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INDIAN FOREST SERVICE

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2025 - 26

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Module - 1

- General Forestry
- Silviculture
- Locality factors
- Tree crop morphology
- Forest Succession
- Forest types in India & in the Jharkhand
- Forest Regeneration
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- Vegetative propagation
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Assistant Conservator of Forest (ACF) – 2023

SILVICULTURE

Paper – 1 | Section – A

EDITION : 2025

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SYLLABUS

Indian Forest Service (IFoS) [Paper 1 | Section A]	***General Silvicultural Principles*** : Ecological and physiological factors influencing vegetation, natural and artificial regeneration of forests; methods of propagation, grafting techniques; site factors; nursery and planting techniques. Nursery beds, polybags, and maintenance, water budgeting, grading and hardening of seedlings; special approaches; establishment and tending. Other state PSC exams also have similar syllabi to the IFoS exam, such as the ***Uttar Pradesh*** PSC State Forest Service [Paper 1, Section A]; ***Odisha PSC*** State Forest Service (Main) Examination [Paper 1 | Section A]; ***Jharkhand PSC*** State Forest Service (Main) Examination [Paper 1], ***Maharashtra PSC*** State Forest Service Examination [Unit – 1],
Jharkhand PSC State Forest Service (RFO) Main Exam 2024 [Paper 1]	◈ ***Forests*** – definitions, role, benefits – direct and indirect. *History of Forestry* - definitions, divisions and interrelationships. ◈ ***Classification of forests*** – High forests, coppice forests, virgin forest and second growth forests, pure and mixed forests - even and uneven aged stands. ◈ ***Forest types of India*** – Classification. ***Agroforestry*** – Farm forestry, social forestry, [Covered in the later sections – ◈ ***Joint Forest Management*** concepts, programmes and objectives. Important ◈ ***Acts and Policies*** related to Indian forests. ◈ ***Global warming*** – forestry options for mitigation and adaptation - ◈ ***Carbon Sequestration***] ◈ Important events/dates related to forests and environment - Themes and philosophy. ***Silviculture General*** : ◈ ***General Silvicultural Principles***; Ecological and physiological factors influencing vegetation, ◈ ***Natural and artificial regeneration*** of forests; ◈ ***Methods of propagation***, grafting techniques; ◈ ***Site factors***; ◈ ***Nursery and planting*** techniques – Nursery beds, polybags, root trainers and maintenance, grading and hardening of seedlings. ◈ ***Tending operations*** special approaches; establishment and tending. ***Forest Soil, Soil Conservation*** : _____ ◈ ***Bio-fertilizers*** : Their importance. ◈ ***Nitrogen fixation*** : Rhizobium-tree legume symbiosis, Frankia v/s Non-legume symbiosis, Asymbiotic and associative N_2 fixation. Nitrification and denitrification in forest ecosystems. ◈ ***Mycorrhizae*** : types, biology and importance with specific relevance to tree crops and mobilization of phosphorus and micro-nutrients. Rhizosphere and phyllo-sphere concept._____ ***Tree Improvement & Seed Technology*** : _____ ◈ ***Planning seed collection*** : Collection of immature fruits – Methods of seed collection. ◈ ***Fruit and seed handling*** : maintaining viability and identity – Special precautions for recalcitrant seeds. ◈ ***Seed processing*** : Operations prior to extraction – Pre-cleaning; methods of extraction – Operations after extraction – Cleaning, grading and Control of moisture level; Factors affecting drying of orthodox seeds. ◈ ***Types of forest nursery***, types of nursery beds, preparation of beds, fumigation. ◈ ***Methods of seed sowing*** and mulching, seedling growth and development, pricking, weeding, hoeing, rotation, organic matter supplements and cover crops, mycorrhizae, fertilization, shading, pruning, root culturing techniques, lifting windows, grading, packaging. Jharkhand PSC State Forest Service Exam में ACF और RFO दोनों के पाठ्यक्रम लगभग *Same* ही हैं। बस, ACF पाठ्यक्रम संक्षिप्त रूप में *Present* किया गया है, जबकि RFO पाठ्यक्रम विस्तृत।

Module - 1

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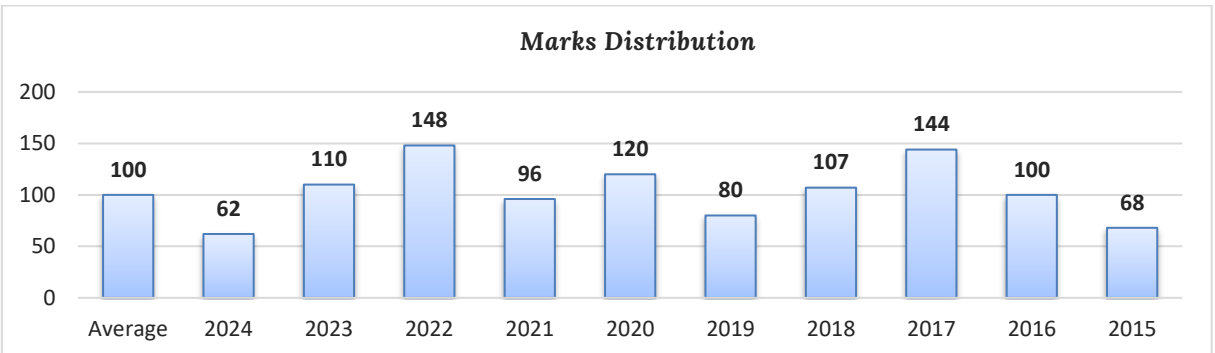


INDIAN FOREST SERVICE (IFoS) PYQs | 2010 – 2024

2024	• What is ***Silvics***? Explain its practical application. Discuss in brief the objects of study of silviculture [P1/4 (b) | 15 M]. • What are ***Ecosystem Services***? Differentiate between use values and non-use values. Explain different methods of valuation of ecosystem services [*Linked Q* | **P2**/Q7 (b) | 15 M]. • Differentiate amongst ***Radiation Frost***, ***Pool Frost*** and ***Advective Frost***. Give at least two examples each for frost hardy, moderately hardy and frost tender tree species [**P2**/6(c) | 10 M]. • Briefly summarize the characteristic features of cold arid forest vegetation. Discuss their mechanism of ***Survival Under Extreme Cold*** temperatures [*Linked* Q : P1/1 (b) | 8 M]. • Give four examples of tree species for each of the following methods by which their flowers are pollinated [P1/1 (c) | 8 M]. (i) Anemophily (ii) Zoophily (iii) Entomophily (iv) Hydrophily • Enumerate the ***Standard Tree Classification*** adopted in Indian Forestry [P1/3 (c) | 10 M]. • "Pruning is an important ***Tending Operation*** in plantation forestry for the improvement of the tree or its timber." Justify [P1/2 (c) | 10 M].
2023	• What is ***Frost Hole***? How does frost affect regeneration? [P1/1 (d) | 8 M]. • What are ***Biofertilizers***? Enlist the factors associated with the ***Mycorrhizal Development*** in trees. Discuss the types of mycorrhizae [15 M] [*Linked Q* | P1/8 (a) | 15 M]. • Explain the following [P1/4 (c) | 15 M]. (*i*) Lignotuber (*ii*) Root sucker (*iii*) Vermiculite (*iv*) Buttresses (*v*) Ortet and Ramet • The shoot portion of seedlings of some tree species like ***Sal*** and ***Sandal***, under ***Natural Regeneration***, keeps on drying year after year but the roots remain alive. Discuss [P1/1(a) | 8M]. • Write the factors which affect the ***Natural Regeneration*** of Sal (*Shorea robusta*). Discuss the procedure to obtain natural regeneration of *Moist Sal Forests* [P1/2 (b) | 15 M]. • Discuss the significance of ***Exotics*** in tree improvement. Name four exotic tree species [*Linked Q* | P1/5 (b) | 8 M]. • Write the botanical names of three tree species each of [P1/1 (e) | 8 M]. (*i*) Non-coppicers, (*ii*) Poor coppicers, (*iii*) Good (fair) coppicers and (*iv*) Strong coppicers. • Describe the ***Seed Collection*** and ***Storage Methods*** of the following tree species [P1/2(a) | 15 M]. (*i*) *Santalum album* (*ii*) *Chukrasia tabularis* (*iii*) *Cedrus deodara*

	(*iv*) *Azadirachta indica* (*v*) *Dalbergia latifolia* • Calculate the ***Quantity of Seeds*** (kg) required to establish a teak plantation over an area of 10 ha. [P1/1 (b) | 8 M]. • What is ***Deforestation***? Discuss the impact of deforestation on the environment [*Linked Q* | P1/6 (c) | 15 M]. • Explain the present status, scope and constraints of ***Biofuel Production*** in India. Write the botanical names of five tree-borne oilseeds [*Linked Q* | **P2**/8 (b) | 15 M].
2022	• What is the ***Purpose of Classifying Forests***? How are the forests classified for silvicultural management? [*Linked Q* | **P2**/1 (a) | 8 M]. • How do ***Sacred Groves*** help in conservation of biodiversity? [P 1/5 (b) | 8 M]. • What is ***Precision Silviculture***? Explain the silvicultural techniques for the following [P1/3 (b) | 15 M]. (a) *Dalbergia Sissoo*, (b) *Eucalyptus tereticornis* • "Success of commercial forest plantations depends on ***Site-Specific*** and ***Strategic Planning***" Justify the statement [**P2**/1 (d) | 8 M]. • Describe the ***Adverse Climatic Factors*** causing damage to forests [**P2**/8 (b) | 15 M]. • Explain the ***Role of Mycorrhizae*** in plant growth and development of forest trees [P1/7 (b) | 10 M]. • What are ***Commensalism***, ***Amensalism***, ***Mutualism*** and ***Symbiosis***? Write the function of an ecosystem [*Linked Q* | **P2**/8 (c) | 10 M]. • What are the ***Biotic and Abiotic Stresses*** on trees? Explain the responses of trees to these stresses [*Linked Q* | **P2**/5 (a) | 8 M]. • Discuss the significance of ***Bamboo Flowering*** [P1/1 (e) | 8 M]. • How are ***Nurseries Classified*** in India? What is a clonal nursery? Explain the nursery technique for *Casuarina equisetifolia* [P1/3 (a) | 15 M]. • Explain the techniques for upgradation and ***Hardening of Nursery Seedlings*** of *Lagerstroemia lanceolata* [*Linked Q* | P1/1 (d) | 8 M]. • What is ***Root : Shoot Cutting***? Write the names of five tree species which are propagated by this method [P1/4 (c) | 10 M]. • Explain the following – (iv) ***Enrichment Planting*** [P1/2 (c) *iv* | 2.5 M]. • Is coastal rehabilitation using mangrove species a success? Explain the ***Plantation Technique*** for degraded mangrove forest [*Linked Q* | P1/3 (c) | 10 M]. • Differentiate between ***Thinning Cycle*** and ***Thinning Intensity***. Why is thinning essential for the management of ***Forest Stand***? Describe the merits and demerits of French thinning [P1/4 (b) | 15 M]. • Explain the ***Salvage Operations*** for plantation trees after natural disasters [*Linked Q* | **P2**/6(c) | 10 M]. • Explain the silvicultural practices that help in the ***Modification of Site Factors*** in forestry [P1/4(a) | 15 M].
2021	• How are ***Forest Sites Classified*** on the basis of vegetation? [P1/4(c) | 10 M].

CHAPTER 1

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*.

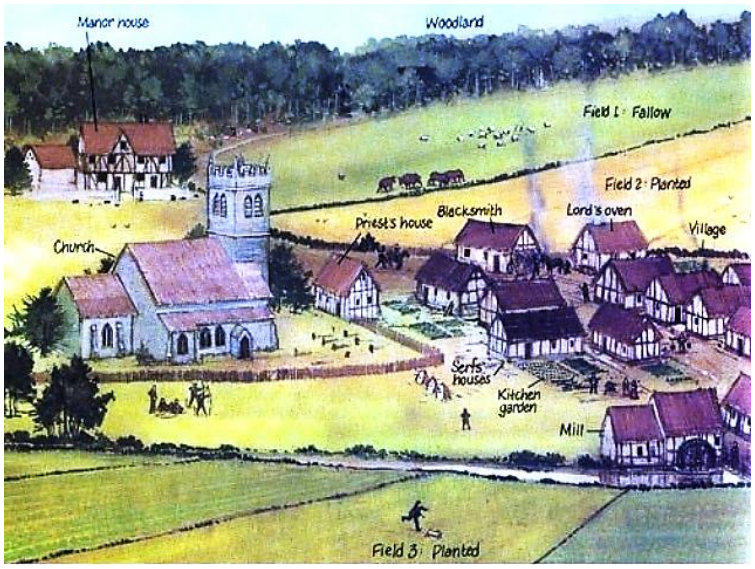


Figure 1.1 : A medieval European village

► 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

– 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***.
- Classification systems provide a *Baseline for tracking changes* in *Forest Health*, *Productivity*, and *Biodiversity*, enabling the monitoring of climate change effects and allowing managers to adapt their practices to changing conditions.
- *Comparability* : Enabling the comparison of forest resources and management practices across different areas is essential for understanding regional variations and identifying best practices.
- Identifying the *Areas of High Biodiversity* or *Ecological Significance* for conservation and sustainable management.
- *Developing sustainable management plans* : By understanding the characteristics of different forest types, managers can develop plans that are tailored to the specific needs of the forest ecosystem.

IFoS 2022 : What is the ***purpose of classifying forests*** ? How are the forests classified for silvicultural management? [Linked Q | 8 M].

IFoS 2012 : Basis of forest classification and why there is ***need for such classification*** [5 M].

- What are the ***Purposes of classifying*** various types of forests? [OPSC Civil (Main) 2022–23 | 5 M].
- What are the bases for the *classification of forests*? Why there is ***need of their classification***? Write the type groups of tropical forests and their distribution and species of the area [OPSC Forest (Main) 2019-20 | 20 M].
- What are the ***objectives of forest classification***? Classify forests on the basis of different criteria used with definition of each class [Arunachal PSC Civil (Main) 2017-18 | 20 M].

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***. 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"*

It can also be classified as

- **Natural Forest** : When regeneration is obtained by natural means, *i.e.*, *virgin Forest*
- **Man-Made Forest** or **Plantation** : When regeneration is obtained by Artificial means, *i.e.*, Miyawaki forest.

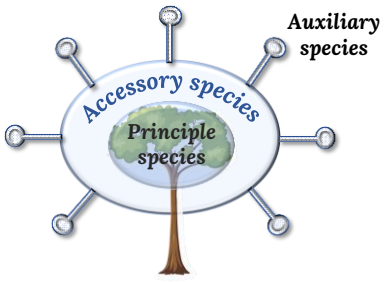
Differentiate between - High Forest and Coppice Forest **[Himachal PSC Civil (Main) 2015 | 5 M; OPSC Civil (Main) 2020–21 | 10 M]**

Write short notes - (a) High Forest (b) Low Forest **[Uttarakhand PSC (RFO) 2012 | 20 M]**.

Aspect	High Forest	Coppice Forest
Regeneration Method	Grows from seeds	By stump, root sprouts, or Coppice shoots
Tree Structure	Taller and single - stemmed trees	Multiple stems from the same rootstock
Tree Age	Even-aged or uneven-aged stands	Even-aged stands within each coppice cycle
Rotation Period	Long (decades to centuries)	Short (A few years to decades)
Examples	Natural forests	Traditional coppice systems in Salix (Willow) plantation

► COMPOSITION OF FOREST VEGETATION (FLORISTIC COMPOSITION)

- **Pure Forest** : A forest predominantly composed of a single species, or at least *not less than 80 %*. It is also called a "*Pure Crop*"
- **Mixed Forest** : A forest composed of trees of two or more species intermingled within the same canopy. Mixed forests may be further divided into –



➲ ***Principal species*** – (a) The species ***first in importance*** in a mixed stand, either by *Frequency*, *Volume*, or *Silvicultural value*; (b) ***Dominant*** and ***most commercially valuable*** species in a forest stand; (c) The species to which the silviculture of a mixed forest is primarily directed.

➲ ***Accessory species*** – a useful species of ***less value*** than the principal species, which assists in the growth of later.

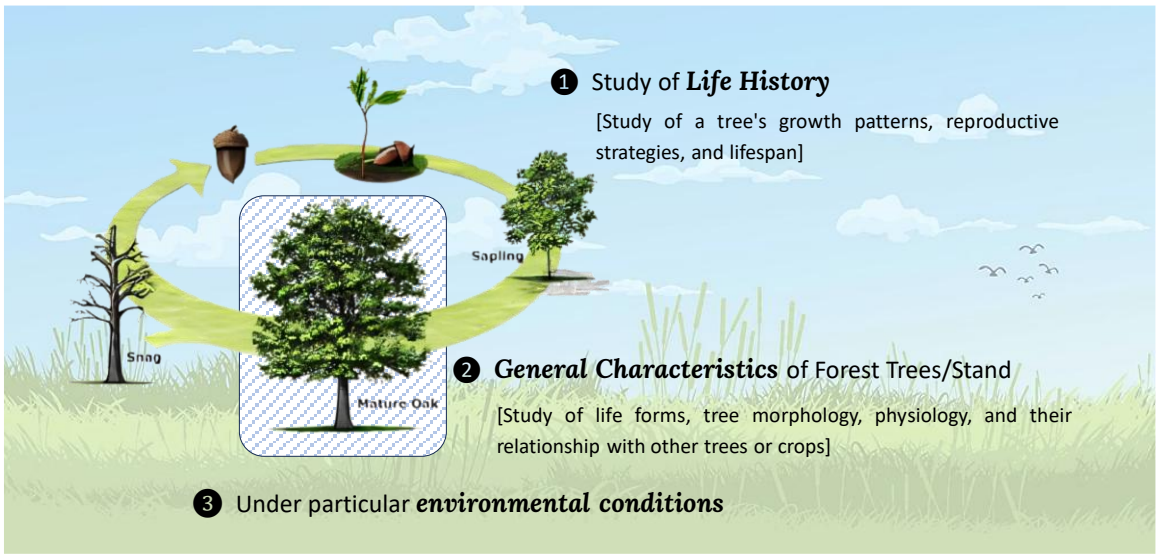
➲ ***Auxiliary species*** – A species of ***inferior quality*** or ***size***, with relatively ***little silvicultural value*** or ***importance*** [*syn.* **Secondary species**, **Subsidiary species**]. These species *play a supportive role in the forest ecosystem*—such as aiding regeneration, providing shade, or improving soil conditions—but are not the primary focus of forest management.

Virgin Forest

A natural forest in its natural state (without any human intervention)

SILVICS

Silvics deals with the biological characteristics of individual trees and their communities. This includes how trees grow and reproduce and the ways that the physical environment influences their physiology and character. Further, it investigates how communities of trees modify the physical environment that supports them and studies the never-ending interaction between vegetation and the physical environment as forests develop and change over time.



Definition : *Silvics is the study of Life History and General Characteristics of forest trees and stand with particular reference to environmental factors*. It focuses on how trees grow, reproduce, and interact with their environment, including factors like climate, soil, and other organisms.

OBJECTIVES OF SILVICULTURAL STUDY

⊳ **Control**

- ***Crop composition*** : controlling the mix of tree species within a stand, promoting desirable species while suppressing unwanted ones.
- ***Stand structure*** & ***Density*** : Operations like thinning and pruning help in manipulate stand structure, arrangement and spatial distribution of trees within a stand.
- ***Growth*** : Silviculturists aim to optimize the growth and development of forest stand. This involves controlling factors that influence growth, such as competition, nutrient availability, and light.

IFoS 2024 : What is ***Silvics***? Explain its practical application. Discuss in brief the ***objects of study of silviculture*** [15 M].

Define Silviculture. What are the ***objectives of studying*** it? [GPSC RFO (Main) 2020-21].

What are the ***objectives of silviculture***? Describe the forest types of India [MPSC (ACF) 2012 | 15 m].

⊳ **Facilitation**

- Production of *large volume per unit area* by selecting appropriate tree species, optimizing stand density, and employing silvicultural systems that promote rapid growth.
- Increasing the *quality of timber*.
- 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.

CHAPTER 2

LOCALITY FACTORS

2.1 LOCALITY FACTORS

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

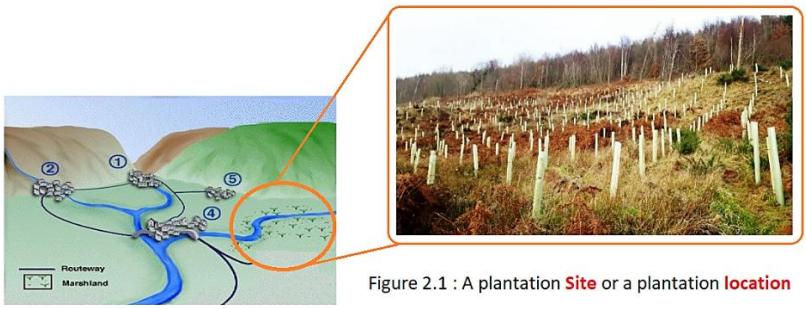


Figure 2.1 : A plantation **Site** or a plantation **location**

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.

Chapter Outline

IFoS 2018 : Explain the *Eco-physiological factors* that are more concerned to Silviculturist (15 m).

IFoS 2011 : Why are *locality factors* considered important for any silvicultural operation? (10 m).

IFoS 2010 : What do you understand by the term *locality factors* ? how these affect the decision of plantations undertaking by the Silviculturist ? (10 m).

- Define the term *locality factors*. How do these factors affect the decision of plantation undertaken by a forester [Mizoram PSC Civil (mains) 2018 | 10 m]
- What are all the *biotic and abiotic factors*, responsible for tree/forest growth? Discuss [Himachal PSC ACF (Main) 2017| 15 m]

thickness, we now fill additional trees to create ***Permanent Canopy Gaps*** and ***Eliminate Vertical Competition***. Once height competition ends, the remaining trees almost stop elongating and redirect their resources to diameter expansion—a late-stage burst of secondary growth known as ***Light Increment***.

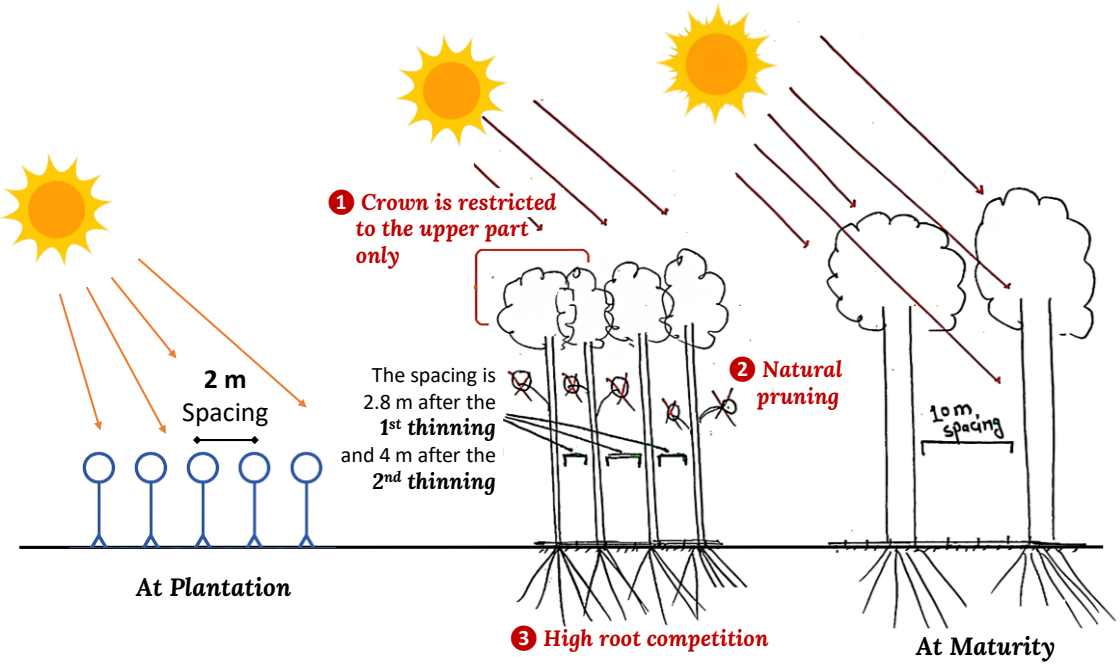


Figure 3.4 : Showing how the Light increment concept works

Linked Questions

IFoS 2017 : Regulation of ***Solar Radiation*** given a ***Powerful Tool*** to the forester justify [10 M].

IFoS 2009 : ***Role of Light*** in obtaining ***high-quality timber***, Explain [10 m].

Discuss the importance and ***effect of light*** on vegetation [OPSC Civil (Main) 2021 | 10 m].

Solar radiation is a fundamental driver of forest ecosystems, and any change in its ***Quality***, ***Intensity***, or ***Duration*** will affect the forest ecosystem's biogeochemical cycles, tree growth, regeneration, morphology, and animal-plant relationships. By managing solar radiation through silvicultural practices, foresters can optimize forest health and productivity for desired outcomes.

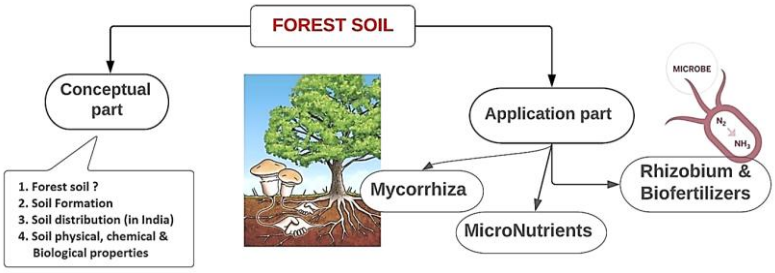
- ***Site management*** : By controlling sunlight, foresters can regulate **temperature** and **humidity**, helping to reduce ***Weed Growth***, prevent ***Soil Erosion***, and promote ***Humification*** in conifer forests. This also helps maintain a stable ***Microclimate***.
- ***Producing High-Quality Timber*** : Controlled light exposure shapes tree ***Stem Form***, prevents excessive ***Crown*** growth, and promotes ***Natural Pruning***. This helps develop ***Straight***, ***Knot-free Boles*** with well-formed ***Growth rings***, while also reducing the risk of ***Pests*** and ***Diseases***, making the forest healthier and more productive.
- Light intensity also affects ***Wood Density***. Strong light promotes ***Latewood***, which has thick cell walls and high density, resulting in *durable timber*. In contrast, shaded areas produce more ***Earlywood***, which is less dense and weaker.

High light → more **latewood** → thicker cell walls → Stronger timber.

CHAPTER 4

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

CHAPTER 5

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

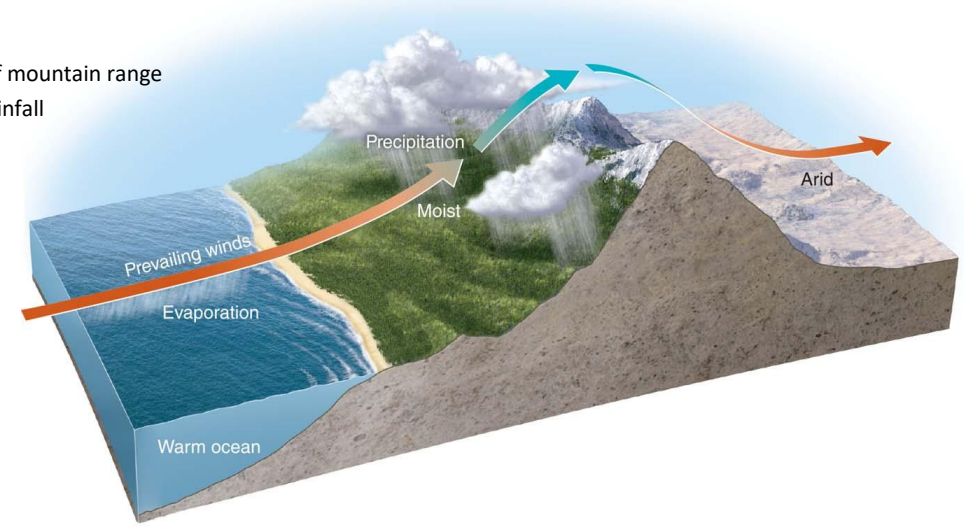


Figure 5.1 : Effect of mountain range on the pattern of rainfall

CHAPTER 6

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.

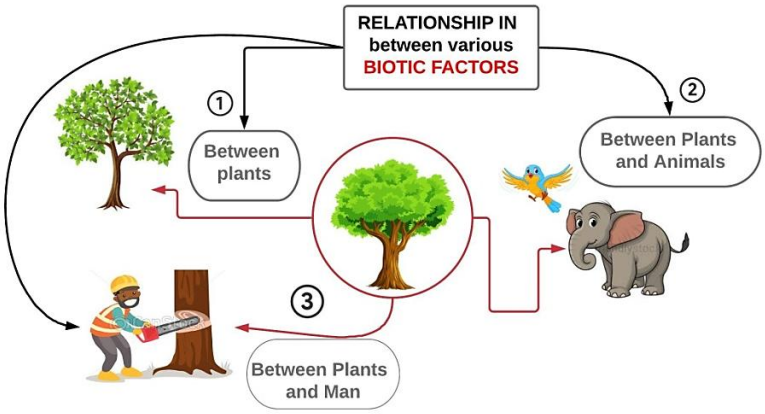


Figure 6.1 : Relationship between various biotic factors.

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

CHAPTER 8

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

Phoenix, Coconut, Borassus

Unbranched stem of Coconut

Conical shape

Abies pindrow (Silver Fir), Eucalyptus, Ashoka

Cylindrical shape

Mango, Neem, Imli, Mahua, etc.

Spherical shape

CHAPTER 12

NATURAL REGENERATION

WHAT IS REGENERATION ?

Regeneration or **reproduction** is an act of *replacing the old crop* with *younger ones*, either naturally or artificially is called regeneration or reproduction.

TYPES ?

- Natural regeneration : by nature.
- Artificial regeneration : when humans were involved in its propagation.

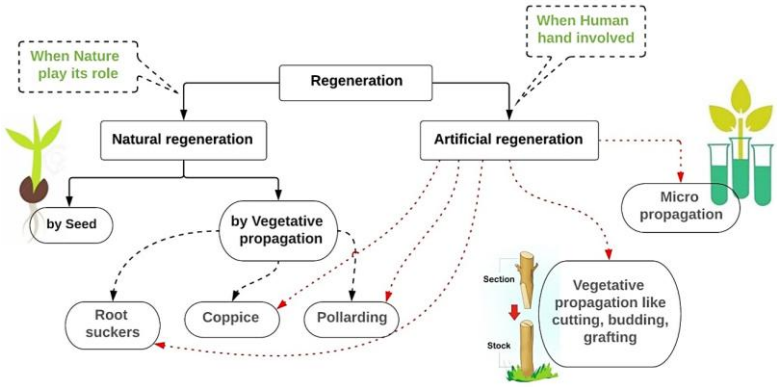


Figure 12.1 : Types of natural regeneration.

NATURAL REGENERATION

Definition : 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 required some suitable conditions of soil, climate, host plants, and topography. Natural regeneration is often not left to nature, but it is induced by creating a suitable environment. The various measures taken to *induce natural regeneration* may be - (a) cutting some matured trees to allow more light to penetrate, (b) coppicing of seedlings or trees, (c) Closing the area to prevent fire and biotic interference and (d) trenching for getting root suckers, etc.

Chapter Outline

What is Regeneration?

- NR
- AR

Natural regeneration by

- Seed
- Coppice
- Root Sucker
- Pollarding

CHAPTER 13

ARTIFICIAL REGENERATION

The renewal of a forest crop by sowing, planting or other artificial means is called *artificial regeneration* (synonyms = plantation). It includes both (i) reforestation and (ii) afforestation. *Reforestation* is the restocking of a felled or cleared forest by artificial means. *Afforestation* is the establishment of a forest by artificial means on a non-forest area (the area from which forest vegetation has been absent).

13.1 OBJECTIVES OF ARTIFICIAL REGENERATION

- **Supplement natural regeneration** : Natural regeneration is a slow and challenging process, and often it does not give adequate and uniform stocking over the area. We cannot rely only upon it; we have to supplement it by artificial means. The natural regeneration in Sal-bearing moist deciduous forests in Uttar Pradesh has always been a problem; fir and spruce forests in Himachal Pradesh are also facing the same issue.
- **Replacing Natural Regeneration** by artificial means : Due to an increase in the biotic pressure, natural regeneration in several areas is lacking, slow, and uncertain. Therefore, it is necessary to regenerate that area with the help of artificial means to speed up the regeneration process (Remember, here we do not just supplement the natural regeneration process. We actually remove the majority of natural seedlings and replace them with plantation).
- **Restocking** & **revegetate** (Reforestation) our degraded and overexploited forest. That was damaged due to heavy biotic pressure. We already have a target of *26 million hectares* of degraded land that should be reforested by 2030.
- **Reclamation** & **Afforestation of Wastelands**, abandoned mining areas, and industrial dumping grounds.
- **Increasing Proportion of Valuable Species** : called - *Forest enrichment****, it also helps in making forest fire-resistant by planting evergreen trees.

Chapter Outline

IFoS 2022 : Explain the following – (iv) ***Enrichment Planting*** [10 M].

IFoS 2014 : Discuss in detail the ***objectives of artificial regeneration*** [10 m]

CHAPTER 14

CHOICE OF SPECIES

In artificial regeneration, one of the most critical decisions is the selection of species. The choice of species deserves thoughtful consideration as it controls the success of artificial regeneration. A minor error in the selection of species may result in the plantation's failure, which will lead to a huge loss of money, time, and energy. Several factors need consideration in the selection of species for artificial regeneration. Essential factors to be taken under consideration in the choice of species are as follows -

(A) Site factors = 4

(B) Purpose of plantation? = Commercial + Envi + Social?

(C) Silvicultural characteristics of a species.

(D) Economic factors.

Extra Notes : Hardwood *v/s* Softwood; Indigenous v/s Exotics species; Fast-growing *v/s* Slow-growing species; Pure crop *v/s* Mix crop; Nurse crop & Cover crop. Controversies - Poplar, Eucalyptus, and P. Cineraria, etc.

Chapter Outline

14.1 FACTORS

A. SITE FACTORS

* **Climatic factors** : Every species requires a specific environment for its growth and development and we have to choose accordingly. For sites located in hot, dry conditions like the semi-arid region of Rajasthan, we have to choose species like ***A**cacia*, ***A**lbizzia*, ***P**rosopis* (in short **AAP,** *jhaduwale* ☺). whereas, for cold deserts, we have to choose species like *Salix*, *Populus* & *Juniperus* spp. We can't interchange these species. Species were suitable for wetland afforestation (Water logging areas) : *Eucalyptus*, *Terminalia arjuna*, *Acacia nilotica*, etc.

Rainfall (mm)	Climate	Suitable species
Less than 250	Hot desert	*Acacia tortilis*, *A. Senegal*, *Prosopis spp*, *Tamarix* spp.
	Cold desert	*Salix*, *Populus*, and *Juniperus* spp.

CHAPTER 15

SEED SUPPLY

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 CO_2 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.

STEPS (A review of this chapter)

Chapter Outline

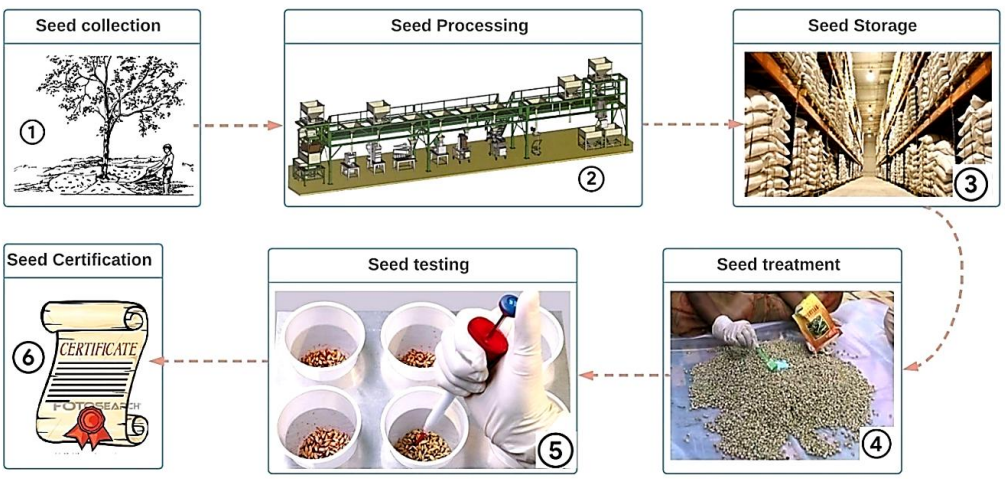


Figure 15.1 : basic steps in the seed collection process

CHAPTER 16

FOREST NURSERY

Forest nurseries are dedicated enclosed facilities where planting material is grown for transplantation purposes. These nurseries play a vital role in afforestation, reforestation and enrichment plantation projects to maintain and enhance forest ecosystems.

Seedlings are young plants obtained from seed sowing. These young plants can be about one meter in height. ***Transplants*** are seedlings that have transferred from one bed to another to make the seedlings suitable for planting. Seedlings, transplants, and other planting material, *i.e.*, rooted cuttings etc., together are generally called ***planting stock***.

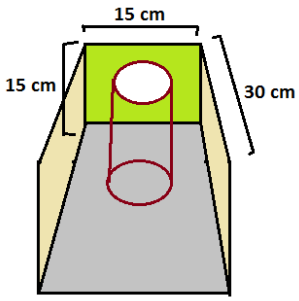
16.1 REQUIREMENTS OF NURSERY?

Artificial regeneration of forests and afforestation of wastelands is carried out either by sowing seeds directly in the field or/and planting nursery-raised seedlings, stumps, cuttings, etc. The easiest and cheapest method of artificial regeneration of forests and afforestation of wastelands is to sow the seeds of desired species directly in the field and tend them to grow after the seeds have germinated. Artificial regeneration by seed sowing has not shown the desired results in the case of several species due to several problems. Planting of Nursery-raised seedlings, stumps, cuttings, rhizomes, etc., offers several advantages over seed sowing. These advantages are as follows

- Several species are *initially slow-grown*. If seeds of these species are sown in the field, the seedlings are most likely to be swamped by weeds and *killed by intense competition*. The nursery-raised seedlings are better equipped to compete with weeds and tolerate adverse site factors, therefore, better success is ensured in planting nursery-raised seedlings.
- Several species *do not seed every year* and produce good quality seeds during a good seed year only. So, we can produce seedlings in the Nursery by collecting seeds through the years.

Chapter Outline

purposes. Its natural flexibility, durability, and water-resistant properties make it an ideal material for creating lightweight and sturdy plant containers.



Brick container

Polybag

Roots trainer

COIR 'ROOT TRAINER'

Eco-friendly, cost-effective, biodegradable coir 'roots trainer' to tack the environmental issues caused by abandoning the plastic covers after planting the saplings

- *Advantages* : (a) Offer better air circulation, (b) Absence of root coiling, (c) More stronger and well grown taproot system, (d) Employment generation, etc.
- *Disadvantage* : (a) Price ≈ 5 rs per pot, (b) Limited availability of coir & market.

What is the best possible way to reduce the plastic usage in nursery? As a DFO what steps you will take to reduce its usage? [IFS (Pro) 2020-22]

Reducing plastic usage in nurseries is important for promoting environmental sustainability. As a Divisional Forest Officer (DFO), I would adopt a multi-pronged approach encompassing policy, education, and practical implementation.

Assess Current Plastic Usage

- Conduct an Audit to Identify where and how much plastic is currently being used in the nursery.
- Categorize Plastic uses and separate single-use plastics from reusable ones.

Incentivise alternatives & innovation : ◈ Biodegradable root trainers & Polybegs: Use pots made from biodegradable materials like Coir, jute, or Bamboo. ◈ Use biodegradable mulching films, ◈ Promote Recycling and Reuse, ◈ Partner with Eco-Friendly Suppliers

Policy and Monitoring : ◈ Plastic Reduction Policy, ◈ Regular Monitoring

Innovative Practices : ◈ *Gravel culture* or *Hydroponics* and *Aquaponics* : it may require less plastic. ◈ Smart Irrigation Systems : reduce the need for plastic pipes and fittings.

16.7 STUMP PREPARATION

+91 78802-71423 Hornbillclasses@gmail.com

CHAPTER 18

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

Site Selection

Site allotted by the Govt.

Green Highway Corridor

CAMPA Forest

CHAPTER 20

TENDING OPERATION

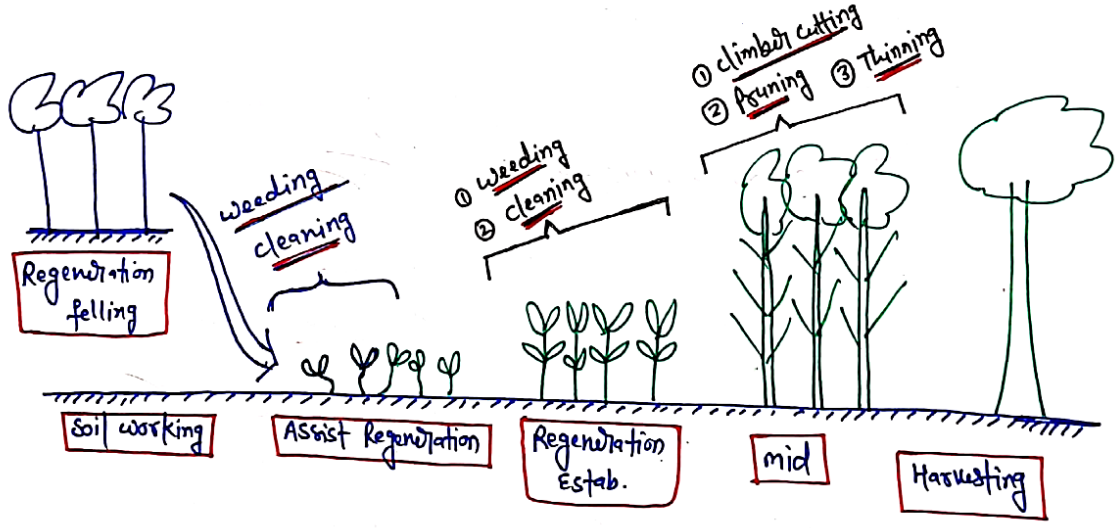
WHAT DO YOU MEAN BY TENDING OR TENDING OPERATION?

From the establishment of the regeneration and subsequent growth to the harvesting, several operations are carried out at different stages of growth in order to provide a healthy environment for their growth. These operations are called tending operations –

- Weeding,
- Cleaning,
- Thinning & improvement felling
- Climber cutting
- Pruning
- Girdling of unwanted growths.

IFoS 2021 : What do you mean by tending operations? Enumerate various tending operations carried out in forest crops. Discuss improvement felling (15 m).

- Explain briefly the tending operations carried out in a forest [UKPSC (ACF) 2018].
- Explain different types of tending operations used in forestry [MPPSC (ACF) 2017| 20 m].
- What do you understand by tending? Write in detail about various tending operations in forest trees. How are tending operations different from cultural operations [Himachal PSC Civil (Main) 2017| 20 m].



CULTURAL OPERATION ?

The operation, as a rule not directly remunerative, undertaken to assist or complete existing regeneration, to promote the proper development of the crop or to minimize the after-effects of felling damage. It, therefore, includes subsidiary felling, weeding, cleaning, unremunerative

IFoS 2011 : Short notes on – cultural operation (5 m).

IFoS 2010 : Distinguish between 'Tending operation' and Cultural operation in Forestry (10 m) [*Also in*, Arunachal PSC civil (Main) 2015-16; Odisha PSC Civil (Main) 2018].

CHAPTER 21

PLANTATION FORESTRY

A forest plantation is an area of land of not less than one hectare owned by the govt. or private sector, upon which the owner proposes to develop and maintain a forest crop of usually even-aged and single species.

Plantation forestry, based on the successful breeding of superior tree genotypes, is becoming more widely used by international forestry companies since it offers the possibility to grow and manage forests of high economic value and superior quality. However, a number of highly desirable traits are not readily available in the breeding population and may be introduced using desirable genes from other organisms.

21.1 OBJECTIVES or NEEDS OF PLANTATION FORESTRY

> Explain the following – (a) Plantation Forestry [OPSC Civil (Main) 2020 | 10 m]

- *Production* purpose : for production of Timber, Fuel wood, fodder, Fibres, pulpwood, etc. to fulfil population demands with depressurized Forest resources.
- *Protection* against adverse weather, *i.e.*, Windbreak, planting a shade tree in Tea gardens (Usually *Albizzia* spp.), Soil and water *conservation* in a given watershed area.
- Forest enrichment and mixing species to control epidemics like the Sal heartwood borer attack in 1998 in central India.
- Climate change and global warming forced many species unsuitable for germinating naturally or sustained after germination, so they required human intervention.
- Our industrial and domestic demands are changing with time in quality, quantity, and requirement specific. We required the introduction of fast-growing species as well as new species.
- To create employment and investment opportunities.
- Environmental concern & Carbon storage purpose : Compensatory afforestation under CAMPA, fulfills our INDC obligations under the *Paris Agreement* by creating an additional carbon sink of **2.5 to 3 billion** tonnes of CO_2 equivalent till 2030. Our PM recently announced, "India will restore **26 m hac**. of degraded land by 2030" at the 14th CoP of UNCCD at Greater Noida.

21.2 PRODUCTIVITY OF INDIAN FOREST

Against the global average productivity of 2.1 million m^3/hectare/ year, the productivity of the Indian Forest is only 0.7 million m^3/hectare/ year.

Causes of Poor Productivity

- Unregulated grazing
- Uncontrolled fuelwood collection : Nearly 50% of the demand for fuel in rural India is being met from the adjoining forests. The annual demand for fuel wood is estimated nearly 250-300 million m^3. The recorded

Congratulations

To all our successful candidates in

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1 AIR

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10 AIR

Shashank Bhardwaj

Forestry Comprehensive Course + Test Series

14 AIR

Ankan Bohra

Forestry Comprehensive Course

16 AIR

Prachi Gupta

Forestry Comprehensive Course

17 AIR

Raj Patoliya

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23 AIR

Vineet Kumar

Forestry Comprehensive Course

27 AIR

Jatin Babu S

Forestry Comprehensive Course

28 AIR

Gaurav Saharan

Test Series

37 AIR

Yash Singhal

Forestry Comprehensive Course

41 AIR

Nitish Pratik

Forestry Comprehensive Course

50 AIR

VAASANTHI P.

Test Series

54 AIR

Sourabh Kumar Jat

Forestry Comprehensive Course

56 AIR

Ekam Singh

Forestry Comprehensive Course + Test Series

57 AIR

Kunal Mishra

Forestry Comprehensive Course

58 AIR

Atul Tiwari

Forestry Comprehensive Course

60 AIR

Aman Gupta

Forestry Comprehensive Course + Test Series

61 AIR

Sanket Adhao

Forestry Comprehensive Course

63 AIR

Preeti Yadav

Forestry Comprehensive Course

65 AIR

Nihal Chand

Forestry Comprehensive Course + Test Series

66 AIR

Shashikumar S. L.

Forestry Comprehensive Course

67 AIR

Dhino Purushothaman

Forestry Comprehensive Course

68 AIR

Diwakar Swaroop

Forestry Comprehensive Course

72 AIR

Rajesh Kumar

Forestry Comprehensive Course

74 AIR

Krishna Chaitanya

Forestry Comprehensive Course

75 AIR

Harveer Singh Jagarwar

Forestry Comprehensive Course

76 AIR

Akash Dhanaji Kadam

Forestry Comprehensive Course

78 AIR

Himanshu Dwivedi

Forestry Comprehensive Course

80 AIR

Sumit Dhayal

Forestry Comprehensive Course

82 AIR

Priyadarshini

Forestry Comprehensive Course + Test Series

91 AIR

Sucheet Balkal

Forestry Comprehensive Course

93 AIR

Harshad Hinge

Test Series

96 AIR

Maharshi Kumar

Forestry Comprehensive Course

97 AIR

Akash Kumar

Forestry Comprehensive Course

104 AIR

P R Sarbajit

Forestry Comprehensive Course

105 AIR

Pawan K. Meena

Forestry Comprehensive Course

110 AIR

Keshav Prasoon

Forestry Comprehensive Course + Test Series

111 AIR

Nagabhushana S

Forestry Comprehensive Course

113 AIR

Shewale Vyankatesh G.

Forestry Comprehensive Course

123 AIR

Chandra Bhushan

Forestry Comprehensive Course

127 AIR

Shubham Kanoujia

Forestry Comprehensive Course + Test Series

128 AIR

Harsh Verma

Forestry Comprehensive Course + Test Series

134 AIR

Gaugin Gyanendra Singh

Forestry Comprehensive Course

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Indian Forest Service (IFoS) 2023