
- **Imperial Forest Research Institute***** was established in **1906*****.
- **Directorate of forest education** (1953) *** = ACF/RFO training
- **1985** : MoEF established.
- **1986** : **Indian Council of Forestry Research and Education** (ICFRE)***, **Dehradun*****, established. Become Autonomous in **1991*****
- **1987** : **Indira Gandhi***** **National Forest Academy** (IGNFA) **Dehradun*****, established = IFoS training.



Sub-ordinated institutes of ICFRE

- **Forest Research Institute** (FRI)***, **Dehradun** (1906)***
- **Tropical FRI, Jabalpur***** (MP, 1988)
- **Arid FRI, Jodhpur***** (Rajasthan)
- **Rain FRI, Jorhat*****
- Institute of **Forest Genetics and Tree Breeding**, **Coimbatore***** (TN)
- Institute of **Wood Science & Tech** (IWST), **Bengaluru*****
- **Himalayan FRI, Shimla** (Himachal)
- Institute of **Forest Productivity**, **Ranchi*****, Jharkhand.
- Institute of **Forest Biodiversity**, **2012@ Hyderabad**

Indian Plywood Industries Research and Training Institute (IPIRTI), Bengaluru — in research, training, testing, and technology development for plywood and other wood-based panel products. It was merged with IWST, in 2022. [CSIR --> ICFRE]

Forest research centres (FRC)

- FRC for Skill development, **Chindwada** (MP)***
- FRC for **Bamboo & Rattan**, in 2004 at **Aizawl**, Mizoram, as a unit of RFRI, Jorhat, Assam.
- **Livelihood Extension Centre Agartala**, 2012, Under RFRI, Jorhat.
- RFC for Eco-Rehabilitation, **Allahabad** : In 1992, Under FRI, Dehradun.
- Coastal Ecosystem Centre, **Visakhapatnam**.

Other Important Institutes under ICAR, CSIR, ISRO and other govt ministries

- The **Indian Institute of Natural Resins and Gums**, formerly known as the **Indian Lac Research Institute**, is an autonomous institute established under the umbrella of the **Indian Council of Agricultural Research** (ICAR) by the Ministry of Agriculture, Government of India, for advanced research on lac and other natural resins and gums. The Institute is located at **Namkum, Ranchi** in **Jharkhand**, India.
- **Central Sericultural Research & Training Institute** (CSRTI), Mysuru
- The **Centre for Environment Education** (CEE) : established in **1984***** at **Ahmedabad*****

- **National Research Centre for Agroforestry (NRCAF)** was established in the year **1988** at **Jhansi**. In December 2014, NRCAF was upgraded to ICAR - **Central Agroforestry Research Institute** (ICAR-CAFRI). All India Coordinated Research Project on Agroforestry (AICRPAF) was initiated in **1983** | HQ – **Jhansi**
- The **Indian Grassland and Fodder Research Institute** (IGFRI), established in **1962**, at **Jhansi** (UP) under the ICAR framework. It fosters research, training, and extension programs on all aspects of forage production and utilization.
- **Animal Welfare Board of India**, Chennai (1962) – Under section 4 of Prevention of Cruelty to the Animals Act, 1960.
- **G. B. Pant Institute of Himalayan Environment & Development**, Almora (UK)
- **National Environmental Engineering Research Institute (NEERI)**, **Nagpur**
- National Zoological Park (Delhi Zoo) : New Delhi
- National Bureau of Plant Genetic Resources (NBPGR), Pusa, New Delhi
- **Salim Ali Centre for Ornithology and Natural History (SACON)**, Coimbatore
- **National Biodiversity Authority (NBA)**, Chennai
- **National Remote Sensing Centre (NRSC)**, Hyderabad
- **Indian Institute of Remote Sensing (IIRS)**, Dehradun

CSIR : President = PM

1.5 FOREST SURVEY OF INDIA (FSI)

About it

- In **1965**, a centre named **Pre-Investment Survey of Forest Resources (PISFR)** was established under a joint project of **FAO, UNDP**, and the **GoI**. Based on the recommendations of the **National Commission on Agriculture (NCA)**, **1976**, this centre was reorganized and renamed as the **Forest Survey of India (FSI)** in **1981**.
- HQ : **Dehradun**, Uttarakhand



Publications

- **Indian State of Forest Report (ISFR)**
 - A **Biennial report** (published once every 2 years) that provides comprehensive data on forest cover, tree cover, and related parameters.
 - **First published : 1987**
 - Latest edition : **18th ISFR (2023)** published in **2025**

Technical Details

Parameter	Specification
Satellite Used	IRS-Resourcesat-2 (LISS-III sensor)
Spatial Resolution	23.5 m × 23.5 m (Medium resolution)
Map Scale	1:50,000
Minimum Mapping Unit (MMU)	1 hectare

Time Frame for Satellite Data Acquisition

- **October to December** : For most Indian states
- **January to April** : For the **Northeastern region, coastal areas,** and the **Andaman & Nicobar Islands**

Purpose of Seasonal Variation : To ensure **cloud-free satellite imagery** and to capture **fully developed foliage**, which improves the accuracy and clarity of forest cover mapping.

FOREST AREA

All such lands which have been notified as forest under any Government Act or Rules or recorded as 'forest' in the Government records. The recorded forest area may or may not have forest cover.

- Total = **77.5 m hectares***** (23.59 %*** of Geographical area)
- Reserves forest > Protected forest > Unclassed Forest.
- Lakshadweep : "0" Reserve forest area

Forest area : Area-wise

MP > MH > Orissa > CG >>>> Punjab > Haryana > Goa

Highest

Lowest

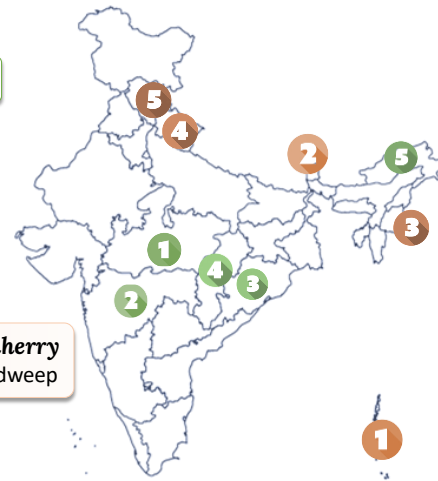
Forest area : Percentage-wise

A&N > Sikkim > Manipur > UK >>>> Punjab > Puducherry > Lakshadweep

(87%) (82%) (78%) (71%)

(6%) (2.6%)

(0%)



ANDHRA PRADESH

- Recorded forest area (RFA)= **37,258 sq. km***** [3.73 million hectares]*** which is **22.87 %***** of state GA.
- of which, **Reserve** forest (31,959 km² = 85.8%) > **Protected** forest (13.6 %) > **Unclassed** forest (0.6 %).
- The state has the **highest / largest area** under forest = MP***

FOREST COVER

All lands, more than one hectare with a tree canopy density of more than or equal to 10% irrespective of ownership, legal status and land use. Such lands may not necessarily be a recorded forest area. It also includes orchards, bamboo and palm.

- Total = **71.5 m hectares***** (21.76 %*** of GA)
- Compare to last report = 156 km² Increase.
- Forest cover in Hill districts = 40% of GA
- Forest cover classification based on canopy density –

As per **Kyoto protocol** : the definition of a forest can varies from one country to another, depending on the country's capacities and capabilities. Basic criteria

- Crown cover percentage** : Minimum tree crown cover falling within the range of 10% to 30%. India adopted a 10% threshold
- Minimum Area of Stand** : Forested areas should have a minimum area between 0.05 and 1 ha. India adopted 1 ha minimum
- Minimum Height of Trees** : Trees in these areas should have the potential to reach a minimum height of 2 to 5m at maturity in their natural habitat.

SN	Forest type	Canopy density	Area (in m hac.)	% of total cover
1.	Very Dense Forest	All lands with tree canopy density of ≥ 70 % ***	10.2	3 %
2.	Moderately Dense Forest (MDF)	All lands with tree canopy have a density b/w 40 to 70 % *** (up to 69.9%)	30.7	9.34 % ***

3.	Open forest (OF)	All lands with tree canopy density of 10 percent and more but less than 40 % ***	30.5	9.33 %
		Total forest cover	71.5	21.76 %*
	Tree Cover	Outside RFA	11.5	3.41
	Scrubland	Below 10 %		1.3 %
	Non-Forest	Lands are not included in any of the above classes (Including water)		73.5 %

STATE-WISE FOREST COVER

% Based	Area Based
1 st : Lakshadweep *** (90 %)	1 st : MP *** (7.7 m hac.)
2 nd : Mizoram *** (84.5 %)	2 nd : Arunachal *** (6.6 m hac.)
3 rd : A & N *** (81.7 %)	3 rd : CG (5.5 m hac.)
4 th : Arunachal (79 %)	4 th : Odisha (5.1 m hac.)
5 th : Meghalaya (76 %)	5 th : MH (5 m hac.)

GREEN WASH AREA ?

In the *Survey of India* (SOI) *topographic sheets*, the forest areas are showed by green colour, which is commonly known as green wash area.

Forest Cover in AP = 30,084 km² [18.46 % of state GA]***

► Forest cover (District wise)***

Area-wise

ASR > Prakasam > >>> West Godavari > Guntur

Highest

Lowest

% of District wise

ASR > Visakhapatnam > >>>> Kurnool > Guntur

55.6 %

28 %

0.9 %

0.55 %

Table 10.1.2 Forest Cover of Andhra Pradesh

Class	Area	% of Calculated Area by Sol
VDF	1,995.71	1.22
MDF	13,725.75	8.42
OF	14,363.50	8.82
Total	30,084.96	18.46
Scrub	8,351.62	5.13

► **TREE COVER** : Tree cover is defined as **all tree patches (including scattered trees)** of size **less than 1 hec. occurring outside the recorded forest area*****

✎ **Trees Outside Forest** (TOF) refers to all trees growing outside of the reserve forest area, irrespective of patch size, which could also be larger than 1 ha***

- Total tree cover = **11.5 m hac.***** (3.41 % of GA)***
- Forest cover + Tree cover = **71.5 m hac** (21.7%) + **11.2 m hac** (3.41%) = **82.7 m Hac.** (25.17 % of GA)***
(↑ 1445 km² compare to last report).

Table: Forest and Tree Cover of India

Class	Area	Percentage of GA
Forest Cover	7,15,342.61	21.76
Tree Cover	1,12,014.34	3.41
Total Forest and Tree Cover	8,27,356.95	25.17
Scrub	43,622.64	1.33
Non Forest	24,16,489.29	73.50
Geographical Area of the country	32,87,468.88	100.00

Northeastern region = 17.4 m hac*** (67% of GA)*** or **24.3%***** of Total Forest cover of India. As per ISFR 2023, it Decrease by 327 km².

- Most prevalent species in TOF : 1st **Mangifera indica**, 2nd **Azadirachta indica**.
- State wise : MH > Rajasthan > UP
- As per ISFR 2023 : Maximum Increases = CG > UP > Odisha | Decrease : MP > Karnataka

To monitor Tree cover, growing stocks, Carbon pool, Bamboo resources, NTFP, Regeneration status, Invasive species, etc. The **National Forest Inventory (NFI)** in India underwent a major transformation in its sampling design in **2016**.

Previous Design (NFI 2002)

- The country was divided into **14 geographical zones**, and **60 districts** were selected for detailed inventory in each cycle (2 years cycle).
- This meant that a district surveyed in one cycle would be revisited only after **20 years**, resulting in a **revisit time of 20 years**.

Revised Design (NFI 2016)

- A **grid-based^{***}** sampling design was introduced, dividing the entire country into **uniform 5 km × 5 km grids**.
- Each year, a specific number of these grids are selected systematically for detailed forest inventory.
- This change significantly **reduced the revisit time from 20 years to just 5 years^{***}**, enabling more frequent and efficient forest monitoring.

► FOREST FIRE MONITORING : MoEFCC = **National Action Plan on Forest Fires in 2018**.

- Main objectives : Reduce the incidences of fires by informing, enabling, and empowering forest fringe communities,
- Nodal Agency : and **Forest Survey of India (FSI)^{***}**
- In 2019, FSI released **Forest Fire Alarm System (FAST) 3.0^{***}** = Complete automatic processes. Detect & share information @ **4 hours^{***}** gap.
- System based on the two satellite-based sensors - **Moderate Resolution Imaging Spectroradiometer (MODIS)^{***}** (at 1 km × 1 km resolution) and **Suomi-National Polar-orbiting Partnership - Visible Infrared Imaging Radiometer Suite (SNPP-VIIRS)^{***}** (at 375 m × 375 resolution) to detect potential fires.
- op 3 states where fire incidences : **Uttarakhand**, Odisha, & Chhattisgarh.
- Major causes in central region : Gathering of tendu leaves (*Diospyros melanoxylon*) + Mahua flowers (*Madhuca longifolia*).

► Total geographical area of India : **328.7 m hac^{***}**

India	Forest area	Forest Cover
1950	40 m hac. (21.8 %^{***} of GA)	82.5 m hac. (25.8 % of GA)
2021	77.5 m hac. (23.58 % of GA)	71.3 m hac. (21.71 % of GA)

► GROWING STOCK (GS)

- **GS_(Total) = 6429 Mm³** [GS_{Forest} = 4478 mm³ + GS_{TOF} = 1950 mm³].
- Total increase = 262 Mm³ (4.25%)
- GS per hectare basis : Forest area = **86.1 m³/hec^{***}** | TOF = **9.5 m³/hec.**
- State wise / in Forest = **Arunachal Pradesh** > Uttarakhand > CG > MP.
- Species wise :
 - ◊ Forest : **Shorea robusta** (11.4 % of total forest GS), **Tectona grandis** (4.46%), **Pinus roxburghii** (4.43%).
 - ◊ TOF : **Mangifera indica** (13% of total TOF GS), **Azadirachta indica** (7%), **Madhuca latifolia** (4.3 %), **Cocus nucifera** (4.1 %).

- Bamboo bearing area = **15.4 m hac** (Maximum = **MP** > Arunachal > MH)

1.9 WILDLIFE PROJECTS

- Project **Hangul** (Kashmiri stag) → 1970
- **Lion** → 1972^{***}, **Gir**^{***} Forest, Gujarat.
- **Tiger** → 1973^{***}
- **Crocodile breeding** project → 1975^{***}
- **Rhino** conservation project → 1987^{***} (Kaziranga^{***}).
Assam (80%) + WB + UP (Dudhwa) + Bihar (Valmiki) + MP (Not now, planning).
- **Snow Leopard** → 2009^{***}
- Project **Elephant** → 1992^{***} : By MoEF, to protection of elephants + Their habitats, + Migration corridors.
 - **Monitoring of Illegal Killing of Elephants (MIKE)** Programme = under **CITES**^{***} to monitor elephant mortality trends and combat poaching.
 - **Haathi Mere Saathi Campaign** : A public awareness campaign @ **MoEF**^{***} + **Wildlife Trust of India (WTI)**^{***} to promote harmonious coexistence b/w humans and elephants.

The **National Action Plan on Climate Change** (NAPCC) was released on **30th June 2008**.

NATIONAL MISSION FOR A **GREEN INDIA** or **GREEN INDIA MISSION (GIM)**

Launched @ **February 2010**^{***}. The year 2011-12 was declared as the preparatory year. Finally approved by the **Cabinet Committee on Economic Affairs (CCEA)** in **February 2014**.

✍ **Green India mission** was launched in **February 2014**^{***}

1.10 NATIONAL & INTERNATIONAL DAY'S & YEAR'S

- **World Wetland Day** : 2nd February
- **World Wildlife day** : 3rd March
- **World Forest Day** : 21st March
- **World Water Day or World water Conservation Day** : 22nd March
- **World Metrology day** : 23rd March
- **World Earth Day** : 22nd April
- **World Press Freedom day** : 3rd May
- **National Agroforestry days** : 8th May
- **World Biodiversity day** : 22nd May
- **World environment day** : 5th June

KPSC ACF (Pre) GS 2015; Assam (ACF) 2018, 2021; Nagaland PSC Technical Exam (Forestry Optional) 2021

Uttarakhand PSC (Pre) G.S 2002; UPPSC (ACF/RFO) 2015; Tripura PSC Forest & Civil (Pre) GS 2021

MPPSC (ACF) 2011; Kerala (RFO) 2015; Nagaland PSC Technical Exam (Forestry Optional) 2015, 2017, 2021; ASRB (ARS/NET) 2013-14, 2017; APPSC Forest Service (Pre) GS 2017; BHU (M.Sc.) Agroforestry Entrance examination 2018, 2021; CGPSC Assistant professor 2019; Assam (ACF) 2019; Assam PSC RFO 2018, SCR 2021 Forestry; CGPSC SFS 2019.

UPPCS (Pre) G.S 2011; MPPSC ACF/RFO Environmental Science 2014; BHU (M.Sc.) Agroforestry Entrance examination 2018; HPPSC RFO 2021

[ICAR (SRF) 2019]

KPSC ACF (Pre) GS 2008; Assam (ACF) 2013 Environmental science, RFO 2014; Mizoram PSC Civil (Pre) GS 2014; BHU (M.Sc.) Agroforestry Entrance examination 2018; Rajasthan ACF/RFO 2018; APPSC-Section officer 2020; ICAR (SRF) 2020; Tripura PSC Civil (Pre) GS 2020, 2021

Tripura PSC Civil (Pre) GS 2020

Nagaland PSC Technical Exam (Forestry Optional) 2018; ASRB ARS/NET 2021

Mizoram PSC Civil (Pre) GS 2017; ICAR (JRF) 2016; ICAR (SRF) 2019; Kerala (RFO) 2019; Karnataka (RFO) 2019; MPPSC ACF/RFO Environmental Science 2019; MPPSC ACF/RFO 2019 GS; RPSC (ACF/RFO) Examination 2018/2021 Environmental science

UPPCS (Pre) 2012, MPPSC (Pre) GS 2009; MPPSC SFS 2011, 2014; Odisha-civil (Pre) 2011; ICAR (JRF) 2012, 2016; Assam PSC (ACF) 2013 Evs, 2019; Assam PSC (RFO) 2014; MPPSC SES (Pre) 2014; Kerala (RFO) 2015; Mizoram PSC Civil (Pre) GS 2016, 2018; ASRB (ARS/NET) 2018; RPSC SFS 2018 Evs.

• World Oceans Day : 8 th June	ICAR (JRF) 2016
• World day to combat desertification and drought : 17 th June	
• Van Mahotsav : 1 st week of July	[Almost in every 2 nd /3 rd paper]
• World population day : 11 th July	ICAR (JRF) 2016; CGPSC SFS 2019; RPSC ACF/RFO (2018) Evs. Optional
• World nature conservation day : 28 th July	
• International Tiger Day : 29 th July	ICAR (JRF) 2016; UPPCS (Mains) G.S 2014
• World Ozone Day : 16 th September [Ozone week : 16 to 23 rd September]	Assam (ACF) 2013 Environmental science; UPPCS (Pre) G.S 2014, MPPCS (Pre) G.S 2014; UPPCS (Pre) G.S 2016; WBPSC Civil (Pre) GS 2017; Maharashtra PSC (Pre) G.S, 2018; Rajasthan ACF/RFO 2018; MPPSC ACF/RFO Environmental Science 2019; ICAR (JRF) 2020
• World car-free day : 22 nd September	TNPSC Civil (Pre) GS 2015
• International coastal clean-up day : 3 rd Saturday in September	
• [National] Green consumer day : 28 th September	
• Wildlife week : 1 st week of October [Gandhi Jayanti]	MPPSC ACF/RFO Environmental Science 2014; ICAR (JRF) 2015; RPSC ACF/RFO (2018) Forestry, Environmental science; ICAR (SRF) 2020; Nagaland PSC Technical Exam (Forestry Optional) 2021; Assam PSC RFO 2021
• World Animal Day : 4 th October	Karnataka PSC (RFO) 2007
• World habitat Day : In 1985 the United Nations designated the <u>first Monday of October every year</u> as World Habitat Day. <u>World habitat day 2021 : 4th October</u>	Karnataka PSC (RFO) 2007; Nagaland PSC Technical Exam (Forestry Optional) 2021; Nagaland PSC CTSE 2023
• World Food Day : 16 th October	ICAR (SRF) 2015; CGPSC SFS 2019
• World city day : 31 st October	
• World Tsunami awareness day : 5 th November	APPSC Forest Service (Pre) GS 2017
• World fishery day : 21 st November	
• Bhopal Gas tragedy day : 2 nd December	
• World Soil Day : 5 th December	APPSC (FRO) 2018; APPSC Forest Section officer 2020
• National Energy Conservation day : 14 th December	Mizoram PSC Engineering Service (Pre) GS 2020
• Kishan divas : 23 rd December	

INTERNATIONAL YEAR

2023 : International Year of **Millet**s

2024 : International year of **Camelids**

2025 : International Year of **Glaciers** Preservation

International Year of **Quantum Science** and Technology

2026 : International Year of **Rangelands** and **Pastoralists**

International Year of the **Woman Farmer**

2027 : International Year of Sustainable and Resilient **Tourism**

ANDHRA PRADESH

2.1 BACKGROUND

- Known as the “**Rice Bowl of India**” (fertile Godavari–Krishna deltas)
- Andhra State** carved out of Madras State : **01 Oct 1953** (Capital : Kurnool) – after the death of Potti Sriramulu (fast unto death, 15 Dec 1952).
- Andhra Pradesh formed (merger with Telangana region of Hyderabad State) : **01 Nov 1956** – AP Formation Day = **1st November**.
- Bifurcation (Telangana carved out) : **02 June 2014** – **AP Reorganisation Act, 2014**
- Capital : **Amaravati** – made statutory by the AP Reorganisation (Amendment) Act, 2026 (gazetted **06 Apr 2026**, w.e.f. 02 June 2024)
- Districts : 13 → 26 (**04 Apr 2022**) → **28 (31 Dec 2025)**; new : **Polavaram** – HQ Rampachodavaram & **Markapuram**).
- Geographical area : **1,62,970 km²** (7th largest state)
- Coastline : **1,053.07 km** – 3rd longest after Gujarat & Tamil Nadu (revised by NHO & Survey of India, 2025; old figure 974 km – 2nd)
- Kolleru** – one of the largest freshwater lakes of India, between Godavari & Krishna deltas.

► STATE SYMBOLS

SN	Symbol	English / Telugu Name	Scientific name	Family
1.	State Tree	Neem (Vepa chettu)	<i>Azadirachta indica</i>	Meliaceae
2.	State Animal	Blackbuck (Krishna Jinka)	<i>Antelope cervicapra</i>	Bovidae
3.	State Bird***	Rose-ringed parakeet (Rama Chiluka)	<i>Psittacula krameri</i> ***	Psittaculidae
4.	State Flower	Jasmine (Malle Puvvu)	<i>Jasminum officinale</i>	Oleaceae

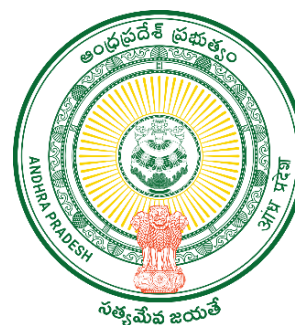
- ❑ State Emblem : **Purna Ghatam** (Purna Kumbham) at the centre, surrounded by a **Dharmachakra** (“wheel of law”), with the State’s name in Telugu, English & Hindi.

► MONSOON & CLIMATE

- SW Monsoon onset (normal) : **≈ 4 June** (Rayalaseema – Anantapur, Tirupati) [IMD normals, 2020]
- SW Monsoon withdrawal : by mid-October (Kalingapatnam ≈ 15 Oct)

Chapter Outline

- 2.1 Background
- 2.2 Forest Department
- 2.3 Forest Resources
- 2.4 Protected Areas
- 2.5 Flora, Fauna & Others



- **NE Monsoon** (Oct–Dec, onset $\approx$ 20 Oct) : $\approx$ 31–33 % of annual rainfall of Coastal AP & Rayalaseema – crucial for South Coastal AP (Nellore, Tirupati)
- Normal annual rainfall : Coastal AP $\approx$ **104 cm** | Rayalaseema $\approx$ **73 cm**
- Highest rainfall : **High Altitude & Tribal Zone** (Alluri Sitharama Raju, Parvathipuram Manyam) $\rightarrow$ 1,400 mm
- Lowest rainfall : **Anantapuramu** ($\approx$ 552 mm) – 2nd driest district of India after Jaisalmer
- Cyclone-prone east coast; latest – Severe Cyclonic Storm **Montha** crossed near Kakinada on **28 Oct 2025**

► **AGRO-CLIMATIC ZONES : 6 (ANGRAU, post-2014)**

SN	Agro-Climatic Zone	Soil Type	Rainfall (mm)	Districts Covered
1.	North Coastal	Red, laterite (acidic)	1000–1100	Srikakulam, Vizianagaram, Visakhapatnam, Anapalli
2.	Godavari	Deltaic alluvium	800–1100	East Godavari, Kakinada, Konaseema, West Godavari, Eluru
3.	Krishna	Black, red & coastal sands	800–1100	Krishna, NTR, Guntur, Bapatla, Palnadu, Prakasam
4.	Southern	Red loams	700–1100	SPSR Nellore, Tirupati, Chittoor, YSR Kadapa, Annamayya
5.	Scarce Rainfall	Red earths, black cotton	500–750	Anantapuramu, Sri Sathya Sai, Kurnool, Nandyal
6.	High Altitude & Tribal	Red, hill soils	> 1400	Alluri Sitharama Raju, Parvathipuram Manyam

- ✎ Planning Commission Agro-climatic Regions covering AP : **Region X** – Southern Plateau & Hills and **Region XI** – East Coast Plains & Hills (Undivided AP had 7 ANGRAU zones; district list on 26-district basis).

2.2 FOREST DEPARTMENT

The forests referred to as “**Dandakaranya**” in the Ramayana spread over a large part of Andhra Pradesh. Before 1953 the forest history of Andhra was that of the **Madras Presidency**. Forest conservancy in Madras was established in **1856** through the efforts of **Dr. Hugh Cleghorn** (first Conservator of Forests, Madras) and the **Madras Forest Act V of 1882** came into force on **01 Jan 1883**. During 1920–1950 large **Casuarina** plantations were raised along the coast. Andhra forests came under separate management in 1953, and the **Andhra Pradesh Forest Department** came into existence on **01 Nov 1956**.

- First Chief Conservator of Forests (CCF) : **Sri Daulat Rai** (1956–60)
- Head Office : **Aranya Bhavan, Mangalagiri** (Guntur district)
- Forest Minister : **Sri Pawan Kalyan**, Deputy CM (Environment, Forests, S&T – since June 2024)

► **ORGANIZATIONAL STRUCTURE**

- Territorial Circles : 5 | Wildlife Circle : 1 | Project Tiger Circle : 1 (Srisailem)
- Forest Divisions : 32 Territorial | 13 Social Forestry | 2 Wildlife

► **FOREST ACTS & RULES**

- **AP Forest Act, 1967** (Act No. 1 of 1967) : came into force in **1967***** – consolidated the Madras Forest Act, 1882 (Andhra) and the Hyderabad Forest Act, 1355 Fasli (Telangana)
- **AP Water, Land and Trees Act (APWALTA), 2002** (Act No. 10 of 2002) – in force from **19 April 2002***** : prior permission to fell trees; **2 saplings for every tree felled**; penalty = 2–5 times the value of tree; 250 m

SN	Name	Year	Area (km ²)	District / Known for
7.	Kolleru ^{***}	1999	308.55	Eluru & Krishna – Ramsar site (2002); pelicans
8.	Coringa ^{***}	1978	235.70	Kakinada – mangroves^{***} (Godavari estuary); fishing cat
9.	Krishna	1989	194.81	Krishna & Bapatla – mangroves (Krishna estuary)
10.	Sri Venkateswara WLS	1985	–	Tirupati & Annamayya – Seshachalam hills
11.	Kambalakonda	2002	71.39	Visakhapatnam – Eastern Ghats dry evergreen
12.	Rollapadu	1988	6.14	Nandyal – Great Indian Bustard, Lesser Florican, Blackbuck
13.	Nelapattu	1976	≈ 4.6	Tirupati – largest breeding colony of Spot-billed Pelican

Source : AP Forest Department; WII National Wildlife Database; MoEFCC

► TIGER RESERVE

- **Nagarjunasagar–Srisailem Tiger Reserve (NSTR)** – **largest Tiger Reserve of India** (3,296.31 km² as per NTCA) in the Nallamala hills; under Project Tiger since 1982-83 (sanctuary 1978); constituent PAs – Rajiv Gandhi WLS & Gundla Brahmeswaram WLS; adjoins Amrabad TR (Telangana) across the Krishna
- NSTR – Sri Venkateswara NP tiger corridor passes through GBM, Sri Lankamalleswara & Sri Penusila WLS
- **Chenchus** – PVTG living inside NSTR (honey & NTFP collectors, traditional forest guardians)

► ELEPHANT RESERVE, BIOSPHERE RESERVE & WETLANDS

- **Rayala Elephant Reserve – 2003**, 766 km², Chittoor (includes Koundinya WLS) – elephants move in from adjoining Tamil Nadu & Karnataka forests
- **Seshachalam Biosphere Reserve^{***}** – **first & only Biosphere Reserve of AP**, notified **20 Sep 2010**; 4,755.997 km² (Tirupati, Chittoor, Annamayya, YSR Kadapa) – endemic Eastern Ghats species, red sanders; **not in UNESCO MAB list**
 - ❑ **Gudem–Maripakala** (Alluri Sitharama Raju dist.) – only proposed as 2nd Biosphere Reserve; not notified
- **Kolleru Lake** – **only Ramsar site of AP^{***}** (designated **19 Aug 2002**; 901 km²); Pulicat Lake is NOT a Ramsar site
- **Important Coastal & Marine Biodiversity Areas (ICMBA)** in AP : Coringa–Godavari mangroves, Krishna mangroves, Pulicat lagoon and **Naupada swamp – Srikakulam district^{***}**
- Coringa ESZ – 177.30 km² notified on 22 Sep 2021

🦋 Tirumala hills added to UNESCO World Heritage **Tentative List** on **27 Aug 2025** | 166 plant taxa endemic to the Eastern Ghats (BSI)

► KEY FAUNA OF AP

Species	IUCN	Location in AP
Jerdon's Courser^{***}	CR	Sri Lankamalleswara WLS (YSR Kadapa) – rediscovered 1986 near Reddipalle; WLS created for it (1988)
Great Indian Bustard	CR	Rollapadu WLS (Nandyal) – no recent sighting
Lesser Florican	CR	Rollapadu WLS
Fishing Cat	VU	Coringa WLS – India's first fishing-cat collaring (WII, 2021)

FOREST FORESTRY & SILVICULTURE

1.1 INTRODUCTION

The term **Forest** has its roots in early medieval European society. The increasing population and the rise of new kingdoms and serfdoms, based on the heavy exploitation of natural resources, caused a severe loss of natural vegetation (that we called in India - **Jungles**) to meet their growing demands for food, fodder, fuel, and timber. The shrinking areas of natural vegetation created a shortage of fuelwood and timber in their ruling regions. As a result, they began designating parts of the land, usually unproductive and located at the boundaries of village territories, for growing tree crops, which became known as **Woodlands** or **Forests**, to produce the required resources.

🦋 **Forest** term derived from a **Latin***** word **Foris***** which means **outside of village boundary*****.

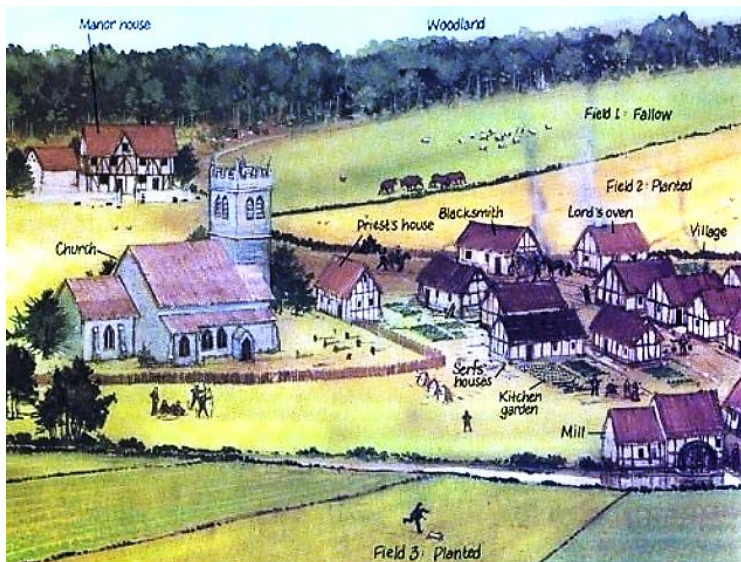


Figure 1.1 : A medieval European village

► DEFINITION

- Forest is an **area set aside** for the **production of timber** and other forest produce or to get other **indirect benefits** from it [Technical definition].

Chapter Outline

- 1.1 Forest
- 1.2 Forest Classification
- 1.3 Forestry
- 1.4 Silviculture
- 1.5 Role of Forest
- 1.6 Forestry development through ages
- 1.7 Important terminology
 - 🌿 Precision Silviculture
 - 🌿 Sacred Groves

- Forest is an *uncultivated land* occupied by *natural vegetation* with a closed or partially *closed canopy*, which *provides shelter to the wildlife* [Ecological definition].
- Forest is any land area that has been *declared as a 'forest'* under any *central* or *state*, or *local laws* (i.e., by Tribal council) [Legal definition]

1.2 FOREST CLASSIFICATION

Forests are classified into various categories to –

- Provide a **Standardized** system for **Identifying, Describing, and Mapping** different types of forests based on their characteristics, such as tree species composition, canopy structure, and ecological function. This information can be used in decision-making processes related to **Conservation, Management, Administration, Research, Land-Use Planning** and **Record-Keeping**.
- For purposes of **Description, Administration, Management, and Record;**

Forest may be classified on the basis of –

- [A] Age
- [B] Regeneration
- [C] Composition
- [D] Ownership
- [E] Function
- [F] Legality
- [G] Growing stock
- [H] Density of Forest cover
- [I] Ecological or Ecosystem-based

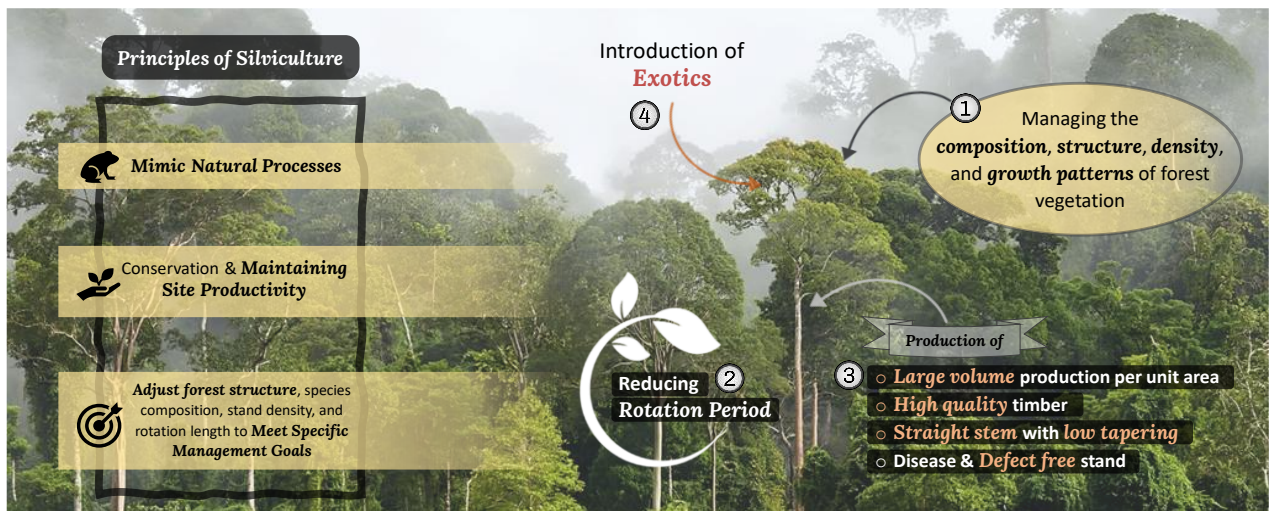
► FOREST TYPES, BASED ON AGE

- **Even-Aged or Regular Forest** : A forest (or stand) composed of trees that are approximately the same age & Size. From a management perspective, a difference of up to 25% of the rotation age is permissible, especially for stands not harvested for 100 years or more. While nature does not naturally create even-aged forests, humans can achieve this through plantation efforts, such as the **Nilambur** teak plantation established in 1842. [In essence, a truly Even-Aged Forest is typically Man-Made].
- **Un-Even Aged or Irregular Forest** : A forest stand comprising trees of various ages. The age difference typically exceeds 20 years, or in the case of long-rotation crops, more than 25% of the rotation age. Natural forests generally exhibit this composition, such as the **Satpura** forests.

► METHOD OF **Regeneration**

- **High Forest** : A forest characterized by a closed or partially closed canopy, *regenerated through Seeds*. It is also known as a “**Seedling Forest**”.
- **Coppice Forest** : A forest *regenerated through some Vegetative* methods like coppicing, root suckers, or ratoons. It is also known as a “**Low Forest**”

- Reducing **rotation period** : It involves shortening the time it takes for trees to reach harvestable size, increasing the frequency of timber harvests, and improving economic returns.
- **Site Protection** : Involves minimizing soil erosion, maintaining soil fertility, and protecting water quality.
- Introduction of **exotics**, *i.e.*, Poplar, Eucalyptus.
- Creation of **Man-made Forest** in place of Natural Forest (Afforestation, reforestation), *i.e.*, Nilambur teak, to prevent **habitat fragmentation**.



SILVICS & SILVICULTURE : TWO SIDES OF THE SAME COIN

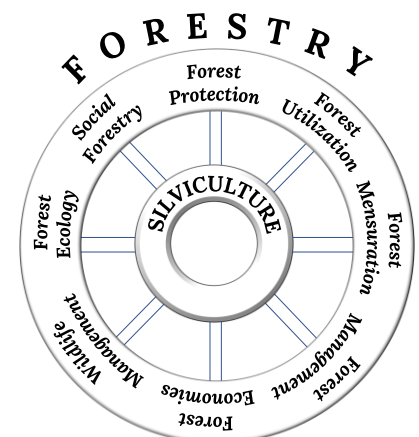
Silvics is primarily concerned with understanding the biological and ecological processes that govern forest growth and development. Silviculture, on the other hand, is focused on applying that knowledge to achieve specific management objectives. A simple analogy to understand the difference between silvics and silviculture is to think of a doctor and a surgeon. Silvics is like the study of human anatomy and physiology – the doctor's understanding of how the body works. Silviculture is like surgery – the application of that knowledge to treat a patient.

Silvics provides the knowledge base for understanding how forests function, while silviculture provides the tools for manipulating forest stands to achieve desired outcomes.

SILVICULTURE & OTHER BRANCHES OF FORESTRY

Silviculture is the hub (Backbone) of the forestry wheel. Other forestry branches, *i.e.*, Forest protection, Forest Management, Forest Mensuration, Forest Economics, etc., are supported by Silviculture.

- **Silviculture & Forest protection** : Forest protection is a branch of forestry which concerned with the activities directed to the prevention & control of damage caused by humans, insects, pests, animals, or fire. Here, Silvicultural principles help us to - (a) mix the crop composition to increase insect/pest resistance, (b) introduction of evergreen species for controlling forest fire, and (c) growing of live fencings to prevent animal damage.



LOCALITY FACTORS

2.1 LOCALITY FACTORS

SITE or **LOCATION** is an area where you want to carry out plantation or management work.

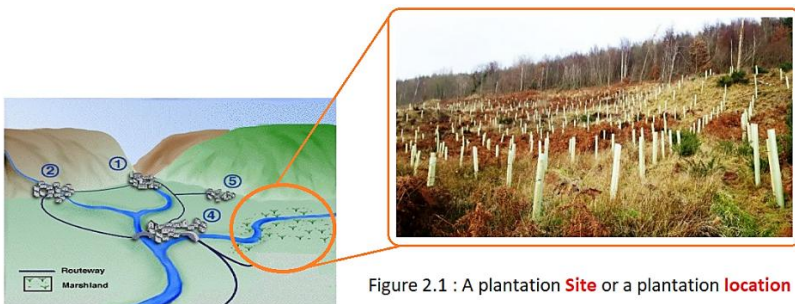


Figure 2.1 : A plantation **Site** or a plantation **location**

SITE FACTORS

The sum of all effective climatic, edaphic, topographic, and biotic conditions of a particular area under which a plant community lives. This means, Site factors are all biotic and abiotic factors of an area that interact and influence vegetation occurrence, distribution, and growth.

➤ Site factors are also known as **Locality Factors** or **Habitat Factors**.

These factors are –

1. Climatic factors : Solar radiation, rainfall, Wind speed, air temperature, etc.
2. Edaphic factors : Soil organic matter, soil texture, soil structure, mycorrhiza, waterlogging, salinity, etc.
3. Topographic or Physiographic factors : Mountains arrangement, Altitude, latitude, slope, aspects, exposure, etc.
4. Biotic factors : insects/pests attacks, invasion of exotics, grazing and browsing by wild and domestic animals, Human interference.

2.2 WHY ARE THESE FACTORS IMPORTANT?

Locality factors are very important in silvicultural operations because they directly affect the growth, health, and success of a forest or

Chapter Outline

- 2.1 Locality Factors
- 2.2 Why are these factors important?
- 2.3 Site Quality
 - Quality classification
 - Site quality Index

plantation. These factors go beyond just technical knowledge and include the natural, social (Naxal), and geographical conditions of the area.

Key reasons why locality factors are important

- We generally refrain from undertaking **large** and **long-term commercial projects** in remote, inaccessible forest areas due to connectivity issues, which can create hurdles during project execution, monitoring, availability of skilled workforce, and the application of protection measures during management. For example, we do not see any large, long-term commercial plantation projects in the middle or greater Himalayan region because of the long distances from major markets, the unavailability of large flat surfaces for project work, lack of backup infrastructure or financial support, and the hilly terrain, which is prone to soil erosion and landslides.
- Adverse local climate/weather : Almost every plantation project or thinning operation requires a large skilled and unskilled human and animal workforce. Drought, frost, forest fires, and landslides can cause casualties and disrupt operations. Generally, we avoid conducting thinning and timber harvesting operations in the peninsular region during the summer and monsoon seasons.
- Before approving any project, the forester needs to understand the socio-economic impact of plantation / silvicultural operations over the local tribal economy, which depends on the minor forest products for livelihood (Forest Right Act). Some areas are facing Naxalite/Militancy issues.
- The Forest Department's ownership, i.e., the Forest Department, has limited powers over the forest areas, those falling under 'Scheduled Areas' and tribal areas' (declared under Article 244).

2.3 SITE QUALITY

Site quality is the **relative productive capacity** of a site **for a particular species** or group of species. As we know, a site is **a complex of physical and biological factors of an area**. Every site responds differently to different species. It is usually measured on the basis of the **Top Height** of the crop at a particular age.

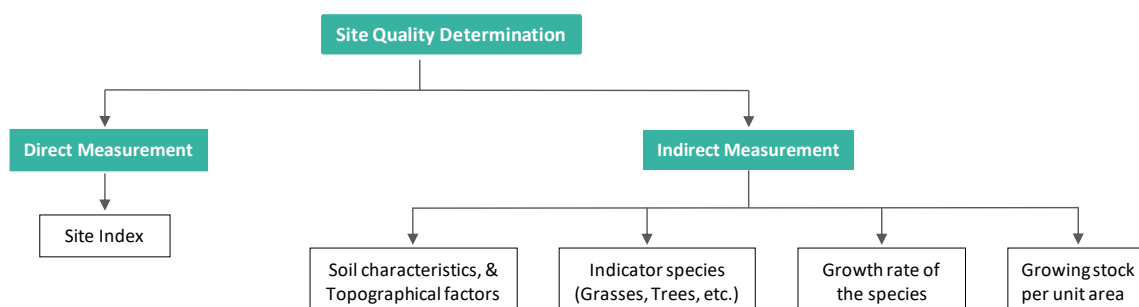
There are four site quality classes for **teak** –

1.	Site Quality I	Top height : 36.6 to 30.5 mt
2.	Site Quality II	Top height : 30.5 to 24.4 mt
3.	Site Quality III	Top height : 24.4 to 18.3 mt
4.	Site Quality IV	Top height : 18.3 to 12.2 mt

Top Height = Dominant height = Maximum height

Top height is the mean height of a fixed number of largest or tallest trees per unit area, e.g., the mean height of the 100 greatest girth (or tallest) trees per Hectare (or 40 Trees/acres).

SITE QUALITY CLASSIFICATION (DETERMINATION)



CLIMATIC FACTORS

Climate is the average weather prevalent in any locality that influences our forest vegetation, *i.e.*, light, atmospheric temperature, pressure & humidity, wind, etc.

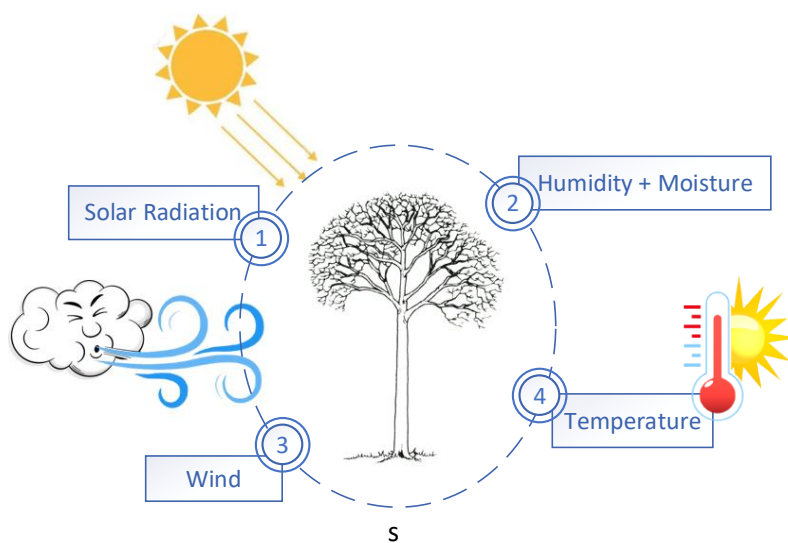


Figure 3.1 : Climatic factors

3.1 SOLAR RADIATION

Solar radiation is the primary source of energy for photosynthesis. Factors such as **Quality**, **Intensity**, and **Duration** of light affect the vegetation or indirectly the entire forest ecosystem.

IMPORTANCE OF SOLAR RADIATION

Plants depend upon solar radiation not only to synthesize food but also to regulate many other metabolic reactions. Such as –

- Essential for **basic metabolic activities** like photosynthesis, transpiration, and the opening and closing of photoactive stomata.
- Light is crucial for the **synthesis of chlorophyll molecules**. A prolonged absence of light results in the degeneration of chlorophyll, turning the leaves yellow—a phenomenon known as **Etiolation**.
- Intense **light increases the rate of transpiration**, leading to

Chapter Outline

3.1 Solar radiation

- ✿ Importance
- ✿ Light Increment
- ✿ Natural pruning
- ✿ Species behaviour toward light

3.2 Temperature

- ✿ Importance
- ✿ Frost : Types, Resistance & Species behaviour
- ✿ Snow : its beneficial & harmful effects

3.3 Wind

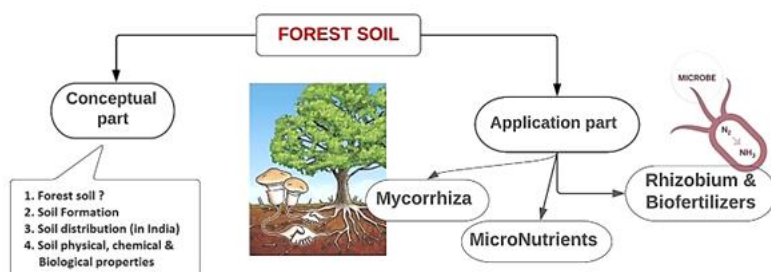
- ✿ Beneficial & harmful effects

3.4 Moisture

- ✿ Types of precipitation
- ✿ Source of Moisture
- ✿ Importance of water
- ✿ Water-logging / Flood
- ✿ Drought
- ✿ Water tapper, Saver and Storer plants

EDAPHIC FACTORS

Edaphic factors are the ecologically influenced characteristics of the soil brought about by its physical and chemical characteristics. These include soil texture, structure, soil water, temperature, porosity, salinity, pH, Electrical conductivity, etc.



4.1 CONCEPTUAL PART

- **Soil** : the uppermost weathered layer of the earth's crust.
- **Forest Soil** : A portion of the earth's surface serves as a medium for the growth and sustenance of forest vegetation.

[Remaining parts such as soil formation, type, distribution, classification, properties, and conservation practices are a part of Soil Science, and, are required to be studied separately at a superficial level under different Sub-head 'Forest Soil'].

4.2 MYCORRHIZA

Mycorrhiza is the **Symbiotic*** relationship between **Fungi** and **Higher Plants** (**Myco** = **Fungi** + **Rhiza** = **Rhizome** = **Roots**). Mycorrhizal fungi are composed of fine, tubular filaments called **Hyphae** (singular **Hypha**). The mass of hyphae that forms the fungus body is called **Mycelium** (plural **Mycelia**).

- ✎ **Mycorrhiza** term was given by – A. B. **Frank***
- ✎ **Symbiosis** term was given by – Anton De **Bary***
- ✎ The term **Rhizosphere** was first time coined by – Lorenz **Hiltner***

TYPES OF MYCORRHIZAE

- **ECTO-MYCORRHIZA** : Under this, fungal mycelium forms a thick **Mantle Sheath** around the lateral roots, and some mycelia

Chapter Outline

4.1 Soil – Conceptual part

4.2 Mycorrhiza

- ✎ Ecto
- ✎ Endo
- ✎ Ecto-Endo
- ✎ Importance

4.3 Biofertilizers

- ✎ Classification

4.4 Soil Nutrients

- ✎ Macro
- ✎ Micro

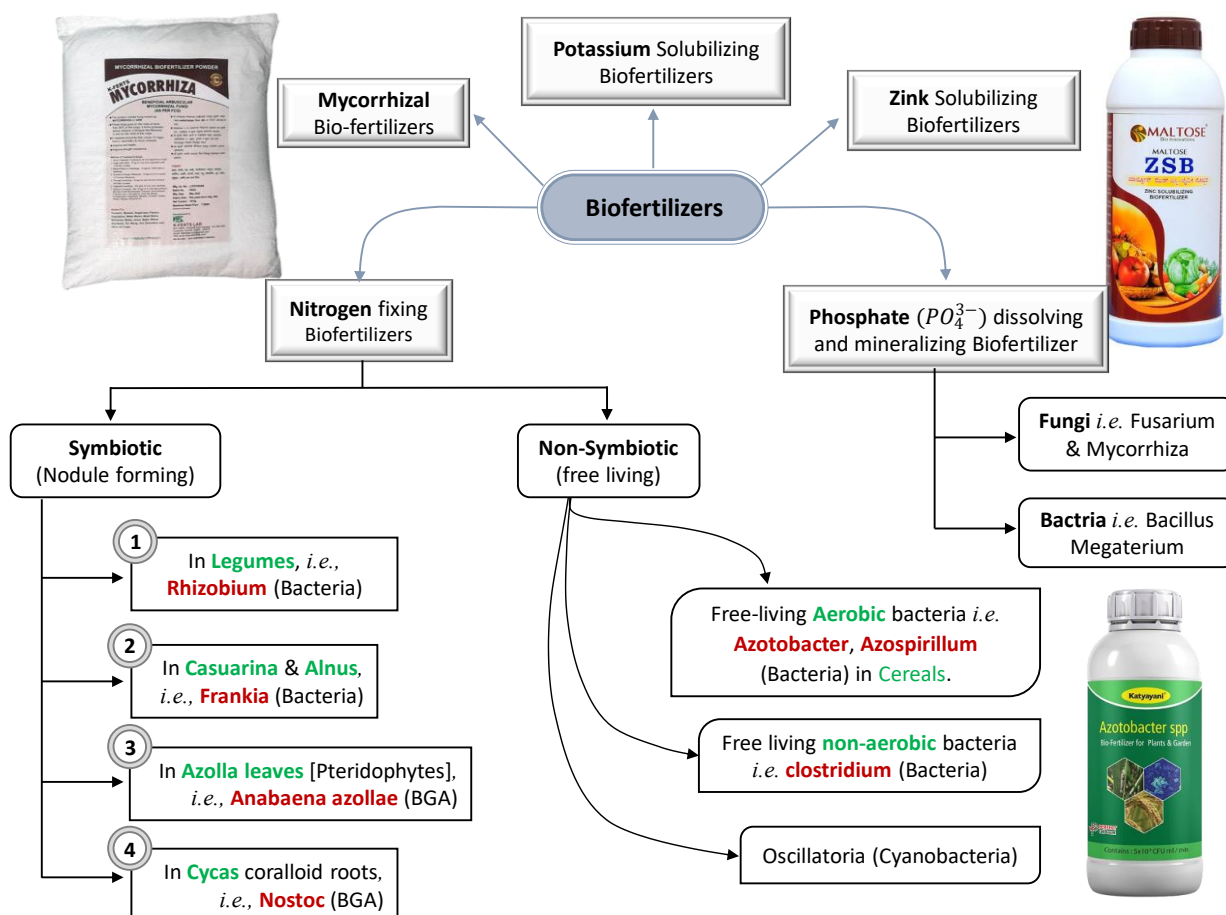
4.5 Nutrients cycling

- ✎ Internal NC
- ✎ External NC

4.6 Influence of Parent rocks on the distribution of species

Way of Application : ♦ Seed inoculants - 20 grams of Rhizobium culture required to treat 1 kg seed. ♦ Soil inoculants - 2 kg/hectare of carrier-based Azotobacter & Azospirillum culture mixed with 25 kg of FYM and 25 kg of soil and broadcasted in the nursery beds uniformly before transplanting work.

CLASSIFICATION OF BIOFERTILIZERS



EFFECT OF BIOFERTILIZERS

- Improve soil fertility and site quality, thereby reducing the risk of plantation failure. For example, Rhizobium can fix 50–200 kg of N/ha/year, while Anabaena can fix up to 40–60 kg N/ha/year, depending on temperature, light, nutrient availability, and the health of the host plant (Azolla).
- Increase the production of plant growth regulators and enzymes, leading to rapid plant growth.
- Improve soil physical properties such as structure, chemical composition, buffer capacity, etc.
- Enhance disease resistance by inhibiting plant pathogens and nematode growth.
- Improve plant tolerance under abnormal conditions by increasing soil acidity.
- Enhance water and nutrient uptake through associations like ectomycorrhiza and endomycorrhiza.

SYMBIOTIC BIOLOGICAL NITROGEN FIXATION

Rhizobium (a bacterium) forms a symbiotic relationship with the roots of **leguminous** plants by developing **root nodules**, where it fixes atmospheric **nitrogen** into **Nitrate** and **Nitrite** forms that plants can absorb.

PHYSIOGRAPHIC FACTORS

The factors concerned with topography or physical features of an area are called **topographic** or **Physiographic** factors, including height, the direction of slope, and slopes' steepness. The topographic factors are also called **indirect factors** as they influence the growth and development of forest vegetation by bringing variations in climatic factors.

These factors are -

- Configuration or arrangement of the land surface, *i.e.*, hills & valleys
- Altitude
- Latitude
- Slopes
- Aspect & Exposure

5.1 CONFIGURATION OF LAND SURFACE

The arrangement of hills and valleys affects the local climate by influencing **rainfall patterns**, **temperature**, **solar radiation**, and **soil profile depth**. It also impacts **wind direction**, which is essential for pollination and seed dispersal in conifers. Himalayan valleys are cooler in winter, and **Pool frost** is common; whereas in summer, the surrounding hills make the valleys extremely hot. The soil in valleys is deeper, more fertile and productive, and supports dense vegetation.

Chapter Outline

5.1 Configuration of land surface

5.2 Altitude

✿ Effect

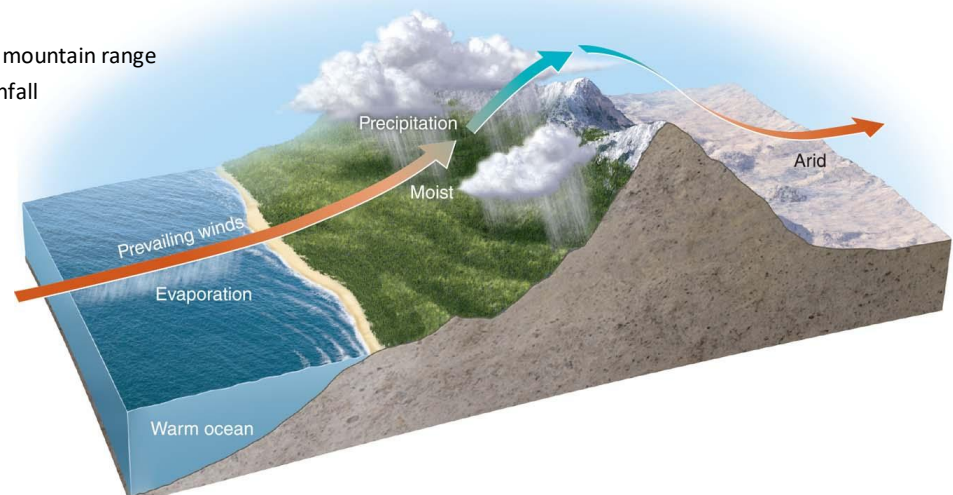
✿ Zonation

5.3 Latitude

5.4 Slopes

5.5 Aspect & Exposure

Figure 5.1 : Effect of mountain range on the pattern of rainfall



BIOTIC FACTORS

Biotic factors are living agents that affect the growth and development of vegetation **individually**. In contrast, **climatic**, **edaphic**, and **physiographic** factors influence the **entire crop**. **Biotic** factors, however, may exert their effects either **individually** (e.g., the Sal heartwood borer) or **collectively**.

Typically, a plant or plant species interacts with other plant species, various wild animals, and humans in diverse ways—both positively and negatively.

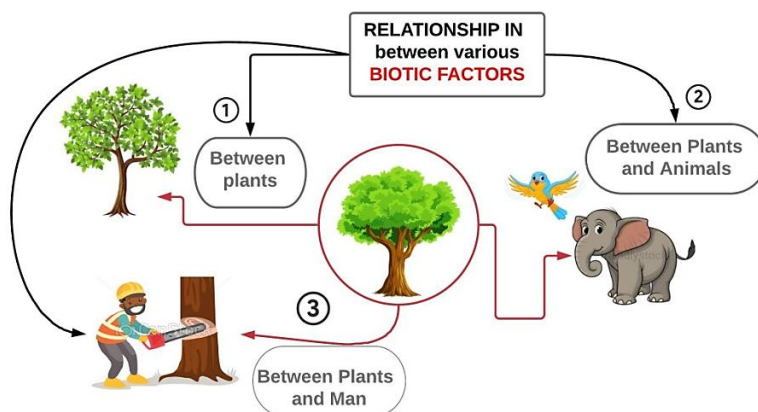


Figure 6.1 : Relationship between various biotic factors.

6.1 RELATIONSHIP BETWEEN PLANTS

Where one plant species affects the growth, development, and distribution of other plant species through the mechanism of -

- **Competitive** relationship : plants fight with each other for light, moisture, space, and Nutrition. So, only a healthy and Vigour plant can survive.
- **Symbiotic** relationship : here, plants help each other survive under stressful conditions, *i.e.*, Mycorrhiza and Rhizobium.
- **Parasitic** relationship : when one species depends upon another for food and protection, *i.e.*, **Sandalwood** is a partial root parasite and usually takes water and nutrients from the other host plants.

Chapter Outline

6.1 Relationship between plants of various species

- ✿ Competition
- ✿ Symbiosis
- ✿ Parasitic
- ✿ Epiphytes
- ✿ Climbers
- ✿ Commensalism
- ✿ Amensalism
- ✿ Helotism

6.2 Relationship between Plants and Animals

- ✿ Insectivorous Plants

6.3 Relationship between plants and man

INFLUENCE OF FOREST ON THEIR ENVIRONMENT

Climate is the average weather prevalent in any locality that influences

A Natural Forest influenced their local environment through the activity of –

- The unbroken canopy in a fully stocked forest intercepts the sun's rays and precipitation, retard wind velocity and loss of heat through long-wave radiation, resulting in creating their microclimate.
- The tree's ability to recycle minerals, reduce bulk density, and add large quantities of leaf litter protected and changed the soil property.
- The interlocking root system binds the soil → to Reduce its erodibility.
- As it changes its environment, subsequently, new environmental factors further induce changes in the vegetation until both achieve their maximum (Climax community); during this process, it also removes many plants and animal species composition.

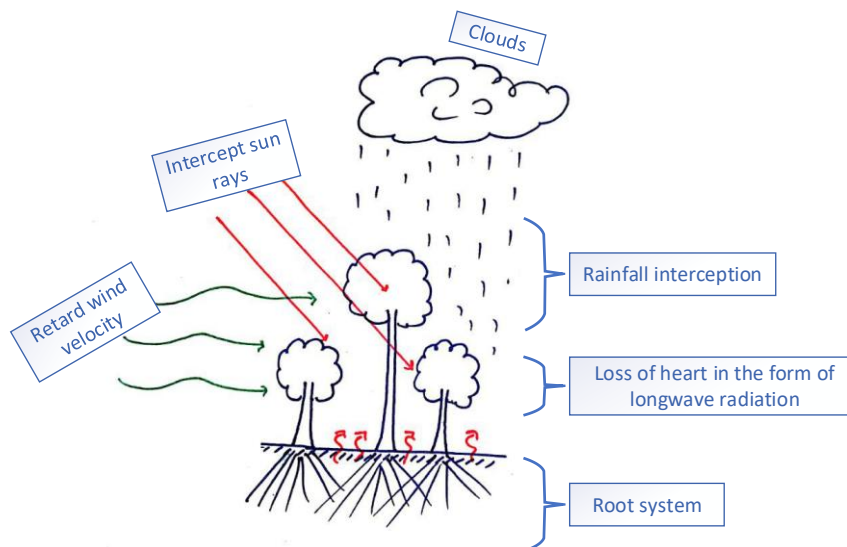


Figure 7.1 : influence of forests on their environment.

7.1 EFFECT OF FORESTS ON THEIR CLIMATIC FACTORS

➤ **WIND VELOCITY** : Forest creates mechanical obstruction by making land surface rougher. On average, a dense forest reduces ≈ 20 to 60% of wind velocity near the surface as compared to an open area through

- Deflecting a significant part of it upwards
- Production of turbulence & slowing down the wind that entered the forest.

We often use this capability of trees to protect our farms and buildings from freezing & warm winds by creating *Shelterbelts* and *Windbreaks*.

TREE'S STRUCTURE & GROWTH FORMS

8.1 WHAT IS A TREE?

Trees are woody plants having one erect *perennial stem or trunk* at least three inches (7.5 cm) in diameter at breast height, a more or less *defined formed crown* of foliage, and a *height of at least 12 ft* (4 m).

CROWN

The crown encompasses all the above-ground parts of a tree, including branches, leaves, and reproductive structures.

FORMS OF TREE CROWN

A crown is an upper branchy part of a tree above the bole. It is the result of branching behaviour in the bole. In some trees, *i.e.*, *Phoenix*, *Cocos*, *Borassas*, etc., there is no branching behaviour in the stem and the crown is formed by larger leaves which come out from the top of the unbranched stems. In other trees crown may be – ♦ **Conical** as in the case of *Pines*, and *Deodar*, ♦ **Cylindrical** as in *silver fir*, *Eucalyptus*, *Ashoka*, etc. ♦ **Spherical** in *mango*, *neem*, *Imli*, *Mahua*, etc., ♦ **Broad & Flat topped** in *Acacia planifrons*, *Albizzia spp.*, ♦ **Broom shape** as in *Acacia nilotica* (*Babool*), and ♦ **Frondose crown** as in *Prosopis juliflora*.

Chapter Outline

- 8.1 What is a tree?
- 8.2 Basic terminology
- 8.3 Tree's growth phases
- 8.4 Tree's growth stages
- 8.5 Reproduction
- 8.6 Exercise

Phoenix, Coconut, Borassus



Unbranched stem of Coconut



Conical shape

Abies pindrow (Silver Fir), *Eucalyptus*, *Ashoka*



Cylindrical shape

Mango, Neem, Imli, Mahua, etc.



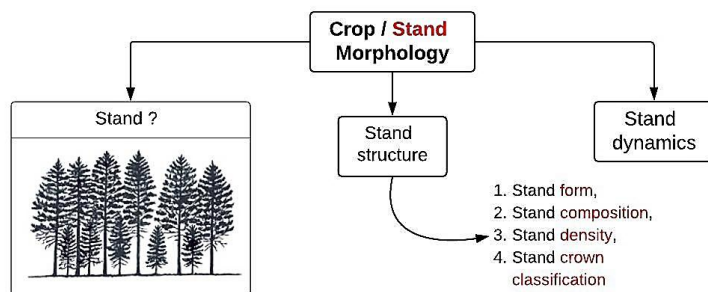
Spherical shape

Trees

- I Gymnosperms : Pine, Conifers = **Naked seeded** plants***
- I Angiosperms : Dicot (*Mango**), Monocot (*Grasses**, *Bamboo**, *Wheat*, etc)

TREE CROP MORPHOLOGY

Morphology means the science of form, especially studying the outer form (structure), inner structure, and development of their parts. **Crop morphology** means studying the outer form of forest crops and their development.



9.1 STAND ?

The **stand** concept has long been central to the practice of Silviculture and has traditionally been defined as *a group of trees that are relatively homogenous in composition, age-class distribution, and structure growing on a site of uniform quality*. Stands, as defined in this context, have served as the primary unit of forest management around the globe with the stand-by-stand application of silvicultural treatments for achieving a sustainable yield of produce.

Stand v/s Forest

A forest is a collection of stands. Remember that a stand is a unit of silvicultural interest. Forester's practice silvicultural operations on stands, but not on forests. It is not an ecological management unit.

9.2 STAND STRUCTURE

Stand Structure refers to the *overall look* of a forest stand. It is the *horizontal and vertical distribution of components* of a stand, including the height, diameter, crown layers and stems of trees,

Chapter Outline

9.1 Stand?

9.2 Stand structure

✿ Stand Forms

✿ Stand composition

9.3 Stand density

9.4 Stand Crown

classification

FORESTRY SUCCESSION

Succession is the process by which **one set of biotic communities** is **gradually replaced** by **another, more advanced** and **distinct nature** biotic community.

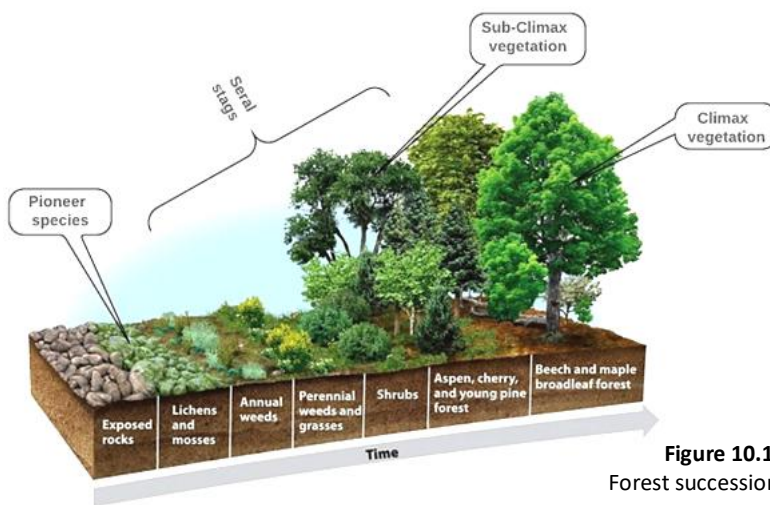


Figure 10.1 : Forest succession.

The 1st species that encroach upon and begin to grow (establish themselves) in a new area are called **Colonizer*** or **Pioneer*** species. **Sere** or **Seral Stages** (sometimes referred to as the **Consolidation Phases**) are the intermediate stages during which plant communities develop, improve soil conditions, and gradually transform into more advanced and stable communities.

- **Climax Stage** – This is the final, mature, and stable community that can sustain itself over a long period while remaining in balance with the existing environmental conditions.
- **Succession** – The process of development and transition of vegetation from one stage to another (e.g., from grassland to woodland) is called **succession**.
- With each stage of succession, **Complexity** and **Biodiversity Increase**.
- When a **colonizer** species begins to grow on barren land where there is **no trace of previous organic matter**, it is called **Primary Succession**.
- If succession begins in an area that **already contains remnants**

Chapter Outline

10.1 Process of Succession

10.2 Types of Succession

10.3 Causes of Succession

10.4 Examples of various types of Succession

- ✿ Mt. Temperate Forest
- ✿ Riverain forest
- ✿ Estuarine succession
- ✿ Sand dunes

10.5 Theories

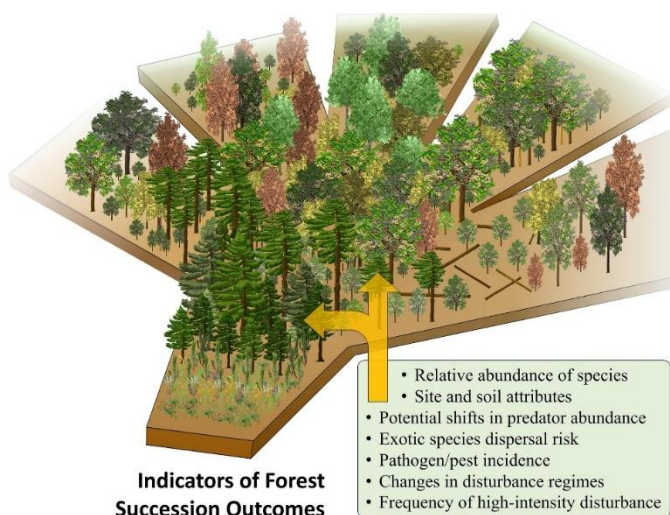
- ✿ Mono-climax theory
- ✿ Poly-climax theory
- ✿ Climax pattern hypothesis
- ✿ Information theory
- ✿ Mosaic theory

- ✿ Succession term was given by "**Hault**".

Climax Pattern Hypothesis : R.H. Whittaker (1953)

According to this idea, different types of vegetation grow in different parts of the same forest area in response to environmental factors such as moisture, temperature, elevation, etc. These factors are not uniform throughout the forest but gradually change as one moves from one side to another. This gradual change is referred to as an **Environmental Gradient**.

Figure : Trajectory of forest succession is not linear but is influenced by a multitude of interacting factors. The branching pathways visually represent how these factors can lead to diverse successional trajectories and ultimately result in different mature forest ecosystems.



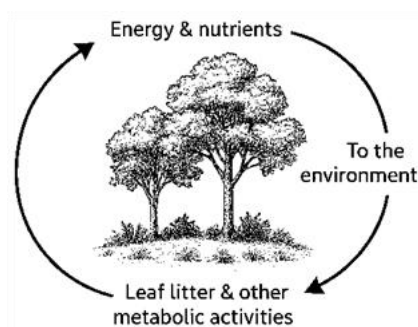
All plants and animals do not respond in the same way to these environmental factors. Each species reacts differently, leading to a gradual variation in the types of plants and animals as we move across different parts of the forest. Instead of having just one final or "climax" community (end point) in an area, Whittaker argued that the climax can consist of many different types of vegetation (A pattern), depending on the combination of environmental conditions.

In Short

- **Vegetation changes gradually** with shifts in climate and environmental factors.
- **Each species responds individually** to these continuous changes.
- There is **No Absolute** or **Single Fixed** climax (a **Definite End Point** of development). Instead, the community composition represents a **pattern of vegetation** in **dynamic equilibrium**, **gradually changing** with the environment.

Information Theory : by Fosberg (1967) and Odum (1969)

According to this theory, succession is a function of **Energy Balance** and **Nutrient Cycling**. The climax stage is reached when the amount of energy and nutrients received by the vegetation from the environment is equal to the amount it returns to the environment through leaf litter and other metabolic activities.



10.6 IMPORTANCE OF SUCCESSION IN SILVICULTURE

Understanding plant succession is very important in forestry (silviculture) because it helps foresters in –

- 🌲 **Helps in Forest Classification** : It allows classification of forests based on their natural stages of development.
- 🌱 **Guides Artificial Regeneration** : It helps in choosing the right tree species and appropriate land treatment when planting new forests, based on their stage in succession.

FOREST TYPES

The forest type is a forest category defined with reference to its geographic allocation, climatic and edaphic features, composition, and condition. **Champion and Seth** defined it as 'A unit of vegetation which possesses (broad) characteristics in physiognomy structure sufficiently pronounced to permit its differentiation from other such units.

➤ **Definition** : Forest type is the categorization of forest vegetation with particular reference to their physiognomic characters, structures, geographical allocation, and specific edapho-climatic conditions; that permit us to differentiate this vegetation.

➤ **NEEDS OF SUCH CLASSIFICATION?**

With only 2.4% of the world's land area, India accounts for 7 % of the world's recorded species. This tremendous biodiversity and ecosystems with extensive geographical and local variations creating issues during conservation, management, and understanding the mechanism and dynamics of the natural ecosystem, especially with the emerging challenge of climate change.

- It helps us understand our forest, its composition, and species-specific variations to comprehend species dynamics with changing environment and forest management.
- It helps to understand how climatic, edaphic, topographic, and biotic factors affect forest vegetation; and how they are responsible for its distribution, composition, and complexity of our forest ecosystem.
- Our 10.8 % tribal population lives in these areas. We depend upon it for food, fodder, medicinal plants, water resources, and cultural values. That directly or indirectly play a role at the grass-root level.

Chapter Outline

Sclerophyll is a type of vegetation that is adapted to long periods of dryness and heat.

NATURAL REGENERATION

WHAT IS REGENERATION ?

Regeneration (or **reproduction**) is the act of *replacing an old forest crop* with a *younger one*, either through natural process or by artificial means.

TYPES ?

- Natural regeneration : by nature.
- Artificial regeneration : when humans were involved in its propagation.
- Natural Regeneration Supplemented by Artificial Methods : A combination approach practised in forests where natural regeneration alone is not adequate. Example: Sal forests in moist deciduous forests of Central and North India.

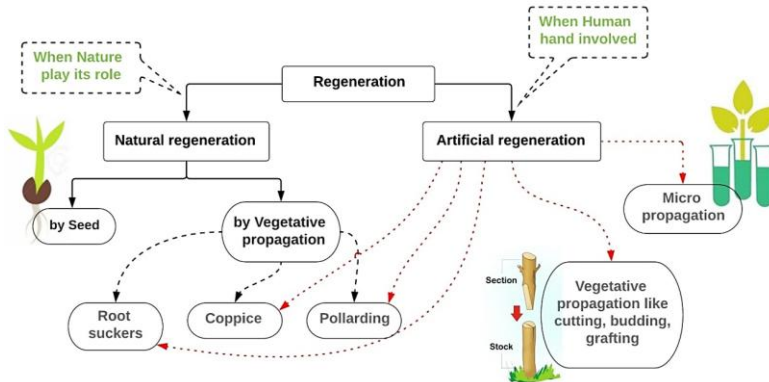


Figure 12.1 : Types of natural regeneration.

NATURAL REGENERATION

Natural regeneration is the *renewal of a forest crop* by means of the *natural process of seed sowing, germination, and establishment* or by *coppice shoots or root suckers*.

However, the new crop derived by natural regeneration also requires some suitable conditions of soil, climate, host plants, and topography.

Natural regeneration is often not left entirely to nature but is induced by creating a suitable environment. The various measures taken to *induce natural regeneration* include: (a) cutting some

Chapter Outline

12.1 What is Regeneration

12.2 NR by Seed

- ✿ Flowering in Bamboo
- ✿ Mechanical barrier
- ✿ Helping NR
- ✿ Dying back phenomenon

12.3 NR by Coppice

12.4 NR by Root Suckers

12.5 NR by Pollarding

trees coppice badly.

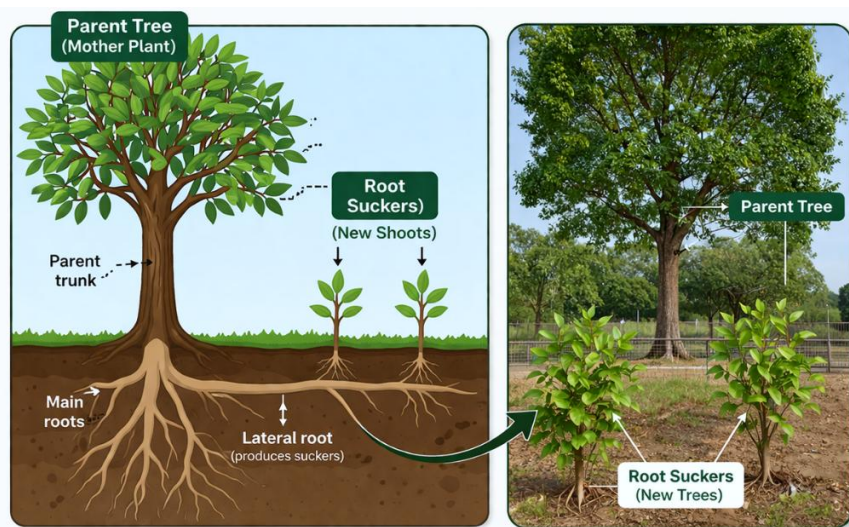
- **Height of Stump** : Some species, such as *Casuarina equisetifolia*, *Hardwickia binata* etc., produce better shoots when the stumps are cut higher.

12.4 NATURAL REGENERATION BY ROOT SUCKERS

Root suckers are new shoots that arise from the superficial roots of the parent plant through adventitious buds. Many species show this natural habit of spreading and conserving themselves against threats like forest fire, heavy pest attacks, or climatic stress.

Example : *Dalbergia sissoo* (Shisham), *D. latifolia*, *Bombax ceiba*, *Diospyros melanoxylon*, *Prosopis cineraria*, *Anogeissus latifolia*, *Butea monosperma*, *Melia dubia*.

Inducing Root Sucker Formation



Root suckers can be induced by : ① Felling the parent tree, or ② injuring the root system. In the Gangetic Plain, where trees have superficial root systems due to high water table, trenches are dug 5–6 m around standing trees (especially *Dalbergia sissoo*) to induce root sucker formation. *Tendu* suckers are obtained this way for bidi leaves.

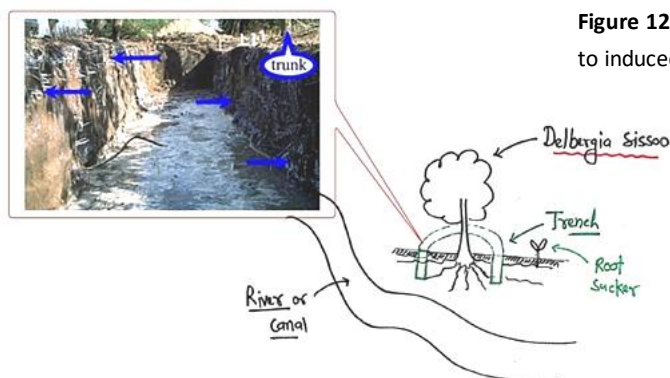


Figure 12.7 : in North Indian plain, trenching method used to induced root suckers in *Delbergia sissoo*.

Challenges : ♦ Often uprooted by wind due to the absence of a tap root system. ♦ They cannot support long tree trunks—commercially unsuitable. ♦ May carry diseases from the mother plant. ♦ Regeneration through root suckers is not fully dependable; artificial restocking should be carried out as a supplement.

Natural Regeneration by Rhizomes

Rhizomes are underground modified shoots that develop into a whole plant. This is the primary natural vegetative regeneration method in *Bamboos*.

12.5 NATURAL REGENERATION BY POLLARDING

Pollarding is an ancient *Pruning* system involving the *Periodic removal* of a *Tree's upper branches* at a specific height—typically **1.8 to 4.5 metres**—to promote a dense cluster of new shoots from the cut point. Unlike coppicing (which cuts at ground level), this height is chosen to keep regrowth out of reach of livestock and wild animals.

WHY WE REQUIRE SEED SUPPLY ?

- Our forests were already experiencing very heavy biotic pressure and other stresses. Now, climate change and global warming are further stressing them. The result? Most of our natural forests are now failing to regenerate naturally. Therefore, if we want to sustain our forests and ecosystems, we must artificially supplement them through nursery-raised plantations. (Can you recall the issue of **Cardinal Temperature** that we discussed in Chapter 3?).
- Restoration of wastelands, abandoned mines, industrial dumping grounds, etc., requires artificially raised planting material.
- Our commitment to the INDC (under the Paris Agreement) includes the creation of 2.5 to 3 billion tonnes of additional CO₂ sinks by 2030. In addition, we have committed to restoring 26 million hectares of degraded land by 2030 under the UNCCD (2019, Greater Noida).
- Artificial plantation is also required under CAMPA, the National Green Highway Project, and to meet the rising industrial demand for timber, pulp, and paper.

*Chapter Outline***15.2** Seed**15.3** Seed collection

- ✿ Requirements?
- ✿ Collection methods
- ✿ Time

15.4 Seed Processing**15.5** Seed Storage

- ✿ Orthodox v/s Recalcitrant
- ✿ Types of storage

15.6 Seed treatment

- ✿ Seed dormancy
- ✿ Seed dressing

15.7 Seed Testing

- ✿ Purity test
- ✿ Germination test
- ✿ Viability test
- ✿ Moisture content

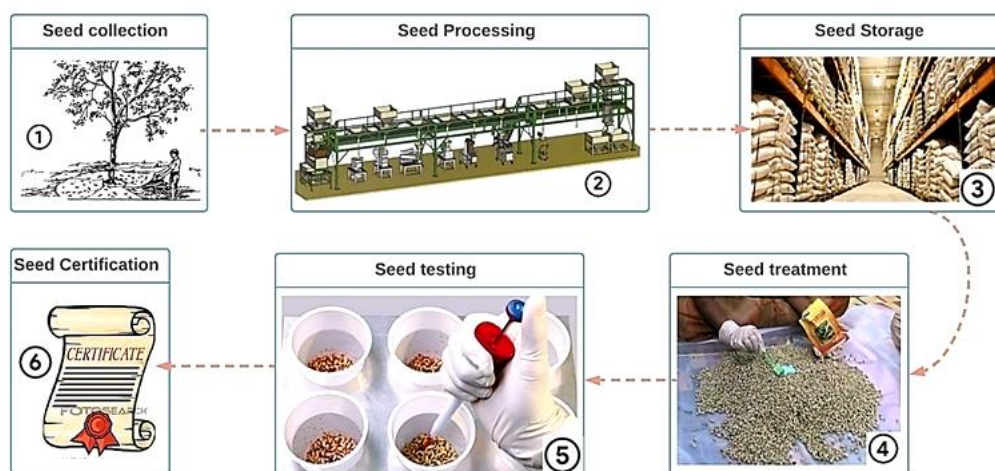
15.8 Eg**STEPS** (A review of this chapter)

Figure 15.1 : basic steps in the seed collection process

Registered seed : This is the offspring of Foundation seed and is produced under agency regulations to maintain varietal purity and identity.

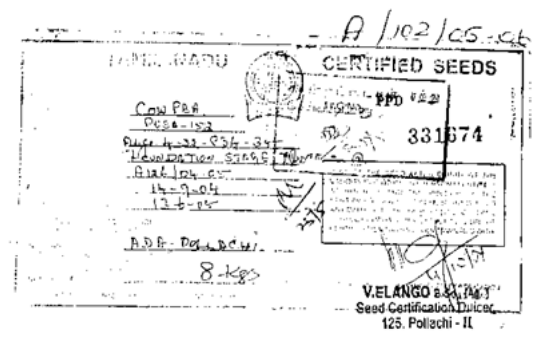
- Used primarily to produce certified seeds.
- In India registered seed is not practiced
- Tag color : **Purple***** Certificate.

► **Certified Seed :**

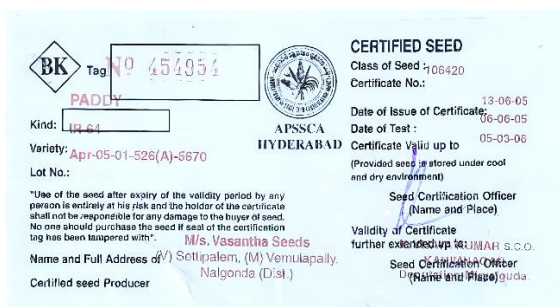
- Derived from foundation seeds **by officially registered growers**.
- **Supervised** rigorously by seed certification agencies.
- **Meets minimum certification standards** for quality.
- Must maintain genetic purity of **at least 99%**.
- Commercially available to farmers.
- Certificate Tag color : **Azure-Blue*****.



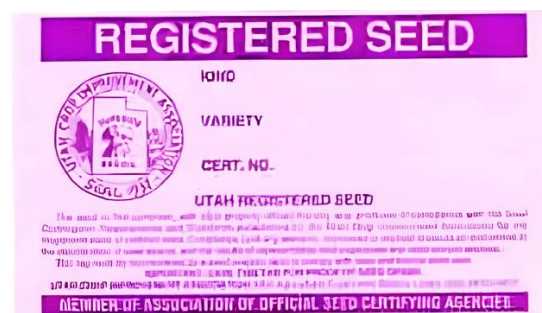
Breeder Seed = Golden-Yellow* Tag**



Foundation Seed = White* Tag**



Certified Seed = Azure-Blue***



Registered seed = Purple

According to Ewart's classification (1908), **seeds** are classified based on their viability lifespan under optimal storage conditions. seeds are divided into three categories,

- **Microbiotic**: Seeds with a lifespan of less than 3 years.
- **Mesobiocytic**: Seeds with a lifespan ranging from 3 to 15 years.
- **Macrobiotic**: Seeds with a lifespan exceeding 15 years.

FOREST NURSERY

Forest nurseries are dedicated enclosed facilities where planting material is grown under controlled conditions for transplantation to field sites for afforestation, reforestation, and plantation programmes. They comprise nursery beds, paths, irrigation channels, compost pits, and associated infrastructure.

Seedlings are young plants obtained from seed. These plants may grow up to about one meter in height. Transplants are seedlings that have transferred from one bed to another to make them suitable for planting. Seedlings, transplants, and other planting material, i.e., rooted cuttings etc., are collectively referred to as planting stock.

16.1 IMPORTANCE OF NURSERY?

Nursery occupies a central place in artificial regeneration. The increase in artificial regeneration work and efforts to raise fast-growing, short-rotation crops involving introduction of exotics have further increased its importance.

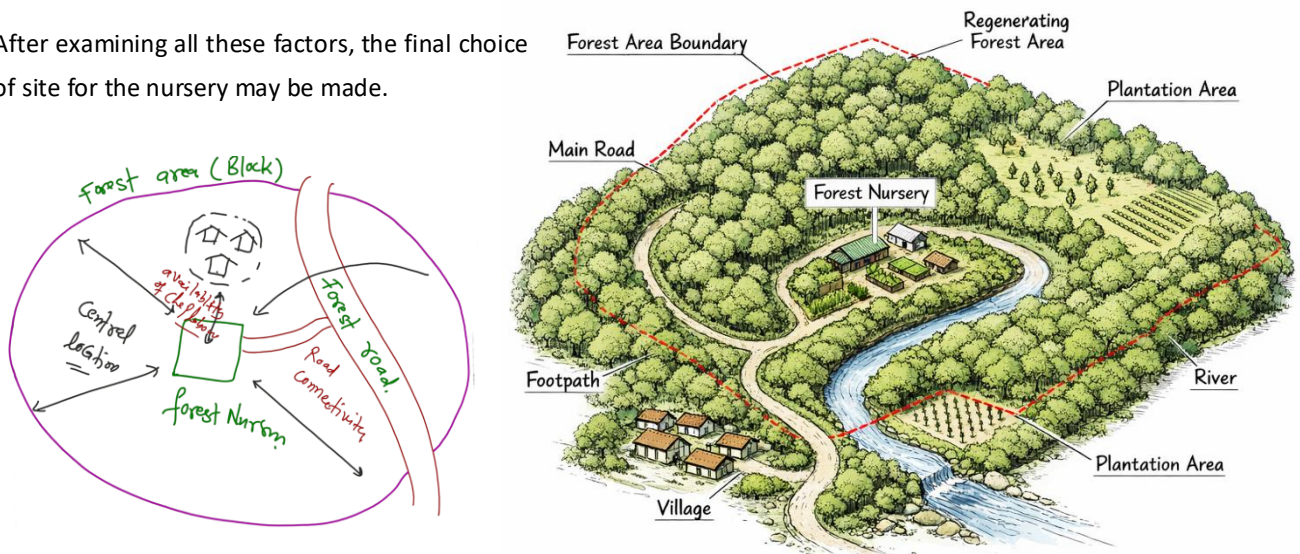
- Several species exhibit slow initial growth and are therefore liable to be swamped by weeds if sown directly in the field; in contrast, nursery-raised seedlings, being larger and more vigorous at the time of planting, are better able to withstand competition and adverse site conditions, thereby ensuring higher establishment success.
- Several species do not seed every year. Plantations can be raised annually only by collecting seed in good years and raising seedlings in nursery for planting out over several years.
- Nursery-raised seedlings tend to reduce the rotation as growth is faster.
- Success of roadside avenue plantations depends on planting tall and sturdy plants, obtainable only from a nursery.
- Introduction of exotics (tropical pines, poplars, Eucalyptus) is best done by planting nursery-raised stock.
- Nursery-raised seedlings are capable of tolerating adverse

Chapter Outline

- 16.1 Importance of nursery
- 16.2 Types of Nurseries
- 16.3 Establishment of a permanent nursery
- 16.4 Seed bed or Nursery bed
- 16.5 Planting stock
- 16.6 Use of Containers for raising seedlings
- 16.7 Stump preparation
- 16.8 Grading of planting material
- 16.9 Hardening
- 16.10 Nursery Journal
- 16.11 Nursery Callender
- 16.12 Nursery register

- A site should be selected with minimum risk of Soil-borne diseases.

After examining all these factors, the final choice of site for the nursery may be made.

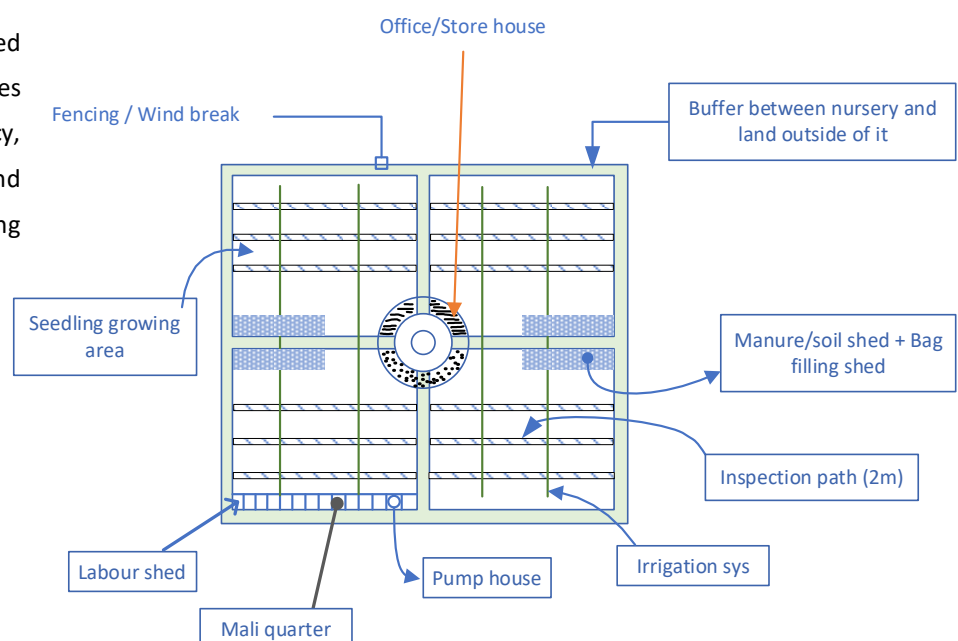


- **NURSERY LAYOUT & DESIGN** : The layout of a forest nursery is a critical factor that directly influences its efficiency, management, and productivity. A well-planned layout ensures smooth movement, proper resource utilization, and effective supervision.

Main Components

- **Fencing** : All permanent nurseries must be properly fenced with cattle-proof or game-proof fence. In dry areas, a line of small trees or shrubs (e.g., *Acacia nilotica*, *Prosopis cineraria*) about 4–5 m high may also be raised along the fence to protect against desiccating hot winds and reduce wind erosion.
- **Inspection Paths** : for easy movement of labour, materials, and supervision.
- **Buildings** : Basic infrastructure such as office, storage (for seeds/tools), labour sheds, Compost preparation area, and Mist chambers for vegetative propagation.
- Shade houses / lath houses (50-75% shade for sensitive species)
- **Nursery Beds** : Central area for seed germination and seedling growth (core functional zone).
- **Irrigation System** : Reliable water supply for uniform watering of plants.
- **Drainage System** : Proper drainage to avoid waterlogging and root damage.

A scientifically planned nursery layout improves operational efficiency, reduces labour cost, and ensures healthy seedling production.



VEGETATIVE PROPAGATION

A Forest nursery is an area where plants are growing for transplanting for use as stocks for vegetative reproduction (*i.e.*, budding, grafting).

➤ **Objective of plant propagation ?**

- Increase the number of plants of the same species
- Preserving the essential characteristics of the plants
- Way to introduce exotics

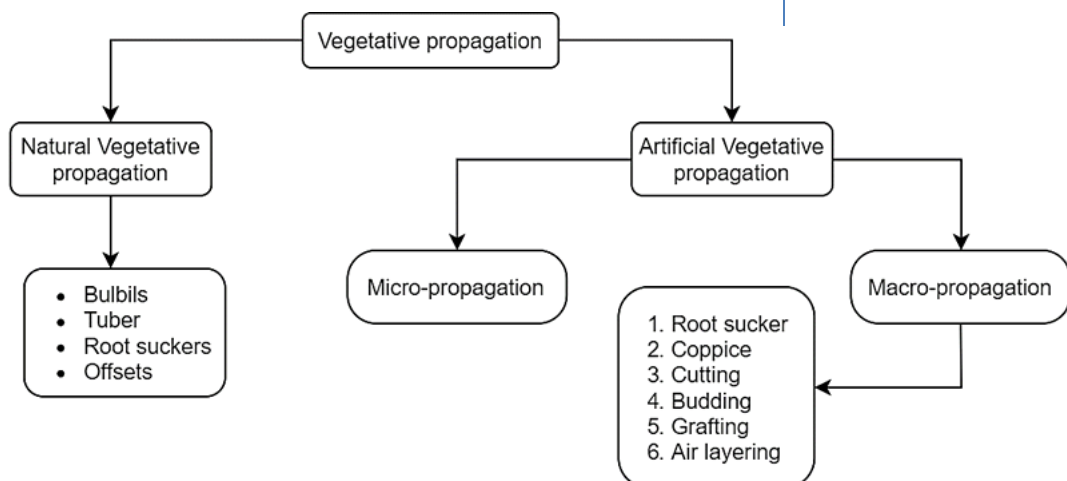
➤ **Methods of plant propagation?**

- Sexual : by seeds
- Asexual : by vegetative parts like cutting, Root suckers, etc.

➤ **Vegetative propagation?**

- *The method to regenerate the new independent plant from the body tissue of the parent plant.*
- Also known as *asexual propagation*.

➤ **Methods of vegetative propagation ?**



Advantages of vegetative propagation

- Vegetative propagation helps to produce genetically identical plants.
- This method eliminates variability and maintains clonal fidelity.

Chapter Outline

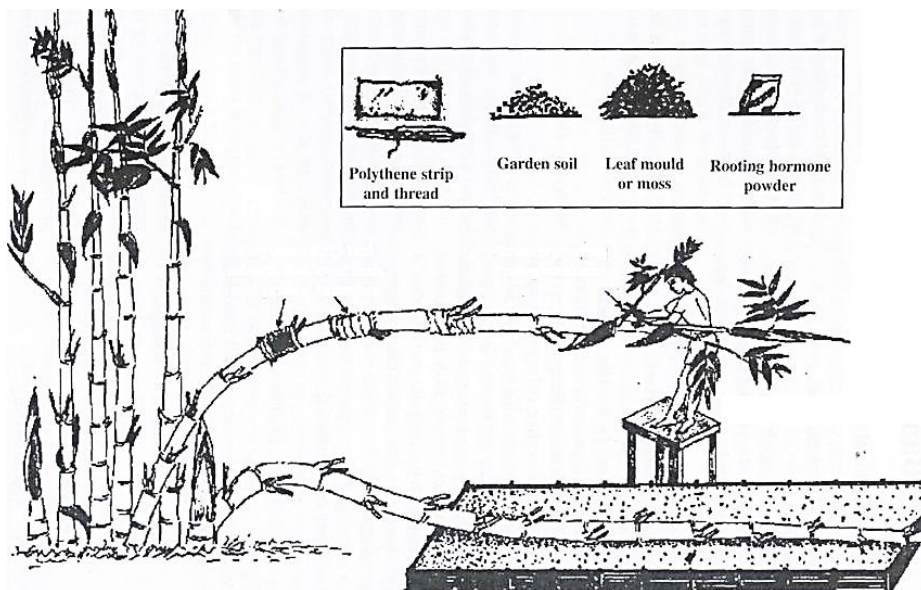
17.2 Macro Propagation

- ✿ Root Sucker
- ✿ Coppice
- ✿ Cutting
- ✿ Budding
- ✿ Grafting
- ✿ Layering

17.3 Micro-Propagation

nutrients and induces root formation above the girdled area.

- **Applying Rooting Hormone (Optional)** : to the exposed area = to enhance root development = increase the success rate.
- **Wrapping with Moist Medium** : Enclose the girdled area with moist sphagnum moss or a similar rooting medium. Ensure the medium is thoroughly moistened but not dripping.
- **Sealing the Layer** : Wrap the moss-covered section with clear plastic wrap or polyethylene sheet, securing both ends tightly with ties or tape to retain moisture. This maintaining humidity around the girdled area.
- **Monitoring Root Development** : Over the next several weeks to months, regularly check the moisture level and root progress. The development of roots may take anywhere from one to three months.
- **Separating and Planting** : Once a significant root system has formed, carefully cut the culm below the rooted section. Plant the new bamboo plant in a suitable location with appropriate soil conditions.



17.2 (D) BUDDING

Budding is an asexual propagation technique used to create new plants by joining a bud from one plant (the desired variety) and inserting it into the bark of a different but compatible plant (the rootstock). The goal is to create a new plant that combines the best qualities of both the bud's parent plant and the rootstock

TYPES

- **Chip budding** : Under this, we replace a triangular-shaped piece of bark with an epicormic bud. Chip budding works well in regions with shorter growing seasons (e.g., Temperate regions).
- **T-budding** or **Shield budding** : "T-bud" name arises from the T-like appearance of the cut in the rootstock, whereas the "shield bud" is derived from the shield-like appearance of the bud piece when it is ready for insertion in the rootstock.
- **Patch budding** : A rectangular patch of bark with a bud is removed from the scion and inserted into a matching window on the rootstock.
 - Suited for plants with thick bark.
- **I-budding** : Similar to T-budding, but the cut in the rootstock resembles an "I" shape.

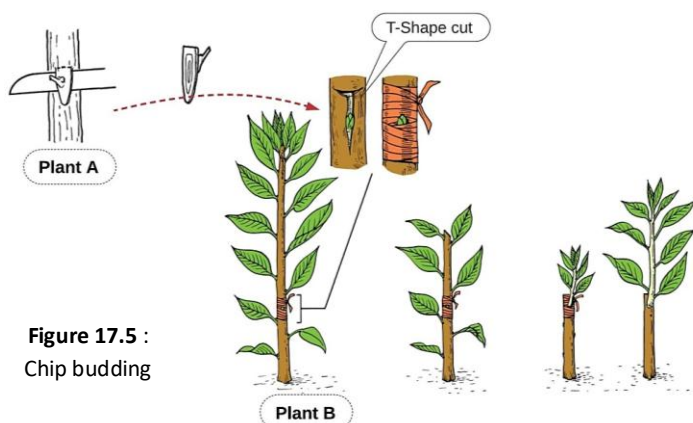


Figure 17.5 :
Chip budding

SOWING & PLANTING

18.1 SITE SELECTION

The selection of a site is one of the vital considerations in the success of the plantation program. If the plantation is raised in a regeneration area or under a CAMPA plantation, the area is generally known.

Plantation sites are usually of four types - (a) degraded forest areas, where soil conditions are generally poor, and soil erosion is rampant, (b) wastelands where sites have one or several limiting factors, (c) forest area where the plantation is to be established either due to absence of natural regeneration or replacement of existing crop and (iv) plantation work along the rail, road, canal sides and agroforestry plantation in agricultural lands.

In most cases, the following points must be taken into consideration in the selection of a site :

- The sites for the plantation, as far as possible, should be easily approachable. If the site is not approachable, there are problems in the transport of planting stock, plantation work, weeding, and other operations. There is a problem in the disposal of produce also.
- There must be enough area for undertaking plantation for several years. It facilitates supervision and protection.
- The site selected should be such that it is easy to obtain participation and involvement of the local population.

Chapter Outline

18.1 Site selection, including planting survey

18.2 Site Preparation

✿ Soil working

✿ Staking

18.3 Seed sowing

✿ Direct sowing

✿ Hydro

✿ Aerial

18.4 Planting-out : When ?

/Size/Age, Method,

Spacing, Planting pattern

18.5 Plantation journal

Site Selection

Site allotted by the Govt.



Green Highway Corridor



CAMPA Forest

PRE-PLANTING SURVEY

MAINTENANCE OF PLANTATION

After plantation work is over, several planted seedlings have died due to –

- Defective & carelessness in planting work, *i.e.*, root coiling, shallow planting, unfirm soil, etc.
- Poor soil conditions, *i.e.*, waterlogged, presence of injurious salt concentration, Sub-surface hardpan formation etc.
- Adverse post-planting weather, *i.e.*, Frost, drought
- Insect & pest attacks; Competitive weed growth; Grazing, browsing and trampling – by both domestic as well as wild animals.

SOLUTIONS

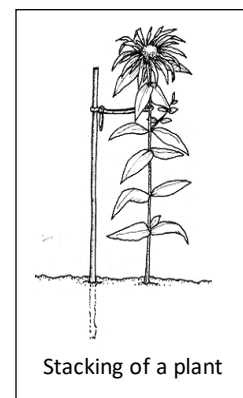
- ❑ **Replace Of Casualties** : ‘Refilling’ process is also known as – Beating-up, Blanking, and In-felling.
- ❑ **Weeding** : removing the weeds. Types – Complete weeding, Line weeding, Spot weeding, Inter row weeding.
- ❑ **Soil Working** : : to improve infiltration rate, remove sub-surface **hardpan** and improve soil aeration.
- ❑ **Watering** : : During the dry season or in case of monsoon failure. Light soil requires more water than heavy soil.
- ❑ **Abnormal Slow Growth** → Casualties replacement
- ❑ **Staking** : providing support to the plantation so it can withstand against a strong wind.
- ❑ **Singling or Re-Spacing** : carried out usually after 2/3 years of plantation.

Singling involves selecting the most vigorous and well-formed shoot from a coppice stool and removing the others. This practice ensures that the selected shoot can grow into a strong, single-stemmed tree, optimizing the quality and uniformity of the stand. The operation is typically performed when the shoots have reached a height of approximately 1 to 2 meters. At this stage, the shoots are sufficiently developed to assess their form and vigor, yet still young enough that removal of the undesired shoots causes minimal damage to the stool and the selected shoot.

After harvesting apply **Wax** on the open part to **prevent fungal infection**.

Re-Spacing : Competing plants of the same or similar species are removed to provide proper spacing and remove unnecessary competition.

- ❑ **Bud Pruning /Debudding**



Stacking of a plant

20.2 WEEDING

Weeding is a silvicultural practice that involves **removing unwanted vegetation**, such as **weeds, shrubs, and undesirable tree species**, that **compete with desired trees** for **resources** like sunlight, water, and nutrients.

OBJECTIVES/PURPOSE

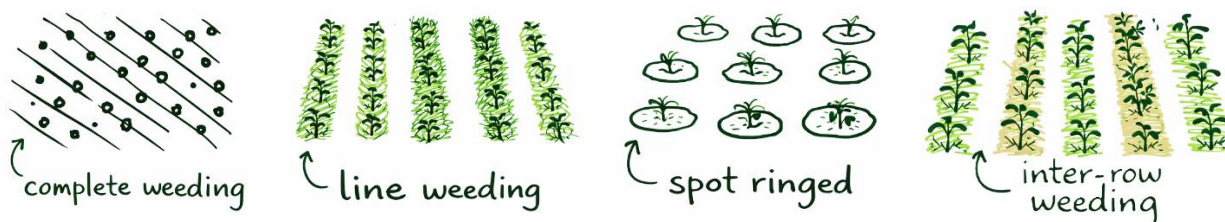
- **Minimizing competition for resources** like **Moisture, Nutrients, Light, and Space** = Early Stand Establishment of Forest Stand.
- Helps in **controlling species composition** by culling undesired ones, hereby favouring the growth of commercially or ecologically valuable trees.
- **Pest and Disease Management** : **Eliminating poorly formed, diseased, or less desirable trees** can improve forest hygiene and **remove shelters** for harmful insects and pathogens.
- **Reduces fuel loads** on the forest floor = Reduce fire hazard.
- **Improved Access** : Removing unwanted vegetation makes it easier to access forest stands for thinning, harvesting, or other management activities, improving operational efficiency.

SEASON, NUMBER, & DURATION OF WEEDING'S

Weeding's should be timed to coincide with the growth season of the desired seedlings, carried out before weeds start suppressing the seedlings. After the growth period is over by the end of September, seedlings may need the protection afforded by weeds against frost and browsing, so weeding's should be stopped.

TYPES OF WEEDING

- **Based on Pattern** : (a) **Complete weeding** : All vegetation competition eliminated from the entire area around and between plants = Labour-intensive + expensive. (b) **Line/Strip weeding** : Hoeing along 1-1.5 m wide strips along the planting line. Suitable for heavily infested areas on slopes. (c) **Spot/Circular ring weeding** : A circular ring of 1-2 m diameter hoed around each plant. Cost-effective when weed growth is heavy but trees are widely spaced. (d) **Inter-row weeding** : Cultivation between rows to prevent weed competition. Often combined with taungya (agroforestry) where food crops are raised between rows.
- **Based on Methods** : (a) **Manual/Mechanical Weeding** : Using sickles, hoes, brush cutters, or two-wheeled pedestrian machines. Most common method in Indian forestry. (b) **Chemical weeding** : Application of herbicides such as 2,4-D (Dichlorophenoxy acetic acid), 2,4,5-T, and Dalapon. (c) **Biological weeding** : Using disease organisms, insects, parasitic plants, or competitive replacement harmful to weeds but harmless to desired plants. Examples: *Teleomemia scrupulosa* (Lace bug from Australia) for Lantana control.



IMPORTANT WEEDS IN INDIAN FORESTS

Weed Species	Forest Type / Region	Impact and Control
Eupatorium	Assam, W. Bengal, Bihar,	Highly invasive shrub, Exotic, allelopathic, causing significant

are retained.

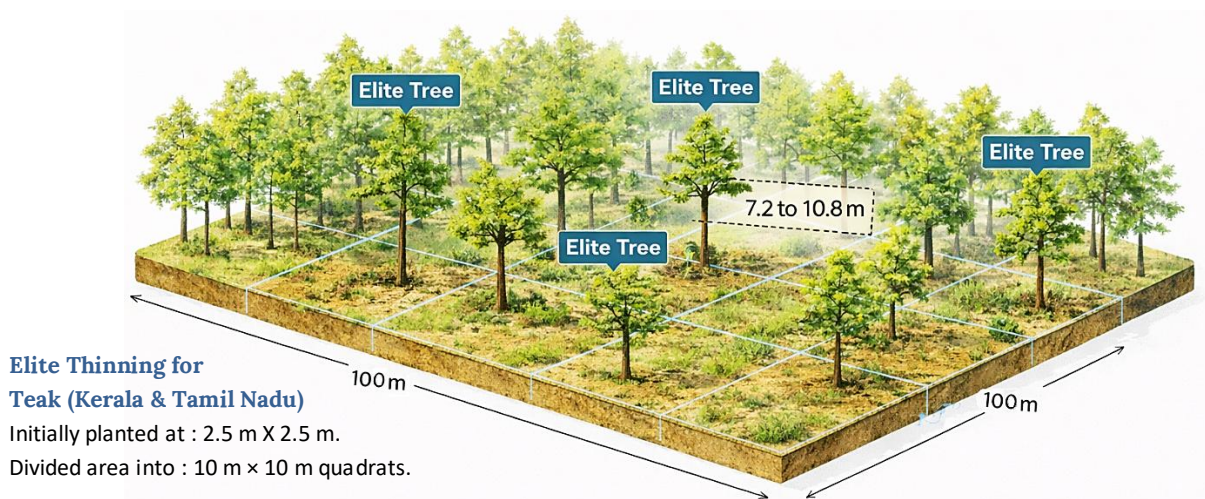
Elite Thinning for Teak (Kerala and Tamil Nadu)

With teak planted at 2.5 m x 2.5 m :

- At age 6 years, the area is divided into 10 m x 10 m quadrats, and one elite tree is selected per quadrat. This gives around 100 trees per hectare, + an additional 10% retained as a safety margin.
- Thinning is then carried out around the elite trees, with care taken to maintain proper spacing. The distance should be no less than 7.2 m and no more than 10.8 m.
- At age 10 years, trees are removed from the periphery of the previously untinned groups, with diagonal trees being the first to be removed.
- At ages 18 and 30 years, further removals are made between elite trees; by age 44 years, the remaining trees are removed.

ADVANTAGES

- Thus, the trees that form the final crop grow free from interference from their youth and, thus, put on a very rapid increment.
- Simple method offering great administrative convenience



DISADVANTAGES

- Not possible to select elite trees reliably at early stages before crown/growth differentiation sets in
- Sometimes obligatory to select a poor elite when the whole quadrat has poor stock.
- Subsequent thinnings are time-consuming as elites must be located.
- In Kerala/Tamil Nadu : conspicuous metal tallies in teak plantation attract elephants, causing extensive damage to elites
- If an elite is damaged by wind, elephants, or Loranthus, there may be no suitable substitute nearby
- Affecting intermediate yield.

MAXIMUM THINNING

A method of thinning in which the main objective is to reduce the number of trees at an early stage so that the available growing space, light, soil moisture, and nutrients are concentrated on a smaller number of retained stems.

The basic principle behind this method is that the total potential increment of the stand should be transferred,

MANGROVES

Mangroves form the coastal and estuarine *wetland ecosystems* in the tropical and subtropical regions of the world. This unique *intertidal ecosystem* acts as a safeguard to the coastlines from the disasters of cyclones, tsunamis, and storm surges. They are one of the most productive and biologically complex ecosystems on earth, providing critical *ecosystem services* including coastal protection, carbon sequestration, fisheries support, and biodiversity conservation.

► Mangroves are a diverse group of *salt-tolerant (Helophytic) evergreen plant communities* found in the *tropical* and *subtropical coastal* and *intertidal zone* of the world, occurring mainly between *latitudes 24°N and 32°S*.

1.1 HABITAT

Mangroves inhabit the *intertidal zone* of coastal and estuarine mudflats, where unique environmental conditions create a highly specialised habitat

- Diurnal **tidal inundation** of marine water, making the soil loose, very wet, salty, and low in oxygen (*anaerobic*) = *Redox reaction sequence*.
- The soil **lacks available minerals** like nitrogen (N), phosphorus (P), potassium (K), iron (Fe), and sulfur (S) due to *leaching* and anaerobic conditions.
- Area experiences **strong winds** from *cyclones and tsunamis*.
- The temperature ranges from **25-35°C**, and there is **1000 to 3000 mm of rainfall** annually.
- **Rich biodiversity** because of the edge effect (ecotone between terrestrial and marine ecosystems).
- **Salt spray**

1.2 DISTRIBUTION

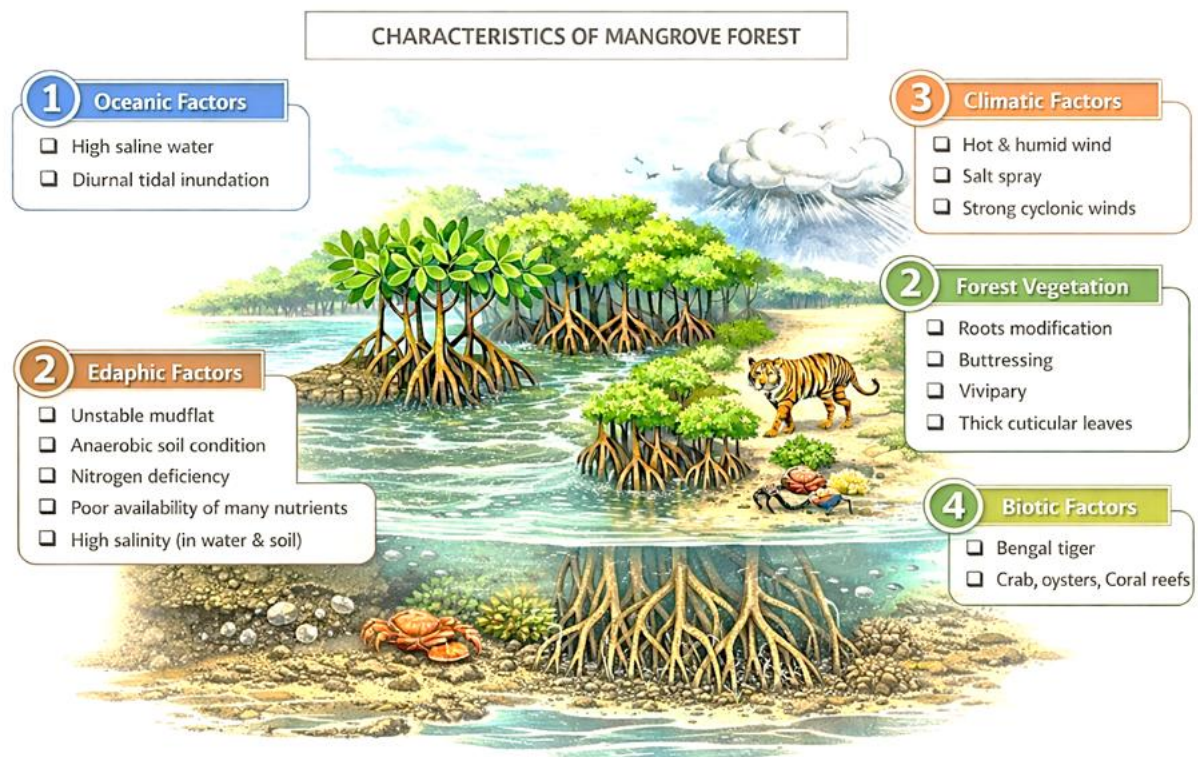
Mangrove distribution is primarily controlled by three factors : ① *Temperature* — Determines latitudinal limits, ② *Tidal regime* — Determines species zonation; ③ *Salinity* — Salt excluder/excreter strategy determines species composition.

Chapter Outline

- 1.1 Habitat
- 1.2 Distribution
- 1.3 Characteristics of mangroves forest
 - ✿ Salt regulation mechanism
 - ✿ Pneumatophores.
 - ✿ Vivipary
- 1.4 Mangroves forest classification
- 1.5 Threats to Mangroves

parenchyma that can store 20–40% extra moisture; and ♦ *mucilage cells*, which help seal damaged tissues and reduce water loss from wounds.

- ▶ **Physiological Adaptations** : ♦ *High osmotic* pressure in the cell sap, which facilitates water uptake under saline conditions; ♦ *Ultra-filtration* in roots, which permits selective ion absorption; ♦ the predominance of the *C₃ photosynthetic pathway*; ♦ stomatal opening mainly during the morning hours to reduce transpiration; and ♦ the production of *recalcitrant seeds*, which are unable to withstand desiccation.
- ▶ **Ecological adaptation** : (a) Wide ecological tolerance, (b) Fixing loose soil, etc.



SALT REGULATION MECHANISMS

To cope with high salinity from regular *tidal inundation* and *salt spray*, mangroves have adopted three main mechanisms:

① **Salt exclusion** — *Ultra-filtration*

Prevents salt from entering the xylem at the root level

- *Multi-layered Endodermis* (root) : The primary site of salt exclusion. Highly developed Casparian strips and suberin lamellae form apoplastic barriers that block the passive movement of ions into the xylem, achieving up to 99% salt filtration from surrounding seawater.
- Elevated *tannin content* in wood and bark reinforces the osmotic barrier.
- *Succulent leaves* : Thick cuticles, reduced stomatal density, and sunken stomata minimise water loss and limit the entry of ions; these features parallel xerophyte adaptations but arise here in response to osmotic, not desiccation, stress.
- Example : *Rhizophora*, *Bruguiera*, *Ceriops*, spp.

② **Salt excretion** — via *Salt glands*

Active removal of salt that has entered leaf tissue

- Despite root-level ultrafiltration, some salt inevitably enters the plant via the transpiration stream. In salt

Cold desert — also known as the **temperate desert** — is a **high-altitude rain-shadow arid zone** ecosystems, where **Extreme cold**, **Aridity**, **rugged barren topography**, **desiccating Katabatic winds** and **stunted vegetation** together produce a **physiologically dry habitat**. Although moisture may be present in frozen form, it remains unavailable to plants for much of the year. As a result, vegetation is **sparse**, **xerophytic**, and highly adapted to low temperature and water stress.

- Compressed altitudinal zonation.
- Cryoturbation.
- The narrow pioneer–climax sequence.

Here, the climate and soil are hostile to plant growth, and the land is largely barren except for isolated, scattered, and often overgrazed shrubs and cushion herbs.

2.1 DISTRIBUTION

India's cold deserts span ≈3% of the country's geographical area across the **Trans-Himalayan** zone and **Inner Dry Valleys**.

Distribution is controlled by three factors :

- ① **Altitude** — determines the lower thermal limit,
- ② **Rain-shadow geometry** — determines aridity.
- ③ **Wind regime** — determines soil denudation and desiccation stress.

TWO PHYSIOGRAPHIC DIVISIONS

- **Trans-Himalayan zone** : Part of the **Tibetan plateau**, lying beyond the Great Himalayan range. Includes the **Leh-Ladakh region**, **Lahaul-Spiti**, and **Pin Valley** of Himachal Pradesh. Extremely arid (< 100 mm rainfall).
- **Inner Dry Valleys** : smaller valleys nested **within** the main Himalayan range, situated in the rain-shadow of the outer ridges. Includes **Kinnaur**, **Chamba** in Himachal Pradesh; **Uttarkashi** (Nelong, Harsil), **Chamoli** (Niti-Mana), **Pithoragarh** (Munsiari) in Uttarakhand; and **Northern Sikkim** (Lhonak, Gurudongmar). rainfall 200–500 mm.

2.2 HABITAT CHARACTERISTICS : PHYSIOLOGICALLY DRY DESPITE OCCASIONAL MOISTURE

Chapter Outline

- 2.1 Distribution
- 2.2 Habitat characteristics
- 2.3 Flora of cold desert
 - ✿ Chilgoza pine

IMPORTANT INDIAN TREE SPECIES

24.1 ACACIA NILOTICA (BABOOL)

- *Syn. Acacia arabica**** = Gum arabic***
- **Family** : *Mimosaceae**** (Leguminosae).
- **Distribution** : A tree of *Semi-arid region****. Hardy to handle damages created by cracking in *black cotton soil****, drought, and moderate frost, so, widely distributed over the north Indian plains, Rajasthan, MP, MH, etc.
- **Fruit** : *Lomentum**** type
- **Phenology** : medium-size *deciduous* tree with brood shape crown



- Leaf fall : April – May
- Leaf renewal : May - June
- Flowering : January to March
- Fruiting : ripen from April to June
- *Thorny branches*.

- **SILVICULTURAL CHARACTERISTICS**

- Drought hardy.
- Frost resistant
- Light demanded
- Good coppice
- Root suckers



Phenology*** is the seasonal changes in the plant behaviors over a year; it is the study of when plants start flowering, fruiting, leaves shedding, etc.

- **UTILIZATION** : *Gum**** (Ladoo making), leaves *Fodder*, *Fuelwood****, and *Timber* for farm implements. *Tannins from Bark and Pods****.

24.2 AZADIRACHTA INDICA (NEEM)

- **Family** : *Meliaceae**** [Non-Leguminous = Rhizobium × = *Nitrogen Fixation* ×]***
- **Distribution** : Neem generally grows in tropical dry deciduous and thorn forests in drier parts up to 1500 m.
- **Phenology** : Neem is a medium size (12 – 15 m) with a broad rounded crown.

- It is an almost evergreen tree but becomes near leafless in dry localities for a short period during February – march [*Deciduous Tree****]
- Flowering occurs from January to March. In south India, it is in January and progressively delayed toward the north up to the Himalayan subcontinent where it is in 1st week of May.



Scientific name	Common name	English name	Family
<i>Abies pindrow</i> ***	Silver fir	fir	Coniferae/Pinaceae
<i>Acacia nilotica</i> *** (syn. <i>Acacia arabica</i>)	Indian gum Arabic	Babool, Kikar	Mimosaceae
<i>Acacia catechu</i> ***	Catechu	Khair	Mimosaceae
<i>Acacia chundra</i> ***		Lal khair	Mimosaceae
<i>Acacia auriculiformis</i>	Australian wattle	Australian babool	Mimosaceae
<i>Acacia concinna</i> ***	Soap pod	Shikakai	Mimosaceae
<i>Adina cordifolia</i> ***		Haldu	Rubiaceae
<i>Aegle marmelos</i> ***	Bengal quince	Bel, Bilva	Rutaceae
<i>Ailanthus excelsa</i> ***	Tree of heaven	Maharukh	Simaroubaceae
<i>Albizzia lebeck</i> ***	Women's tongue tree***	Kala siris	Mimosaceae
<i>Albizia procera</i>	White siris	Safed siris	Mimosaceae
<i>Anacardium occidentale</i>	Cashew nut	Kaju	Anacardiaceae
<i>Anogeissus latifolia</i>	Axle wood***	Dhawada, Ghatti fum	Combretaceae
<i>Areca catechu</i>	Betal palm	Supari	Palmae
<i>Artocarpus heterophyllus</i>	Jack fruit	Kathal	Moraceae
<i>Azadirachta indica</i>	Margosa tree	Neem	Meliaceae
<i>Bambusa bamboo</i>	Thorny bamboo	Kakila bans	Gramineae/Poaceae
<i>Bambusa vulgaris</i>	Yellow/Golden bamboo	Kalaka	Gramineae
<i>Bixa orellana</i>	Annatto	Bixa	Bixaceae
<i>Borassus flabellifera</i>	Fan palm	Taad	Palmae
<i>Boswellia serrata</i>	Indian frankincense	Salai	Burseraceae
<i>Butea monosperma</i>	Flame of the forest	Palas, Dhak	Papilionaceae
<i>Butea superba</i>		Palas bel	Papilionaceae
<i>Cassia fistula</i>	Golden shower	Amaltas	Caesalpiniaceae
<i>Casuarina equisetifolia</i>	Sea oak	Seru	Casuarinaceae
<i>Cedrus deodara</i>	Himalayan cedar	Deodar	Pinaceae
<i>Ceiba pentandra</i>	Silk cotton	Kapok	Bombaceae
<i>Cinnamomum camphora</i> ***	Camphor tree	Kapoor	Lauraceae
<i>Cocus nucifera</i> ***	Coconut	Nariyal	Palmae
<i>Coffea arabica</i> ***		Coffee	Rubiaceae
<i>Dalbergia latifolia</i> ***	Rose wood***	Shisham	Papilionaceae
<i>Dalbergia sissoo</i>	Sissoo	Sissoo	Papilionaceae
<i>Delonix regia</i> ***	Flamboyant tree	Gulmohar	Papilionaceae
<i>Dendrocalamus strictus</i> ***	Male bamboo***	Bans	Gramineae
<i>Dendrocalamus giganteas</i>	Giant bamboo		Gramineae
<i>Diospyros melanoxylon</i> ***	Coromandel ebony	Tendu	Ebenaceae***
<i>Elaeocarpus gantrus</i> ***	Sacred bead tree	Rudraksh	Elaeocarpaceae
<i>Emblica officinalis</i>	Emblic myrobalam	Amla, Aonla	Euphorbiaceae***
<i>Eucalyptus camaldulensis</i>		Nilgiri, Safeda	Myrtaceae
<i>Eucalyptus globulus</i>	Blue gum	Nilgiri, Safeda	Myrtaceae***
<i>Eucalyptus tereticornis</i>	Gray gum	Nilgiri, Safeda	Myrtaceae
<i>Ficus benghalensis</i>	Banyan tree	Bad, Bargad	Moraceae
<i>Ficus elastica</i> ***	Indian rubber tree	Rubber	Euphorbiaceae***
<i>Ficus religiosa</i>	Botree	Pepal	Moraceae***
<i>Gmelina arborea</i>		Shewan sag, Safed teak	Verbenaceae***
<i>Grevillea robusta</i>	Silver oak	Oak	Proteaceae
<i>Hardwickia binata</i>		Anjan	Caesalpiniaceae***
<i>Hopea parviflora</i>	Iron wood of malabar		Dipterocarpaceae
<i>Indigofera tinctorial</i> ***	Indigo	Neel	Papilionaceae

Congratulations

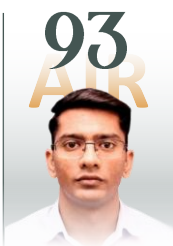
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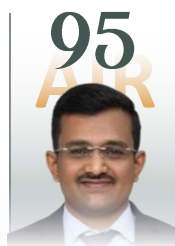
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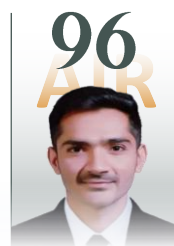
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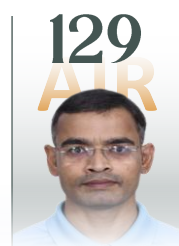
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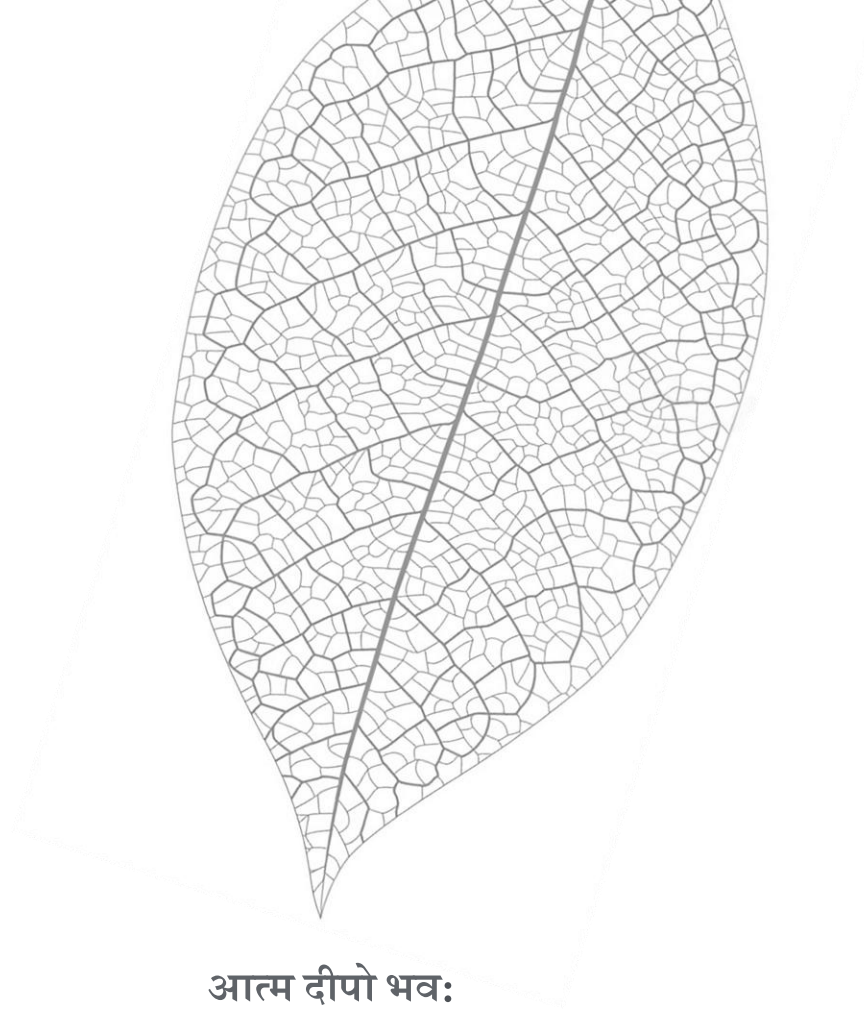
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