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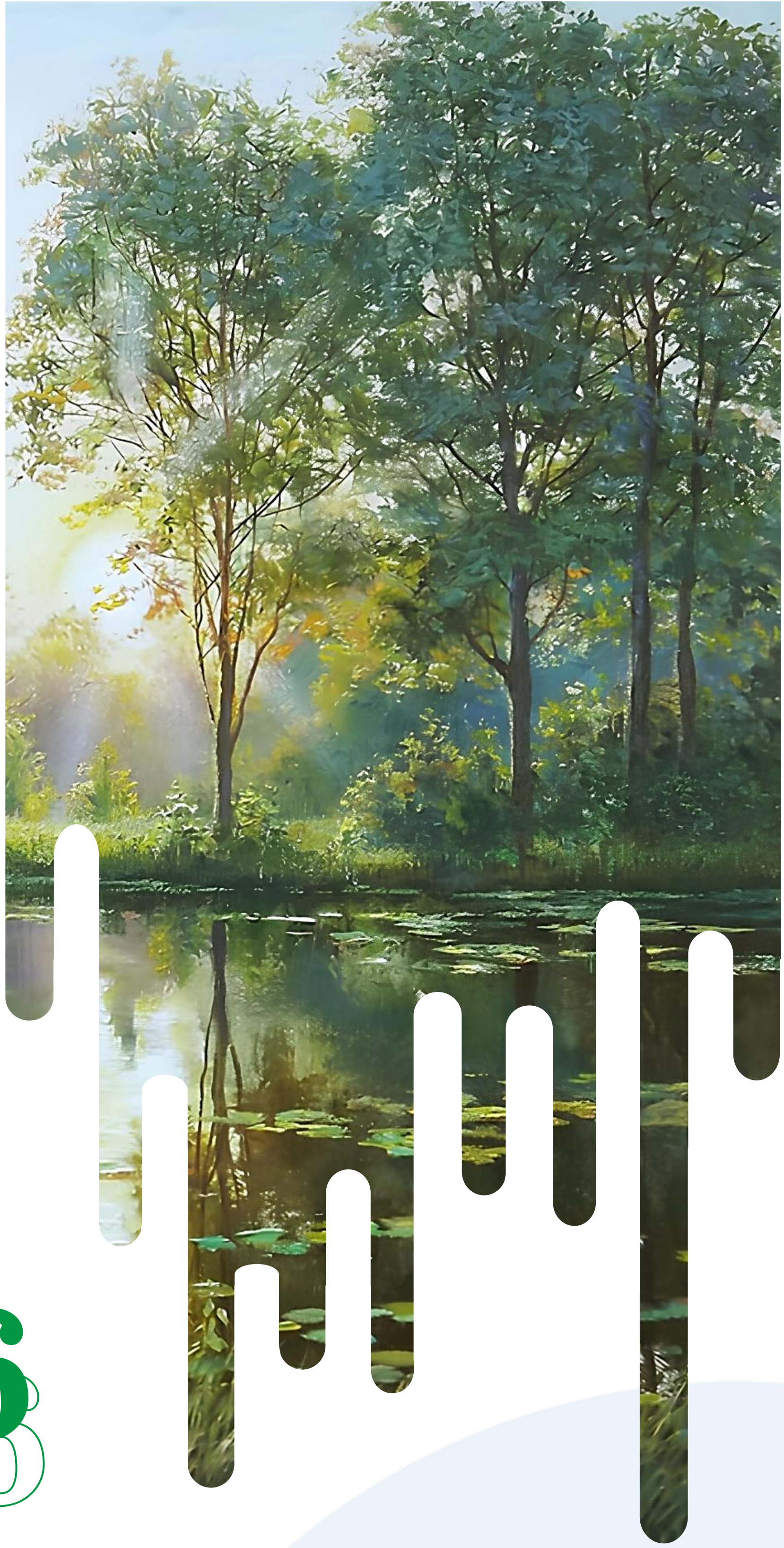

Module - I

2026

2026

The Science of Forest Cultivation

SILVICULTURE

Paper – 1 – Section – A

Indian Forest Service (Main) Exam

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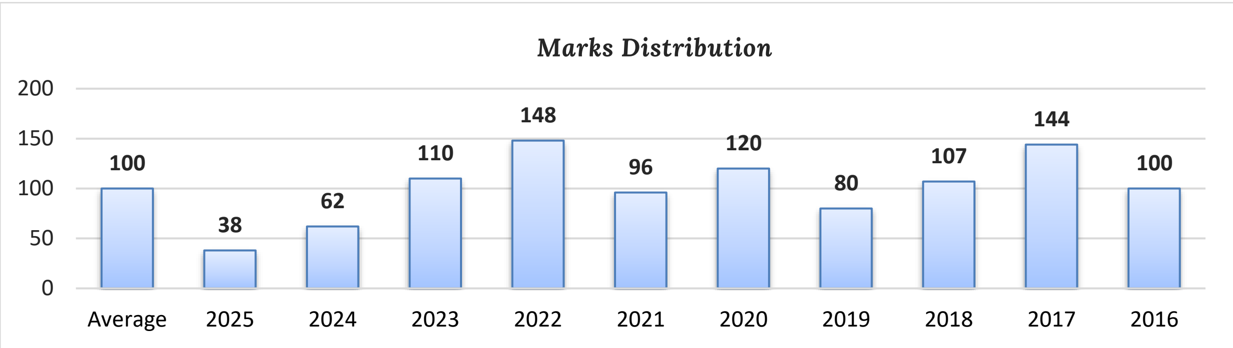
SYLLABUS

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],



Module - 1

CONTENTS

INDIAN FOREST SERVICE (IFoS) PYQs | 2010 – 2025

2025	• Answer the following : How does **light** affect the forest vegetation? Explain with suitable examples [P1/1 (a) | 8 M]. • Describe the external factors of environment which affect the germination of **seeds** in the natural forests [P1/2 (a) | 15 M]. • Describe briefly the following : (i) Site quality, (ii) Hardening, (iii) Tending, (iv) Thinning, (v) Grading [P1/3 (a) | 15 M].
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].

	• Explain the **Role of Fire** in the silviculture of *Shorea robusta* [10 M]. • Differentiate between [5 × 2 = 10 M]. (a) Exogenous **Dormancy** and endogenous dormancy (b) Artificial regeneration and Natural **Regeneration** • Explain the following points in relation to **Nursery Management** – (1) Site selection and layout, (2) Soil working, (3) Methods of raising nursery stock, (4) Plant protection measures, (5) **Nursery Register**. [4 × 5 = 20 M]. • How do we calculate the **Seed Requirement** *of a species* while raising nursery? Also explain the method of calculating the number of plants required per hectare for plantation [10 M]. • Write Short notes on – (i) _____, (ii) **Cultural Operations** [P1/3 (b)*ii* | 5 M].
2010	• Why do forest **Plantations Fail**? cite relevant examples. [P1/1(a) | 5 M]. • What are the different **Types of Containers** used in raising forest nurseries? List their advantages and disadvantages [P1/1(c) | 5 M]. • Explain the role of **Growth Regulators** in rooting of cuttings [P1/1(e) | 5 M]. • Briefly discuss **Low-Temperature Injuries** in forest trees [P1/1 (g) | 5 M]. • Briefly describe the merits and demerits of '**High Density Short Rotation**' forestry. Enlist suitable species in this regard along with their productivity potential [P1/2 (a) | 10 M]. • What do you understand by the term **Locality Factors**? How these affect the decision of plantations undertaken by the silviculturist? [P1/2 (b) | 10 M]. • Why is **LAI** important in deciding the productivity of forest trees? Explain the concept of optimum LAI and how it varies with the type of forest and climate [P1/Q2 (c) | 10 M]. • Differentiate between the – (ii) Photosynthetic efficiency and Nutrient use efficiency (iii) **Site Quality** and **Site Index**, (v) **Gregarious Flowering** and sporadic flowering in bamboo. [P1/3 (a) | 4× 3 = 12 M]. • Comment on following – (a) **Pure stand** of forest result incomplete utilization of the site, (b) Plantation forestry has high production potential but low conservation value [5 × 2 = 10 M]. • Distinguish between "**Tending operations**" and "**Cultural operations**" in forestry [10 M] • Write short notes on – (a) **Canopy architecture**, (b) Radiation absorption and energy balance in forest, (c) **Seed coating** and pelleting, (d) **Nutrient cycling** in natural forest [5 × 4 = 20 M]. • Write on tree species for smoke and dust pollution control. [*Linked Q* | P1/7 (c) (i) | 5 M]. • Mention 10 species (Scientific name) of trees tolerant to salinity [*Linked Q* | 10 M]. • What morphological, Anatomical, and physiological features are suited in **Xerophytic Plants**. [P**2**/Q6 (a) | 10 M]. • What are **Live Fences**? Name five plant species most commonly used as live fences. How do these differ from other types of fences? [P**2**/Q6 (c) | 10 M]. • How are **Ectomycorrhizal** fungi beneficial in managing soil borne diseases of forest nurseries? Give examples. [P**2**/Q7 (a) | 10 M]. • How do variation in density and quality of a forest influence annual yield estimation? [*Linked Q* | P**2**/1 (d) | 8 M]. • Illustrate the succession of mangrove vegetation in sea coast [P**2**/5 (e) | 8 M].

This module also covers questions from **Gujarat** PSC ACF/RFO (Main) 2024 (held on 28/01/2026), **Jharkhand** PSC RFO (Main) 2024 (held on 24/01/2026), **UKPSC** ACF/RFO/Logging Officer (Mains) 2025 (held on 26/11/2025), **Maharashtra** PSC ACF/RFO (Main) 2024 (held on 14/05/2025), and **Kerala** PSC RFO (Main) 2022 (held on 05/05/2025).

CHAPTER 1

FOREST FORESTRY & SILVICULTURE

Chapter Outline

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*.

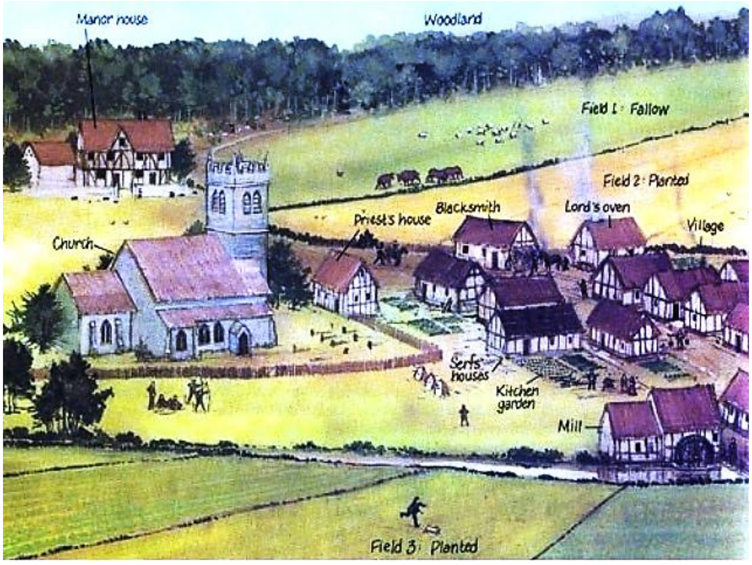


Figure 1.1 : A medieval European village

► 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].

- 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].

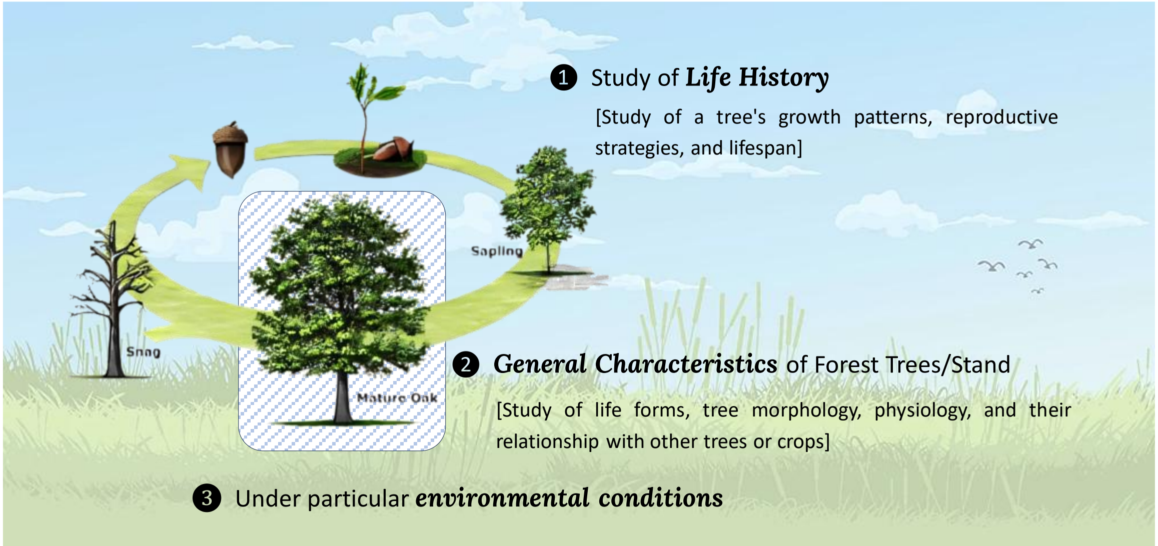
Forest may be classified on the basis of –

[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 & 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*].

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

> 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].

- **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.
- **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.
- *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*.

CHAPTER 2

Locality Factors

Chapter Outline

2.1 LOCALITY FACTORS

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

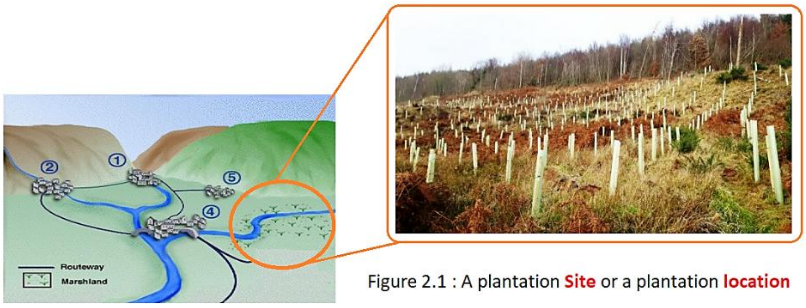


Figure 2.1 : A plantation **Site** or a plantation **location**

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.

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]

CHAPTER 3

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.

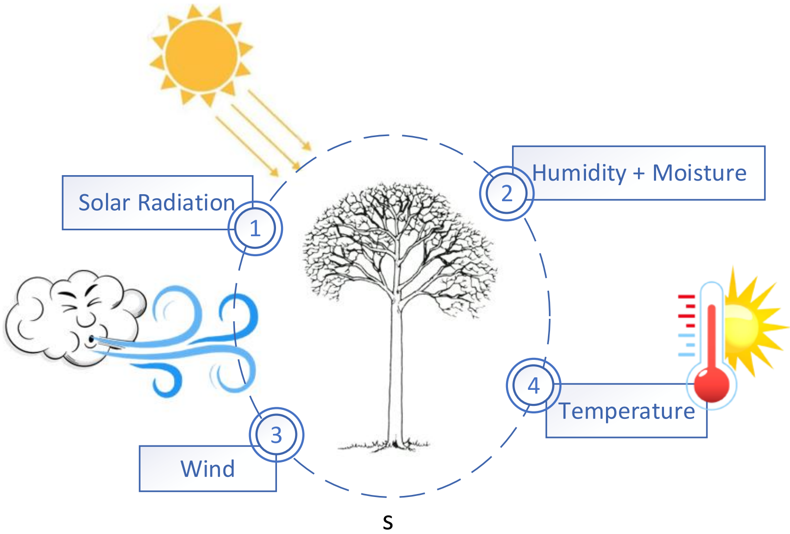


Figure 3.1 : Climatic factors

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 –

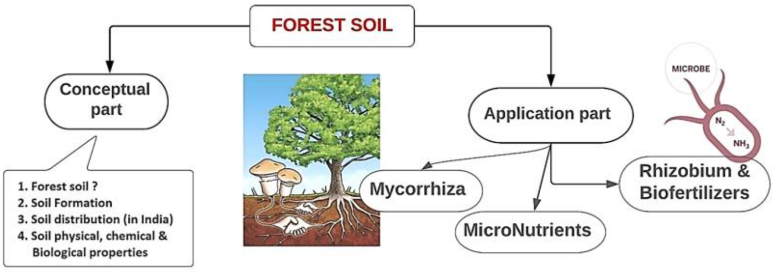
- *Essential for **basic metabolic activities*** like photosynthesis, transpiration, and the opening and closing of photoactive stomata.
- Light is crucial for the ***synthesis of chlorophyll molecules***. A prolonged absence of light results in the degeneration of chlorophyll, turning the leaves yellow—a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

Chapter Outline

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 -

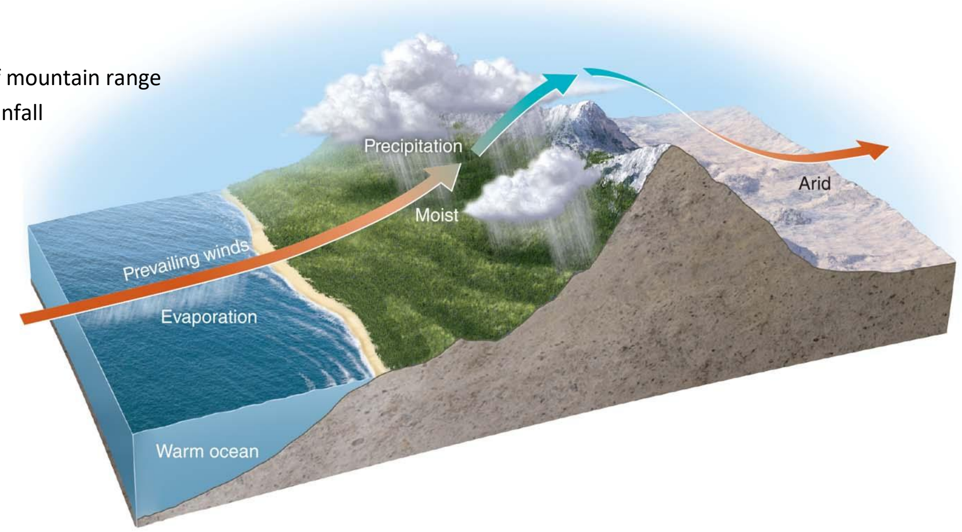
- Configuration or arrangement of the land surface, *i.e.,* hills & valleys
- Altitude
- Latitude
- Slopes
- Aspect & Exposure

Chapter Outline

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.

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



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 10

Forest Succession

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

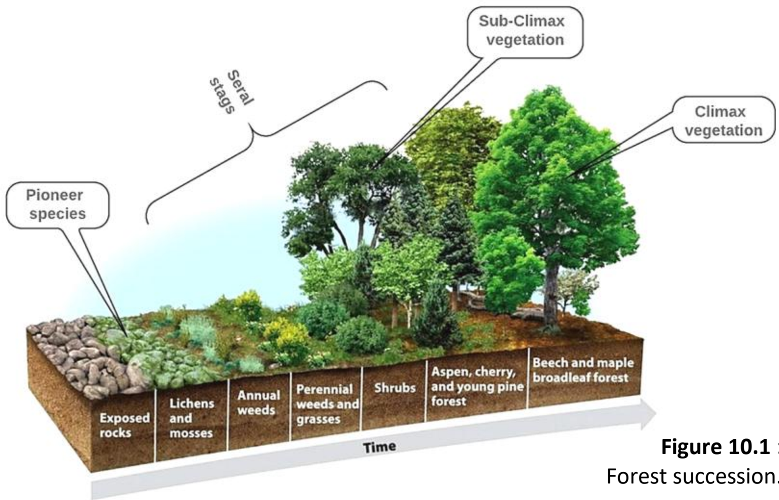


Figure 10.1 : Forest succession.

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.

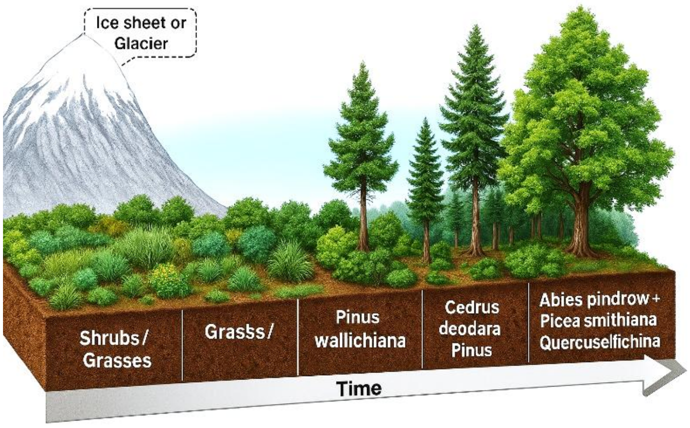
- **Climax Stage** – This is the final, mature, and stable community that can sustain itself over a long period while remaining in balance with the existing environmental conditions.
- **Succession** – The process of development and transition of vegetation from one stage to another (e.g., from grassland 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***.

Chapter Outline

10.4 VARIOUS TYPES OF PRIMARY SUCCESSION

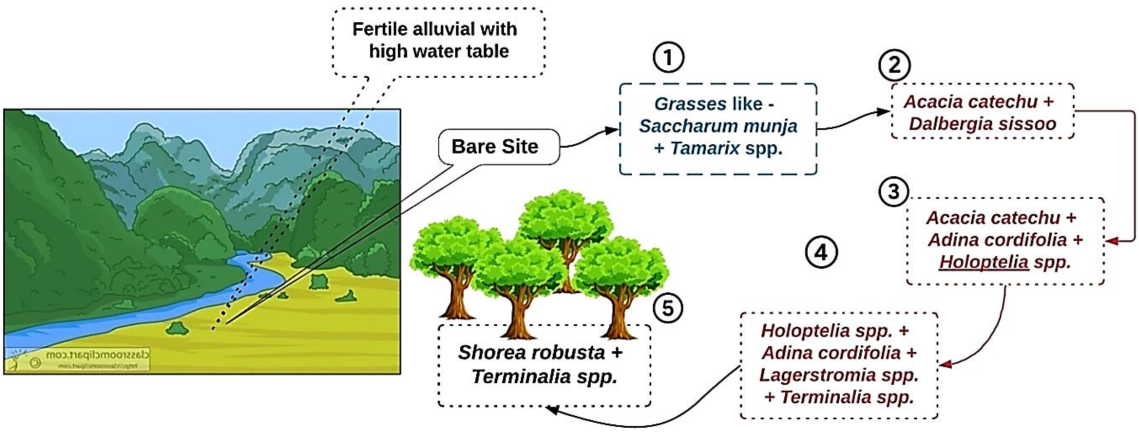
SUCCESSION IN MOUNTAIN TEMPERATE FOREST

In the temperate zone above 2400 m, in the landslips and landslides sites, the typical stages in succession are - (a) shrub associations, (b) *Pinus wallichiana*, (c) mixed coniferous forests of *Picea smithiana, Cedrus deodara,* and *Pinus wallichiana* and (d) the climax stage consisting of mixed forests of *Abies pindrow, Picea smithiana,* and *Quercus semecarpifolia.*



RIVERAIN SUCCESSION : Riverain succession in Gangetic-alluvium provides a typical example of primary succession. The pioneer species include *Saccharum, Tamarix*, etc. and climax stage is formed by Shorea and its associates. The approximate stages are following – (1) *Saccharum* + *Tamarix*, (2) *Acacia catechu* + *Dalbergia sissoo*, (3) *A. catechu* + *Holoptelea* + *Adina* + *Albizia*, (4) *Holoptelea* + Adina + *Lagerstromia* + *Bombax* + *Terminalia*, (5) *Adina* + *Lagerstroemia* + *Terminalia* + *Shorea*, (6) Shorea + Lagerstroemia + Terminalia + Adina , (7) Shorea + Terminalia.

In deep soils, *Trewia nudiflora* and *Toona ciliata* appear in stage 4 and *Terminalia alata* in stages 5 and 6 with *Syzygium* in the understorey.



IFoS 2011 : Describe the ***initial causes*** of ***secondary succession***. Write various *seral stages of succession leading to the development of Shorea robusta* (10 m).

- Describe the various causes responsible for primary and secondary plant succession. Also discuss the different stages of riverain succession [Himachal PSC Civil (Main) 2012| 30 m].

ESTUARINE SUCCESSION : The successional stages on the mudflats and tidal estuaries are exemplified in Sundarbans. The succession stages are : (i) *mangrove scrub*, (ii) *tree mangrove*, (iii) *slow-growing saltwater Heritiera*, (iv) *freshwater swamp forest* without Heritiera, and finally, (v) the *local climax vegetation* of evergreen forests.

CHAPTER 12

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.

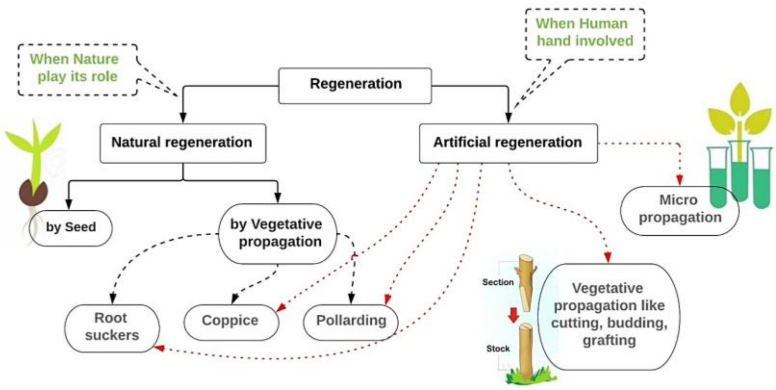


Figure 12.1 : Types of natural regeneration.

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

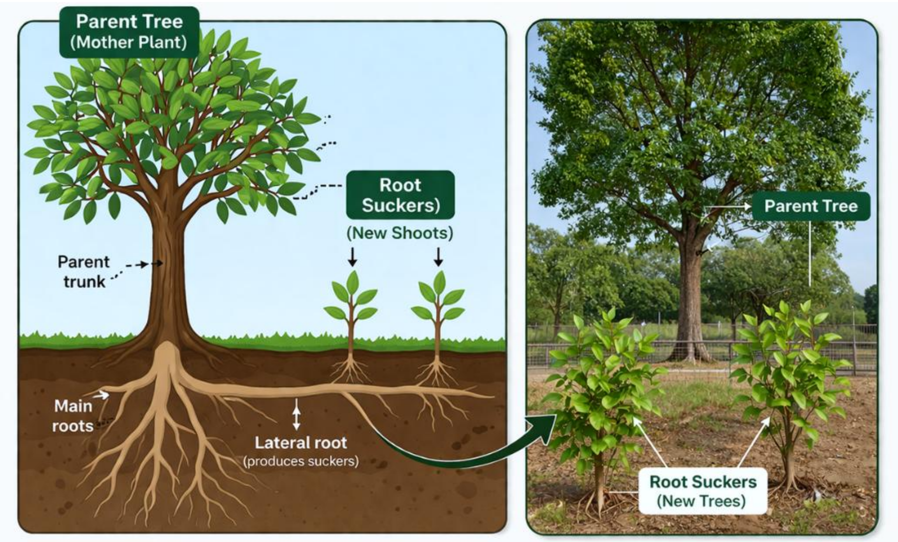
Strong coppicers	*Tectona grandis* (Teak), *Shorea robusta* (Sal), *Dalbergia sissoo* (Shisham), *Acacia catechu* (Khair), *Albizzia lebbeck* (Black siris), *Emblica officinalis* (Aaonla), *Eucalyptus globulus*, *Butea monosperma* (Dhak or Palash), *Diospyros melanoxylon* (Tendu), *Salix alba*, *Azadirachta indica* (Neem), *Prosopis juliflora* (Khejri), etc.

- Conifers : Non Coppicer
- Babool (A. nilotica) : Bad coppicer.

- **Season of coppicing** : It is best to coppice when there is a large reserve of food material in the roots so that all of it is utilized in the growth of coppice shoots. Delay affects the quality of coppice shoots. The *best season of coppicing is* **Feb-March** and not the monsoon. In places where there is late frost in spring, coppicing is done after the frost danger is over.
- **Age of Tree** : The younger saplings and poles give early and profuse coppice shoots, whereas the older 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.

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.

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.

Chapter Outline

STEPS (A review of this chapter)

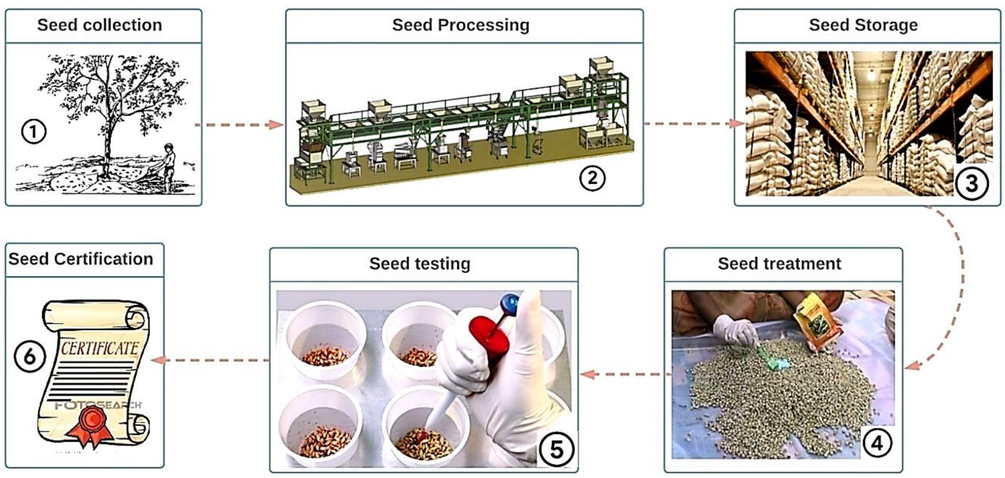


Figure 15.1 : basic steps in the seed collection process

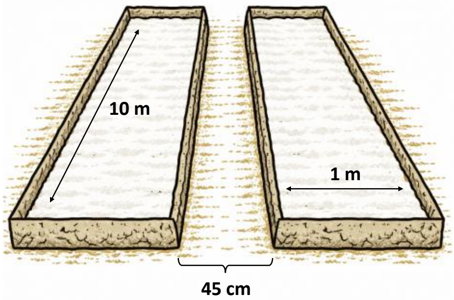
PREVIOUS YEAR QUESTION

IFoS 2011 : Explain the following points in relation to nursery management – (a) Site selection and layout, (b) Soil working, (c) ______, (d) ______, (e) ______. [4 × 5 = 20 M].

- Describe the essential features of a centralized nursery [BPSC (ACF) 2019-20].
- How will you select nursery site? _______? [Himachal PSC Civil (Main) 2020 | 10 M]
- Give diagrammatical representation of a forest nursery depicting different components [OPSC Civil (Main) 2016].
- Steps involved in establishment of a forest nursery [Mizoram PSC Civil (mains) 2018].
- What are the advantages of raising nursery? Discuss the layout and essential features of forest nursery [Himachal PSC Civil (Main) 2012].
- What are the important considerations for selection of nursery site? [MH PSC (ACF) 2012].
- What are the factors influencing selection of site for establishing a forest nursery [KN PSC (RFO) 2011]
- What are the factors to be kept in view while establishing a good forest nursery? Describe a schedule of operation to raise a good nursery [Himachal PSC Civil (Main) 2011| 30 M].

16.4 NURSERY BEDS or SEED BEDS

A seedbed or nursery bed is a specially prepared area in the nursery where seeds are sown and seedlings, transplants, or cuttings are raised for further planting.



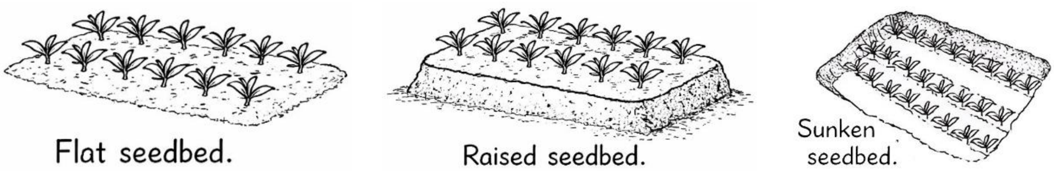
- **SIZE OF BED** : Rectangular-shaped beds are generally preferred, having a width of ***1–1.2 m*** and a length of ***10–12.2 m***. The width is kept limited so that weeding can be done from both sides without entering the bed.
- **TYPES OF BEDS** :
  - **Raised bed** : Used in *high rainfall areas*. These are prepared about *10–15 cm above* ground level with the support of bricks or stones. They are suitable for seeds that do not require excessive moisture.

    Advantages : good drainage, better aeration, and easy access for operations.
  - **Flat / Ground-Level beds** : Used in areas of *normal rainfall* (e.g., *Teak* plantations). The surface should be perfectly level or provided with a slight camber to facilitate drainage.
  - **Sunken beds** : Used in *dry localities* where water conservation is essential. These beds are prepared *10–30 cm below* ground level. The main objective is to prevent water loss and retain moisture within the bed.

Standard Size of Nursery Beds

- 10 m × 1 m
- 12.2 m × 1.2 m (40 ft × 4 ft)
- 12.5 m × 1.2 m (A typo error).

Based on their use, nursery beds can be further classified into : (a) ***Seedling beds*** : Used for raising seedlings directly from seeds. (b) ***Transplant beds*** : Seedlings are transferred here for further growth, hardening, and ease of transportation.



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

20.1 TENDING OPERATION ?

From the ***Seedling Stage*** to the ***Final Harvesting Stage***, various operations are carried out at different stages of the forest crop to ensure its healthy growth. Such operations, covering both the crop itself and the competing vegetation, are known as ***Tending Operations***.

Tending operations include ***Weeding***, ***Cleaning***, ***Thinning***, ***Improvement Fellings***, ***Pruning***, ***Climber Cutting***, and ***Girdling*** of unwanted growth.

However, tending does ***not include*** regeneration fellings or ground operations such as soil working, drainage, irrigation, and controlled burning.

CULTURAL OPERATIONS

Cultural operations are an "*operations, 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*"

Cultural operations include subsidiary felling, weeding, cleaning, unremunerative improvement fellings, thinning in groups of advance growth, girdling or poisoning of unwanted growth, climber cutting, piling of felling debris, and controlled burning. They are generally associated with silvicultural systems relying primarily on natural regeneration.

TENDING *v/s* CULTURAL OPERATIONS

Criterion	Tending	Cultural Operations
Definition	Operations for the ***benefit of a crop*** from ***seedling to mature stages***	Operations to ***assist regeneration*** and ***promote crop development***
Primary aim	Creating best possible growth conditions for the existing crop	Assisting natural regeneration.
Includes pruning?	Yes	Usually not
Includes controlled burning?	No	Yes
Includes regeneration?	No	No, but it helps in ***creating hygienic*** conditions conducive to proper crop growth
Scope	Focuses on crop and competing vegetation.	Includes ground operations and post-felling damage minimization

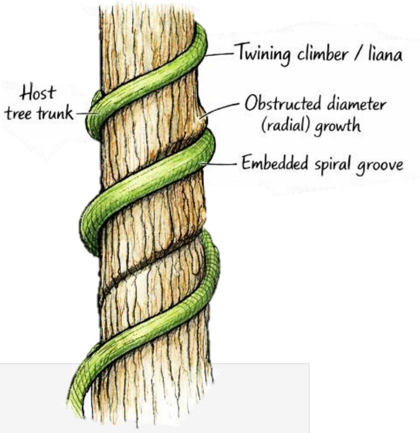
— Improve hygiene.

— regulating crop composition.

Season, Frequency, and Duration of Cleaning operations depend on the species, their growth behaviour, and the density of competing vegetation. They are generally carried out during the active growth period of the favoured species, preferably in the monsoon season. In dense and fast-growing shrub growth, cleaning may be annual; otherwise, it is done at intervals of a few years.

Criterion	Weeding	Cleaning
Stage of crop	Seedling stage***	Sapling stage***
What is removed	Only unwanted plant species (weeds)	Both unwanted species AND poorly performing individuals of desired species
Primary purpose	Reduce competition for moisture, light, nutrients; check insect/pest growth	Reduce light and root competition; regulate composition and structure of crop
Includes singling?	No	Yes (singling of coppice shoots)
Transition	Merges with cleaning as seedlings become saplings	Merges with thinning as saplings become poles
Example	Removing Lantana from Sal seedling areas	Removing Mallotus philippensis and Clerodendron from Sal sapling areas

20.4 CLIMBER CUTTING



Climber cutting is a tending operation involving the removal of lianas, vines, and woody climbers that make strongholds around tree trunks, particularly in old forests and moist deciduous forests.

To obtain Sal (Shorea robusta) regeneration in a moist Sal forest, climber cutting along with removal of *Mallotus philippensis* and *Clerodendron* was carried out as a key silvicultural measure.

PREVIOUS YEAR QUESTION

IFoS 2008 : Differentiate between ***Weeding*** and ***Cleaning*** in forest stands with suitable examples [10 M].

- Write objectives of : (1) Weeding (2) Cleaning [OPSC Civil (Main) 2020].
- Differentiate between Chemical and Biological weed control [Himachal PSC Civil (Main) 2018].

20.5 PRUNING

Pruning is the "*Selective removal of live or dead branches, shoots, or roots* from the standing trees for the *betterment or improvement of trees or their timber.*

In plantation forestry, pruning is a crucial tending operation because of its direct impact on the quality, health, and market value of the tree and its timber.

Aim / Purpose

- ***Improves Timber Quality*** : By removing lower branches early, the tree forms *clear*, *straight boles free from* ***knots*** and *defects* = Increases timber market value.
- ***Enhances Tree Health*** : Removal of diseased, dead, or pest-infested branches **reduces the risk of infections** and promotes overall tree vigour = balance crown + reduce structural weakness.

CHAPTER 21

PLANTATION FORESTRY

21.1 WHAT IS A FOREST PLANTATION?

A forest plantation is an *area of land*, typically *not less than one hectare*, *owned by the government* or *private* sector, upon which the owner *establishes and maintains* a forest crop that is usually *even-aged* and *single-species*. Unlike natural forests that develop over centuries through ecological succession, plantations are deliberately created by human intervention with specific objectives in mind.

Plantation Forestry has gained strategic importance globally because it offers the possibility of *growing and managing forests of high economic value and superior quality within predictable timeframes*. With advances in *tree breeding* and *clonal technology*, superior genotypes can now be mass-produced, making plantation forestry one of the most efficient methods of meeting the rising demand for wood-based products.

WHY DO WE NEED PLANTATION FORESTRY?

- ***Production Purpose*** – Meeting the ever-growing demand for timber, fuelwood, fodder, fibre, pulpwood, and other minor forest products. India's natural forests alone cannot sustain the extraction pressure from a population exceeding 1.4 billion. Plantations take this pressure off natural forests by creating dedicated production zones.
- ***Protection Purpose*** – Windbreaks in arid regions, shade trees in tea and coffee gardens (commonly Albizia spp.), shelterbelts along coastlines, and soil and water conservation plantings in degraded watersheds. These plantations serve ecological functions rather than direct commercial ones.
- ***Forest Enrichment and Epidemic Control*** – Monoculture natural forests are vulnerable to pest outbreaks. The devastating Sal heartwood borer (*Hoplocerambyx spinicornis*) attack of 1998 across Central India demonstrated the need for species-mixing through enrichment planting to build ecological resilience.
- ***Climate Adaptation*** – Climate change is altering temperature and rainfall patterns across forest zones, making natural regeneration unreliable for many species. Assisted migration and deliberate

Chapter Outline

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