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Module - 1

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

SILVICULTURE

Paper – 1 | Section – A

EDITION : 2026

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Gole ka mandir, Morar, Gwalior (MP) 474005

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],

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).

Module - 1

CONTENTS

UPPSC ACF/RFO (Main) | 2017 – 2021

▶ *Locality Factors*

Year	Questions
2021	वन वनस्पति की वृद्धि और विकास को प्रभावित करने वाले विभिन्न पारिस्थितिक और कार्यिकीय कारकों का वर्णन करें। Describe different ecological and physiological factors influencing growth and development of forest vegetation. [P1/2 | 40 M] निम्नलिखित को विस्तृत रूप से स्पष्ट कीजिए / Explain the following in detail — वेसिकुलर अर्बुस्कुलर माइकोराइजा I /Vesicular Arbuscular Mycorrhizae (VAM) [P1/8(e) | 8 M]
2019	वनों के प्राकृतिक पुनःसंचरण के लिए पारिस्थितिक तथा शरीरविज्ञानीय कारकों का वर्णन कीजिए। Describe ecological and physiological factors influencing natural regeneration of forests. [P1/2 | 40 M]

▶ *Forest Succession*

2020	पारिस्थिकी अनुक्रम तथा पराकाष्ठा से क्या तात्पर्य है? विभिन्न प्रकार की पराकाष्ठाओं का उदाहरण सहित वर्णन करें। What is meant by ecological succession and climax? Discuss various types of climaxes with examples [P2/6(a) | 20 M]
2017	पादपों में चरमोत्कर्ष की विभिन्न अवधारणाओं का वर्णन करें। इसके विभिन्न प्रकारों का उदाहरण सहित विवरण दें। Describe the various theories of climax in the plants. Write various climaxes with examples [P2/8(b) | 20 M]

▶ *Forest types & classification*

2021	चैम्पियन व सेठ के वर्गीकरण के अनुसार भारत में वनों के प्रकार को स्पष्ट करो। उत्तर प्रदेश राज्य में पाये जाने वाले वनों के उक्तानुसार वन प्रकारों का वर्णन करो। Explain the classification of Forests of India as per Champion and Seth's classification. Describe the forest types found in the Uttar Pradesh State as above classification [P2/7(a) | 20 M]
2019	"चैम्पियन और सेठ के द्वारा किये गये वनों का वर्गीकरण पारिस्थितिकी तन्त्र पर आधारित है", व्याख्या करें। उक्त वर्गीकरण के अनुसार उत्तर प्रदेश में पाये जाने वाले वनों की विस्तृत सूची बनाएं। 'Classification of forests by Champion and Seth is based on ecological system', explain. Give detailed list of forests found in Uttar Pradesh based on this classification [P2/4(b) | 20 M]
2018	निम्नलिखित के बीच अंतर लिखें – उष्णकटिबंधीय और तटीय वनस्पति Differentiate between the following – Tropical and coastal vegetation [P1/4(c) | 4 M]

▶ *Natural & artificial regeneration*

2021	अवधि खण्ड में पुनर्जनन की लंबाई के लिए जिम्मेदार कारक। Factors responsible for length of regeneration in a periodic block [P1/1(a) | 8 M]
2018	निम्नलिखित के बीच अंतर लिखें – प्राकृतिक एवं कृत्रिम पुनर्जनन Differentiate between the following – Natural and artificial regeneration [P1/4(a) | 4 M]

▶ *Seed technology*

2021	• निम्नलिखित पर संक्षिप्त टिप्पणी लिखिए – अनैच्छिक और रूढ़िवादी बीज। Write a short note on the following – Recalcitrant and orthodox seeds [P1/1(d) | 8 M] • बीज उद्यान क्या है? बीज उद्यान कितने प्रकार के पाए जाते हैं? बीज उद्यानों के प्रबंधन के लिए इनकी स्थापना से पहले और बाद के विभिन्न पहलुओं का वर्णन करें। What is seed orchard? How many types of seed orchards are found? Describe different aspects

	of prior and after establishment of seed orchards for its management. [P1/6 | 40 M]
2020	निम्नलिखित को विस्तृत रूप से स्पष्ट कीजिए : बीज उत्पादन क्षेत्र। Explain the following in detail : Seed Production Area [P1/8(b) | 8 M]
2019	निम्नलिखित के बीच अंतर करें (अधिकतम 5 बिन्दु अथवा 5 पंक्तियाँ) : बीज स्त्रोत बनाम बीज उद्गम क्षेत्र Differentiate between the following (Maximum 5 points or 5 lines) : Seed source v/s provenance [P1/5(d) | 8 M]
2018	• निम्नलिखित पर संक्षिप्त नोट लिखें : हवाई बीजारोपण। Write brief notes on the following : Aerial seeding [P1/1(e) | 5 M] • सहजन (मोरिंगा ओलेईफेरा) की कृंतक बीज उद्यान की स्थापना की विधि का वर्णन करें। Write down the procedure for establishment of clonal orchard of Sahjan (*Moringa Oleifera*) [P2/5(a) | 5 M]

▶ ***Forest Nursery & Vegetative propagation***

2021	निम्नलिखित पर संक्षिप्त टिप्पणी लिखिए : गुणवत्तापूर्ण रोपण स्टॉक के लिए आधुनिक नर्सरी तकनीकें। Write a short note on the following : Modern nursery techniques for quality planting stock [P1/1(b) | 8 M]
2020	निम्नलिखित पर संक्षिप्त टिप्पणी लिखिए / Write a short note on the following — पौधशाला के प्रकार / Types of nurseries [P1/1(c) | 8 M] — विभिन्न प्रकार के वानस्पतिक जनन / Different types of vegetative propagation [P1/1(d) | 8 M]
2019	निम्नलिखित पर संक्षिप्त टिप्पणी लिखिए / Write a short note on the following — पौध का श्रेणीकरण का मानदण्ड / Criteria for grading of Seedlings [P1/1(b) | 8 M] — जल लेखांकन / Water budgeting [P1/1(c) | 8 M] — कलम बाँधना / Grafting [P1/1(a) | 8 M] निम्नलिखित के बीच अंतर करें / Differentiate between the following — धसी नर्सरी क्यारी एवं उभरी नर्सरी क्यारी / Sunken nursery bed and raised nursery bed [P1/4(a) | 10 M] — नंगी जड़ पौध एवं पौली बैग पौध / Bare-root seedlings and polybag seedlings [P1/4(d) | 10 M]
2018	निम्नलिखित पर संक्षिप्त नोट लिखें / Write brief notes on the following — कोमल पौधों का दृढ़ीकरण / Hardening of seedlings [P1/1(d) | 5 M] निम्नलिखित के बीच अंतर करें / Differentiate between the following — बीज क्यारी और पौधशाला क्यारी / Seed bed and nursery bed [P1/4(b) | 4 M]
2017	निम्न के लाभ बताइए / Describe the benefits of the following: — प्लास्टिक थैली पौध / Poly bag planting material [P1/1(a) | 5 M] — पौध का श्रेणीकरण / Grading of planting material [P1/1(b) | 5 M] — कायिक प्रवर्धन (वेजिटेटिव प्रोपागेशन) / Vegetative propagation [P1/1(c) | 5 M] — ग्राफ्टिंग (कलम बाँधना) / Grafting [P1/1(d) | 5 M] — रोपण क्यारियाँ / Nursery beds [P1/1(e) | 5 M] निम्न में अन्तर बताइए / Differentiate between the following — बीजू पौध एवं कलम पौध / Seedling and grafted plant [P1/4(b) | 4 M]

▶ ***Sowing and Planting***

2021	• निम्नलिखित के मध्य अन्तर कीजिए / Differentiate between the following

	— वर्ग रोपण एवं त्रिकोणीय रोपण। / Square planting and triangular planting [P1/4(d) | 10 M] • वन कक्ष, वन ब्लाक, कक्ष इतिहास, कार्य योजना वृत एवं वृक्षारोपण कूप से आप क्या समझते हैं? विस्तार से वर्णन करो। / What do you mean by forest compartment, forest block, compartment history, working plan circle and plantation coupe? Describe in detail [P2/4(a) | 20 M]
2020	• निम्नलिखित के मध्य अन्तर कीजिए / Differentiate between the following — पुनर्वनीकरण एवं वनीकरण। / Reforestation and Afforestation [P1/4(a) | 10 M] — नम जड़ रोपण एवं ढूँठ रोपण (स्टंप रोपण)। / Bare root planting and stump planting [P1/4(b) | 10 M] — वर्ग रोपण एवं त्रिकोणीय रोपण। / Square planting and triangular planting [P1/4(c) | 10 M] • औद्योगिक वृक्षारोपण क्या है? वनों के संरक्षण में इसके महत्व को स्पष्ट करें। यह प्राकृतिक वन से कैसे अलग होता है? What is an Industrial plantation? Explain its importance in forest conservation. How is it different from a natural forest? [P2/1(c) | 8 M] • किसी वृक्षारोपण की सफलता को सीमित करने वाले क्या कारक हैं? वन वृक्षारोपण की सफलता सुनिश्चित करने के लिए क्या उपाय आवश्यक हैं? What are the limiting factors for the success of a plantation? What are the methods used for ensuring the success of a forest plantation? [P2/4(a) | 20 M]
2019	निम्नलिखित पर संक्षिप्त टिप्पणी लिखिए / Write brief notes on the following — वृक्षारोपण के लिए प्रजाति चयन के कारक / Factors deciding choice of species in plantations [P1/1(e) | 8 M]
2018	निम्नलिखित पर संक्षिप्त टिप्पणी लिखिए / Write brief notes on the following — रोपण तकनीक / Planting technique [P1/1(a) | 5 M] — समृद्ध रोपण / Enrichment planting [P1/1(b) | 5 M]
2017	• निम्न के तकनीकी व्योरों एवं लाभों का वर्णन कीजिए / Describe the technical details and benefits of the following — वृक्षारोपण वनवर्धन / Plantation silviculture [P1/3(b) | 4 M] • आवर्तन की परिभाषा लिखें तथा विभिन्न आवर्तनों का वर्णन करें। पथ वृक्षारोपणों के आवर्तन चयन में आप क्या प्राथमिकता देंगे? Define rotation and describe various kinds of rotation. Which preference will be given by you in selection of rotation for roadside plantations? [P2/4(a) | 20 M]

▶ ***Tending Operations***

2021	निम्नलिखित के मध्य अन्तर कीजिए / Differentiate between the following — गर्डिलिंग और पोलार्डिंग। / Girdling and pollarding [P1/4(b) | 10 M]
2020	निम्नलिखित पर संक्षिप्त टिप्पणी लिखिए / Write short notes on the following — वानिकी में रख रखाव। / Tending in forestry [P1/1(a) | 8 M] विरलन क्या है? विभिन्न प्रकार के विरलन का वर्णन कीजिए। What is thinning? Describe various types of thinning. [P1/2 | 40 M]
2017	निम्न के तकनीकी व्योरों एवं लाभों का वर्णन कीजिए / Describe the technical details and benefits of the following — विरलन / Thinning [P1/3(c) | 4 M]

▶ ***Others***

2018	निम्नलिखित पर संक्षिप्त नोट लिखें / Write brief notes on the following — उष्णकटिबंधीय वन-संवर्धन अनुसंधान में प्रगति / Advances in tropical silvicultural research [P1/3(c) | 4 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*.

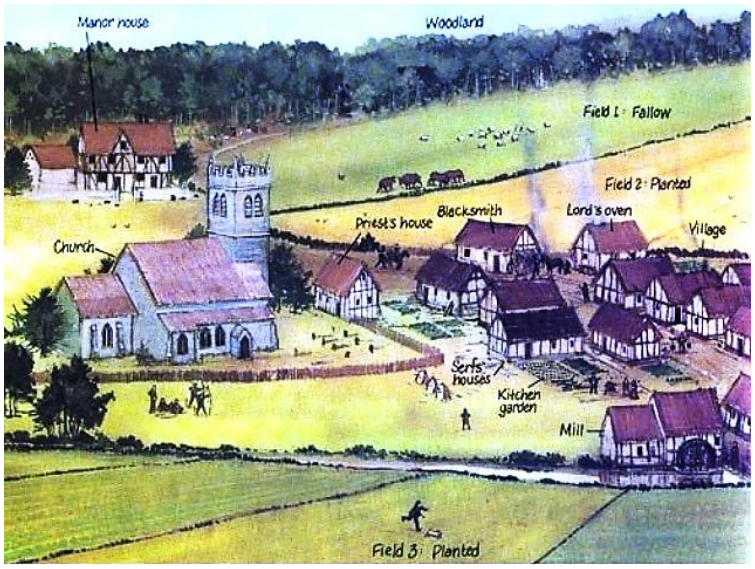
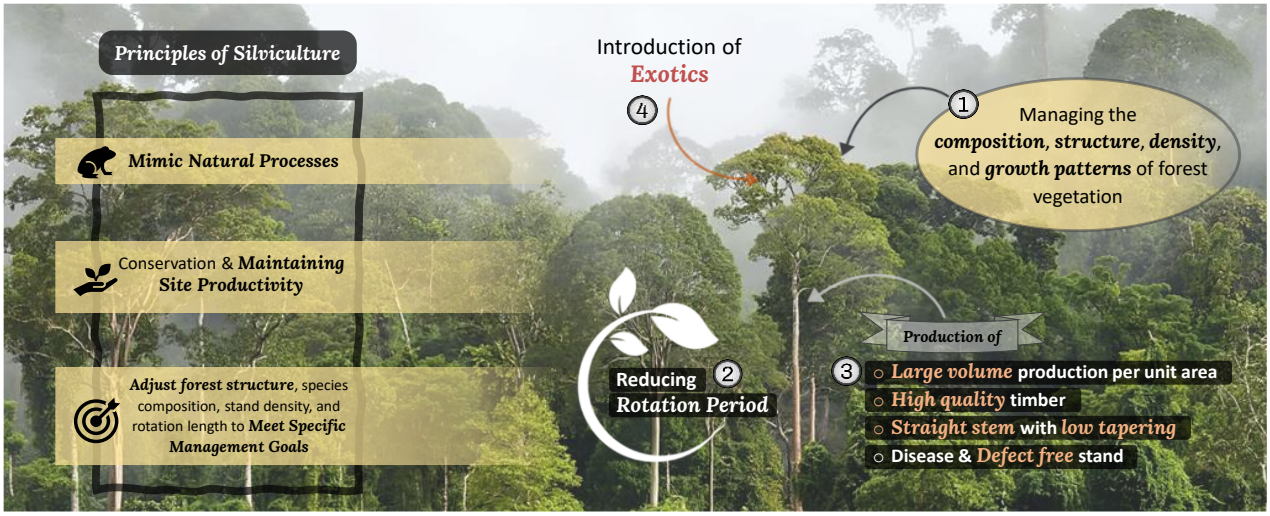


Figure 1.1 : A medieval European village

► 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



SILVICS & SILVICULTURE : TWO SIDES OF THE SAME COIN

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

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

Application

- Silvics guides forest managers in selecting suitable species for ecological restoration based on ecological factors like soil type, moisture, and shade tolerance.
- Understanding tree growth rates and regeneration characteristics ensures sustainable timber harvesting schedules.
- Silvics teaches us that different tree species have varying tolerances to shade. This knowledge is applied in the shelterwood regeneration method, where the amount of light reaching the understory is carefully managed to promote the growth of desired species. For example, if a forester wants to regenerate a stand with a shade-tolerant species like *Abies pindrow*, or *Santalum album* they would leave a denser overstory to create the necessary shade conditions [*Crucial for successful regeneration*].
- Silvicultural practices like thinning, pruning, and fertilization are based on an understanding of how trees grow and respond to different treatments. Silvics helps determine the timing and intensity of these operations to optimize growth and health.
- Silvics helps in understanding the ecological roles of different tree species and how they interact with other components of the forest ecosystem. This knowledge is critical for managing forests to maintain biodiversity and ecosystem services. promote carbon sequestration + making forest climatically more resilient.

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CHAPTER 2

LOCALITY FACTORS

2.1 LOCALITY FACTORS

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

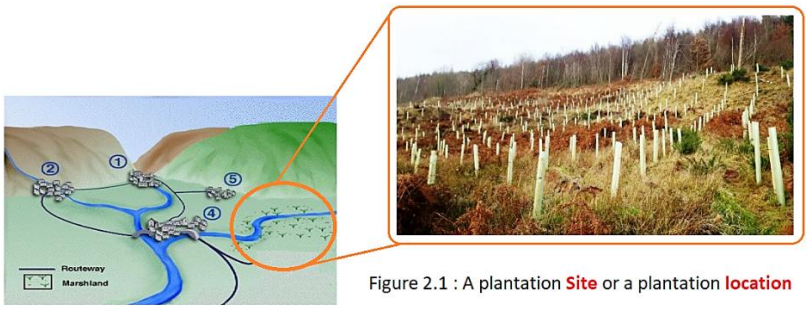


Figure 2.1 : A plantation **Site** or a plantation **location**

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]

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.

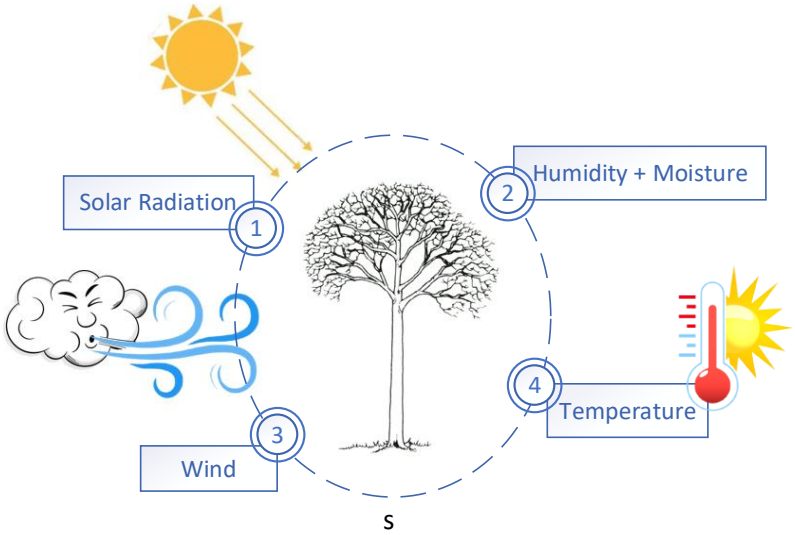


Figure 3.1 : Climatic factors

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 –

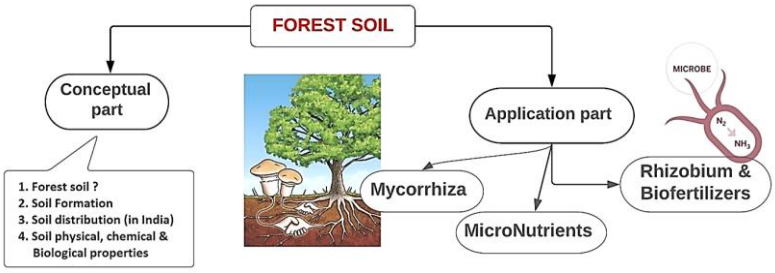
- *Essential for* ***basic metabolic activities*** like photosynthesis, transpiration, and the opening and closing of photoactive stomata.
- Light is crucial for the ***synthesis of chlorophyll molecules***. A prolonged absence of light results in the degeneration of chlorophyll, turning the leaves yellow—a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

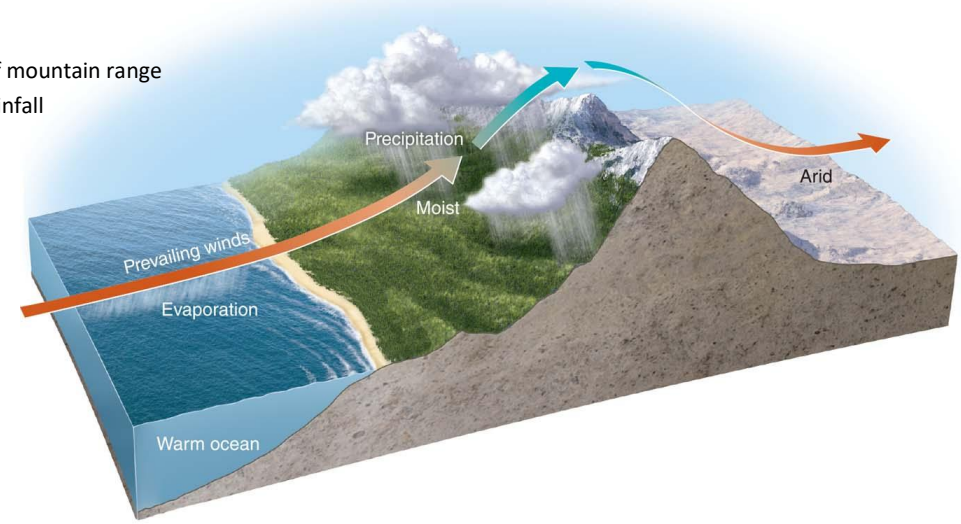


Figure 5.1 : Effect of mountain range on the pattern of rainfall

CHAPTER

7

INFLUENCE OF FOREST ON THEIR ENVIRONMENT

Climate is the average weather prevalent in any locality that influences

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

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

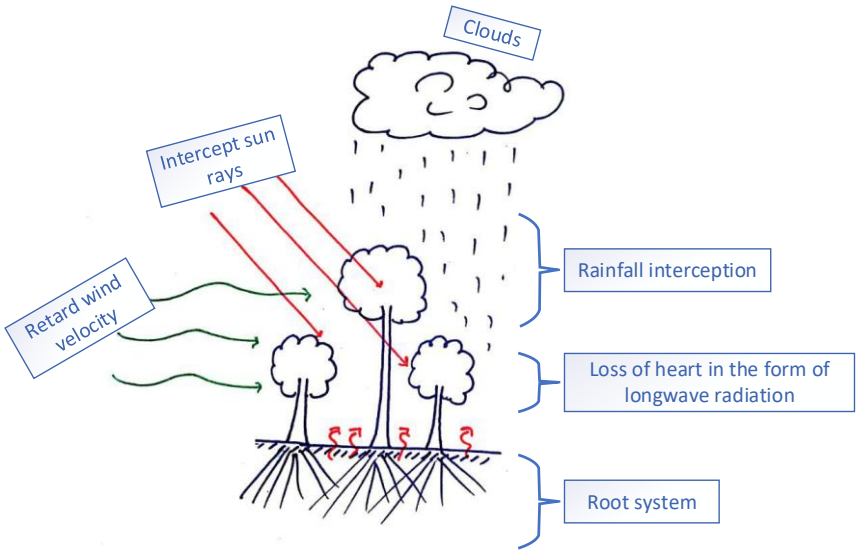


Figure 7.1 : influence of forests on their environment.

7.1 EFFECT OF FORESTS ON THEIR CLIMATIC FACTORS

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

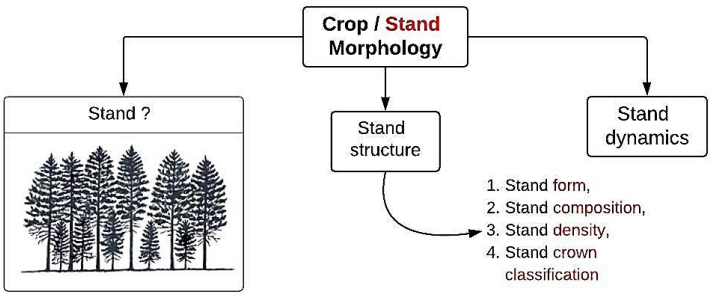
- Deflecting a significant part of it upwards
- Production of turbulence & slowing down the wind that entered the forest.

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

CHAPTER 9

FOREST CROP MORPHOLOGY

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



9.1 STAND ?

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

Stand *v/s* Forest

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

9.2 STAND STRUCTURE

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

Chapter Outline

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.

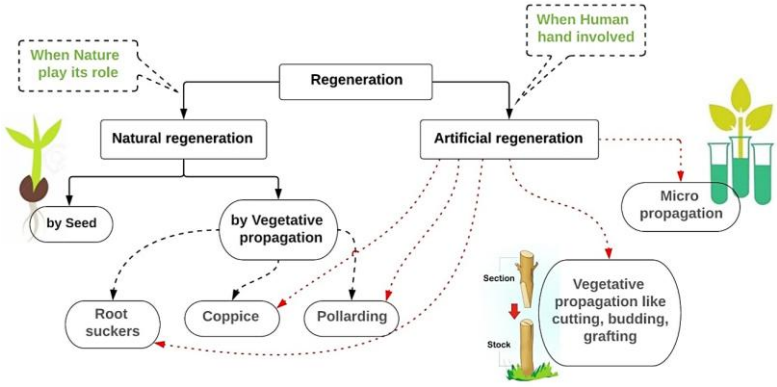


Figure 12.1 : Types of natural regeneration.

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

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 16

FOREST NURSERY

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

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

16.1 IMPORTANCE OF NURSERY?

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

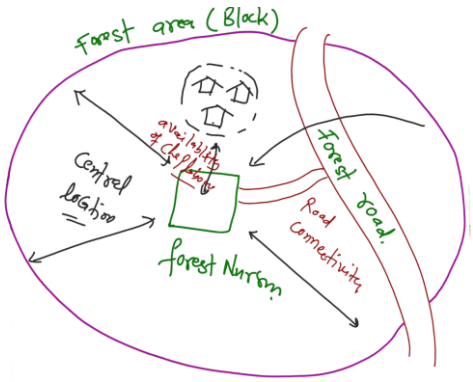
- Several species exhibit *slow initial growth* and are therefore liable to be *swamped by weeds* if sown directly in the field; in contrast, nursery-raised seedlings, being larger and more vigorous at the time of planting, are better able to withstand competition and adverse site conditions, thereby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

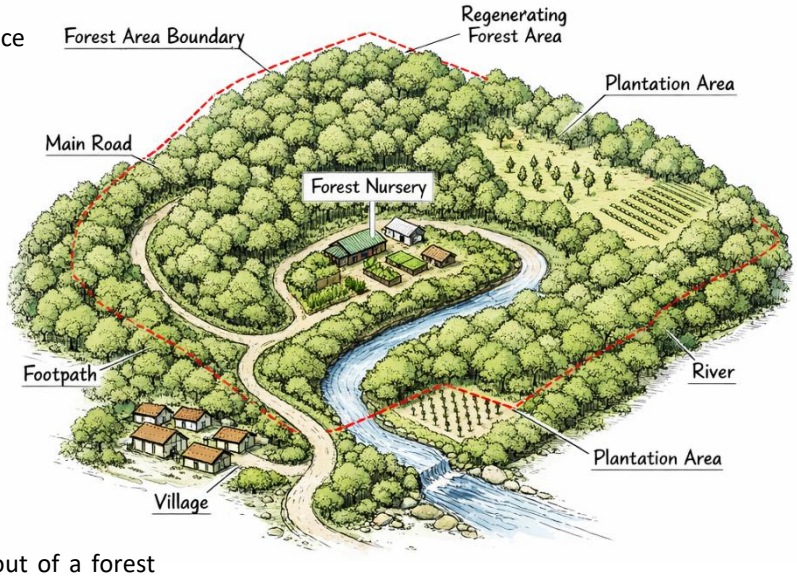
Chapter Outline

- ***Central location*** & ***Accessibility***
  - The nursery should be centrally located with reference to plantation areas to minimize transportation costs and time while distributing seedlings.
  - It should be close to a source of labour supply for timely operations.
  - The area should be easily accessible by road or located near a Ranger's or Forester's quarter for close and regular supervision.
- ***Soil Requirements*** : The soil should be well-drained, sandy loam, rich in nutrients and humus, slightly acidic (6.5–7.5) to neutral in reaction, and free from injurious salts and chemicals.
- ***Water Availability*** : The selection of a nursery site is greatly influenced by the availability and quality of water. The water should be free from excessive salts and alkalinity. Therefore, the nursery should preferably be situated near or slightly below the source of an adequate water supply.
- ***Topography & Aspect*** : In hills, a flat or gently sloping site (not exceeding 5°) is ideal. Flat terrain simplifies nursery layout and irrigation, while gentle slopes aid in drainage. Steep or undulating terrain should be avoided, as it increases the need for costly levelling or terracing.

  In hills, both altitude and aspect are important in the selection of a site for the nursery. In the Aravalli region, the eastern aspect should be preferred. Also, as far as possible, nursery sites should be selected within the species' altitudinal limit.
- Availability of ***skilled and unskilled labour***.
- ***Vegetation*** : The nursery site should not be very densely wooded. At the same time, it should not be completely devoid of trees. There should be enough trees along the boundary and a few scattered within the nursery to protect the seedlings from cold, hot sun, and strong winds.
- A site should be selected with minimum risk of ***Soil-borne diseases***.

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





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

Main Components

— **Fencing** : All permanent nurseries must be properly fenced with cattle-proof or game-proof fence. In dry areas, a line of small trees or shrubs (e.g., *Acacia nilotica*, *Prosopis cineraria*) about 4–5 m high may also be raised along the fence to protect against desiccating hot winds and reduce wind erosion.

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

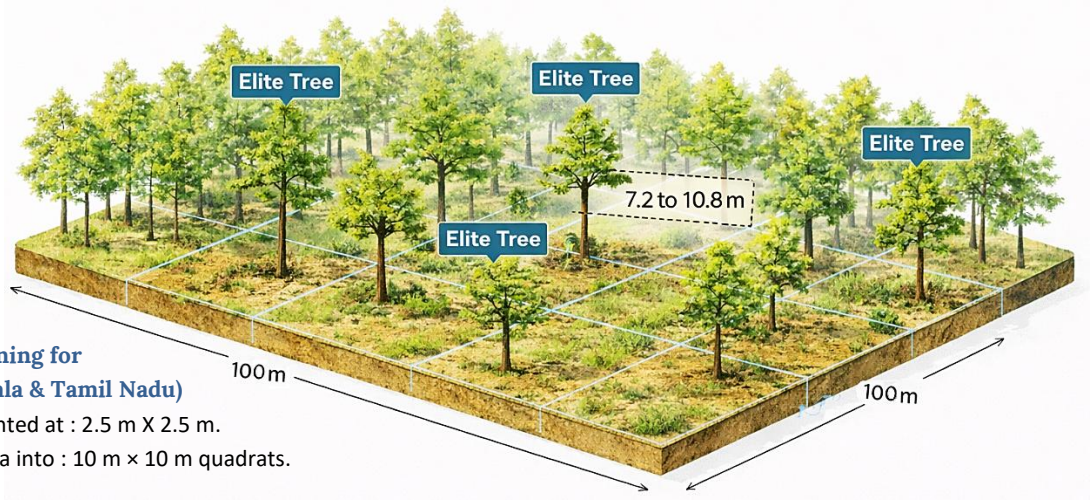
Cultural operations are an "*operations, as a rule not directly remunerative, undertaken to assist or complete existing regeneration, to promote the proper development of the crop, or to minimize the after-effects of felling damage*"

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

Chapter Outline



Elite Thinning for Teak (Kerala & Tamil Nadu)
Initially planted at : 2.5 m X 2.5 m.
Divided area into : 10 m × 10 m quadrats.

DISADVANTAGES

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

MAXIMUM THINNING

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

The basic principle behind this method is that the total potential increment of the stand should be transferred, as far as possible, to the retained trees. When too many trees remain in a stand, each tree receives only a small share of the available resources, and much of the increment is distributed among numerous small or suppressed stems. In maximum thinning, these extra stems are removed early, so that the retained trees receive a greater share of the increment and grow faster in diameter and volume.

Thus, this thinning method emphasizes number rather than merely the condition or class of trees. The stand is thinned to a low density from an early age, retaining only those trees that are sufficient to occupy the growing space effectively. The retained trees are expected to expand their crowns and root systems and utilize the site fully without excessive competition.

- Developed by ***Gehrhardt*** as a modification of Heck's free thinning.

(E) | ADVANCE THINNING

- Also known as ***Craib's thinning*** = Developed by Craib & O'Connor.
- It differs from all other methods described above as *thinning is carried out before the competition among individual trees has set in.* The surplus individuals are taken out regularly to remove the unnecessary competition from the residual ones.
- Application : Advance thinning was tried for Sal, teak, and Chir-pine stands.

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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