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INDIAN FOREST SERVICE (MAIN) EXAM

FORESTRY

MODULE - 3

EDITION : 2025

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SYLLABUS

- **TRIBOLOGY** : Tribal scene in India; tribes, the concept of races, Principles of social grouping, stages of tribal economy, education, cultural tradition, customs, ethos and participation in forestry programs.
- **JFM** : Details of steps involved such as the formation of Village Forest Committees, Joint Forest Participatory Management. Principles, objectives, methodology, scope, benefits and role of NGOs.
- **ENVIRONMENTAL CONSERVATION AND BIODIVERSITY**

  Environment - components and importance, principles of conservation, impact of deforestation; forest fires and various human activities like mining, construction and developmental projects, population growth on environment.

  Pollution - types, global warming, greenhouse effects, ozone layer depletion, acid rain, impact and control measures, environmental monitoring; concept of sustainable development. Role of trees and forests in environmental conservation; control and prevention of air, water and noise pollution. Environmental policy and legislation in India. Environmental Impact Assessment. Economics assessment of watershed development *vis-a-vis* ecological and environmental protection
- **TREE IMPROVEMENT AND SEED TECHNOLOGY** : General concept of tree improvement, methods and techniques, variation and its use, provenance, seed source, exotics; quantitative aspects of forest tree improvement, seed production and seed orchards, progeny tests, use of tree improvement in natural forest and stand improvement, genetic testing programming, selection and breeding for resistance to diseases, insects, and adverse environment; the genetic base, forest genetic resources and gene conservation in situ and ex-situ. Cost benefit ratio, economic evaluation.
- **FORESTS SOILS** : Classification, factors affecting soil formation; physical, chemical and biological properties.
- **SOIL CONSERVATION** : Definition, causes for erosion; types – wind and water erosion; conservation and management of eroded soils/areas, wind breaks, shelter belts; sand dunes; reclamation of saline and alkaline soils, water logged and other waste lands. Role of forests in conserving soils. Maintenance and build-up of soil organic matter, provision of lopping's for green leaf manuring; forest leaf litter and composting; Role of micro-organisms in ameliorating soils; N and C cycles, VAM.
- **WATERSHED MANAGEMENT** : Concepts of the watershed; the role of mini-forests and forest trees in overall resource management, forest hydrology, watershed development in respect of torrent control, river channel stabilization, avalanche and landslide controls, rehabilitation of degraded areas; hilly and mountain areas; watershed management and environmental functions of forests; water-harvesting and conservation; groundwater recharge and watershed management; the role of integrating forest trees, horticultural crops, field crops, grass, and fodders.

Module - 3

CONTENTS

TRIBOLOGY

2023	• Enlist the ***Problems Faced*** by the tribal communities in India [P1/7(a) | 10 M].
2015	• Enumerate and discuss the ***factors responsible for restricting*** tribal population in the national parks [P**2**/8(c) | 10 M].
2014	• ***Name*** different tribes of India ***State-Wise*** and their specific ***Characteristics***. How can we make use of their ***Traditional Knowledge*** in forest conservation (flora and fauna) ? [P1/8(a) | 20 M].
2013	• Give the fundamental ***Characteristics*** of the tribal economy in India [P1/5(b) | 8 M].
2011	• Write short notes on (i) Tribal economy, (ii) Chola Naickans, (iii) Gujjars, (iv) Gonds [P1/5(b) | 10 M]. • Discuss the ***Characteristics*** which are shared by the diverse tribal groups all over India [P1/6(d) | 10 M].
2010	• How can we make use of the ***Traditional Knowledge*** of the major tribes of India in forest conservation (both flora and fauna) ? [*Linked Q* | P1/1(b) *i* | 10 M].

JOINT FOREST MANAGEMENT (JFM)

2024	• Elucidate the impact of ***Joint Forest Management*** on the conservation of natural forests and improvement of rural environment [P1/7(c) | 10 M]. • What is ***Eco-Development Committee*** (EDC)? Explain its role in forest conservation and mitigation of human-wildlife conflict [P**2**/3(c) | 10 M].
2023	• Write a note on the gender issues in Joint Forest Management (JFM). [P1/5(d) | 8 M]. • What is ***Village Forest Committee***? Explain its role in forest management. [P**2**/2(c) | 10 M].
2022	• "Participatory Forest Management is a success". Illustrate with examples [P**2**/4(c) | 10 M].
2021	• How do the ***Ownership Rights*** of forests ***Influence the Success*** of joint forest management? [P1/5(b) | 8 M].
2020	• How does collaborative forest management ensure community and household resilience? [*Linked Q* | P2/1(c) | 8 M].
2019	• Why are ***Participatory Rural Appraisal*** (PRA) techniques important for planning and execution of Joint Forest management (JFM) Activities? Explain the ***tools and techniques of PRA***. [P1/6(a) | 15 M].
2018	• Explain the environmental and economic role of community forestry in India [P1/5(d) | 8 M]. • What are the ***Objectives*** of Joint Forest Management (JFM)? Give ***Methods*** used for preserving forest resources through JFM [P**2**/7(b) | 15 M].
2017	• Write in detail as to why the Joint Forest Management Policy was initiated and what are its

	Constraints in implementation? [P**2**/4(b) | 15 M].
2016	• Trace the ***History of JFM*** in India, narrate any one success story with details [P**2**/3(a) | 15 M]. • Describe the role of ***Corporate Social Responsibility*** (CSR) towards sustainable forest production through Public-Private Partnership (PPP) approach [P**2**/8(a) | 10 M].
2014	• Introduction of JFM in various states in India was found ***Positive in biodiversity conservation***, discuss in details. [P**2**/1(d) | 8 M].
2013	• Describe constitution of ***JFM Network*** by MOEF, GOI with its terms of reference [P**2**/4(b) | 7 M]. • What entry point activities are recommended in joint forest management? [P1/5(d) | 8 M].
2012	• What shifts in attitude among Forest Personnel from the present are required for better success of Joint Forest Management? Discuss [P**2**/4(c) | 10 M].
2010	• How can we make use of the traditional knowledge of the major tribes of India in forest conservation (both flora and fauna) ? [P1/6(b) *ii* | 8 M]. • How can NGOs, Schools, Banks and Industry help to carry out an afforestation programme? [P1/8(c) | 20 M].

POLLUTION, CLIMATE CHANGE & ENVIRONMENTAL CONSERVATION

2024	• What is the ***Greenhouse Effect***? Define it. Describe in detail, accounts of its causes, sources and environmental impact [P1/5(e) | 8 M]. • Explain the concept of ***Sustainable Development*** of forests. How is it associated with the biodiversity, forest ecosystem conservation and forest ecosystem health? [P1/6(c) | 15 M]. • Critically analyse the impact of mining, construction projects and human population on ***Environmental Degradation***. Analyse comparatively the management practices followed in India and China [P1/b) | 15 M].
2023	• ***Greenhouse Gases*** result in global warming. Discuss [P1/5(e) | 8 M]. • What is ***Environmental Impact Assessment*** (EIA)? Describe the activities involved and general procedure in EIA [P1/8(c) | 15 M]. • Write on ***Carbon Sequestration*** and discuss the role of afforestation in absorptions of carbon dioxide (CO_2) from atmosphere [P1/6(c) | 10 M]. • Write the components of vehicular air pollution and list the damages caused to roadside trees. [P**2**/5(c) | 8 M]. • What is deforestation? Discuss the impact of deforestation on the environment [*Linked Q* | P1/6(c) | 15 M].
2022	• How do tree and shrub mass influence the mitigation of ***Particulate Matter*** and noise in urban settings? [P1/6(c) | 10 M].
2021	• What is the ***relationship between air pollutants and climate change***? How does forest vegetation abate different types of pollutants? Describe Air (Prevention and Control of

	small water reservoir [P1/6(d) | 5 M].
2011	• Explain the various applications of geo-textiles for soil conservation [P1/5(c) | 10 M]. • Write short notes on – (ii) ***Riparian Buffer*** [P1/7(c)ii | 2½ M]. • Discuss the factors to be considered for efficient ***Recycling of Harvested Water*** [P1/8(d) | 10 M]. • Discuss strategies and plans adopted for the treatment of catchment areas [*Linked Q* | P**2**/3(b) | 10 M].

AFFORESTATION OF DIFFICULT SITES

2024	• Describe in brief the types of forest soils existing under diverse ecological zones. Suggest suitable techniques for the conservation measures followed under ravines, water logged, hot deserts and coastal areas [P1/8(b) | 10 M]. • Explain the concept of soil biological fertility. Suggest a suitable plan for the restoration of soil biological fertility through the use of eco-friendly sources [P1/8(c) | 15 M]. • Briefly describe the current scenario of the ***Saline*** and ***Alkaline Soils*** in India. Draw a management plan using suitable plant species [P1/5(b) | 8 M].
2023	• How does moisture influence the soil formation and growth of vegetation? [P1/5(c) | 8 M]. • Explain the theory of humus formation predominant in forested vegetation [P1/6(b) | 10 M].
2022	• How does C: N ratio of plant residue in soil influence the rate of decomposition and nitrogen availability to plants? [P1/5(d) | 8 M]. • Give a detailed profile of a soil showing various zones and explain the function of each soil zone [P1/7(c) | 10 M]. • Explain the principles of ***Bioengineering*** measures for soil and water conservation. Write in brief four common bioengineering techniques for hill and slope stabilization works using plants [P1/7(a) | 20 M]. • Discuss the components of ***Desert Ecosystem***. Write steps to control shifting of sand dunes [*Linked Q* | P**2**/6(b) | 15 M].
2021	• How does soil organic matter decomposed influence forest productivity? [P1/5(d) | 8 M]. • Explain the terms – (a) Cation Exchange Capacity, (b) Salinity & Alkalinity [P**2**/5(a) | 8 M].
2020	• Write short notes on the following – (a) Soil texture and structure, (b) Soil organic matter, (c) Carbon nitrogen ratio. [P1/8(c) | 15 M]. • What is the different soil type found in India? Identify five tree species growing each in Alluvial soils, red soils, Black cotton soils and Arid and desert soils. [P1/7(b) | 15 M]. • Define afforestation. Discuss in brief the afforestation techniques, including the choice of species, for ravine lands [P1/3(a) | 10 M].
2019	• Soil is an interface of air, minerals, water and life. Comment [P1/5(c) | 8 M]. • What are the ***Paedogenic Process***? Explain the important process of soil formation [P1/8(c) | 15 M].

	• What are the characteristics of ***Saline*** and ***Alkaline Soils***. Explain the reclamation of saline and alkaline soils with suitable tree species [P1/7(a) | 15 M].
2018	• Write in detail about the influence of ***Parent Rock*** in the distribution of tree species [*Linked Q* | P1/5(c) | 8 M]. • Write the ***Soil-Water Relationship*** of any forest area. Describe the influence of water table in the growth and development of tree species. [P1/7(a) | 10 M].
2017	• What are the various methods adopted to conserve the soil on sloping areas? Explain in brief. [P1/7(b) | 10 M]. • Where are ***Cold Deserts*** found in India? Explain site characteristics encountered in a cold desert and steps suggested to overcome problems in their afforestation [*Linked Q* | P1/3(a) | 10 M]. • Describe the technique of ***Sand Dune Fixation*** in the thar desert. Also mention the choice of species for plantation [P1/3(b) | 15 M].
2016	• Write distinguish features of ***Saline Alkaline Soil*** [P1/5(b) | 8 M]. • Explain ***Types of Rocks*** based on formation and minerals based on chemical compositions [P1/5(d) | 8 M]. • Write the characteristics of ***Cold Desert***. Discuss soil working and planting techniques for cold desert [*Linked Q* | P1/1(d) | 8 M].
2015	• Why is a lot of emphasis laid on research relating to soil conservation? Discuss [P1/5(b) | 8 M]. • Describe different textural classes of soil and the way they affect plant growth. [P1/6(b) | 10 M]. • Why is ***Saline-Alkaline Soil*** considered problematic? can you suggest any procedure to make it suitable for plant growth? [P1/7(b) | 10 M].
2014	• Specific problem of ***Coastal Land*** and ***Hot Deserts*** [*Linked Q* | P1/2(b) *iv* | 5 M].
2013	• What are the specific problem of the following wasteland? suggest at least 3 species for planting in each of them (20 m) – (a) Hot desert, (b) Saline alkaline soil, (c) Wetland, (d) Cold desert. [P1/2(a) | 5 × 4 = 20 M].
2012	• Explain different process of soil erosion. Briefly describe them giving examples as to how the vegetation including trees can help in conserving soil and water [P1/7(b) | 10 M]. • Describe briefly the afforestation techniques adopted for ***Ravenous Lands of Yamuna*** giving suitable species [P1/5(f) | 5 M]. • Give suitable forestry techniques for the reclamation of ***Salt Affected Soils*** [P1/6(b) | 8 M]. • How shelterbelt and wind breaks are helpful in ***Sand Dune Stabilization*** and desert control? [P1/5(a) | 5 M]. • Discuss afforestation of inland sand dunes by giving their distribution, site conditions, planting techniques and species suitable in such areas [P1/5(e) | 5 M]. • List the Pioneers flora of sand dunes under – [*Linked Q* | P2/5(b) | 8 M]. (d) On dunes, (e) Spread out sand, and

CHAPTER 1

INDIAN TRIBES

Since prehistoric times, India has been a country of multi-racial community, spread throughout the Indian peninsula with its definite cultural variations and level of development. Among them, many groups are still in a primitive state and are very weakly affected by so-called modernization. Therefore, those people are called *aboriginals,* and the popular names we often used for them are Vanvasi, Pahari (in HP, UK), Adimjati (Primitive People), Adivasi (Indigenous People), Anusand Janajati (Scheduled Tribes (ST), etc.

1.1 DEFINITION

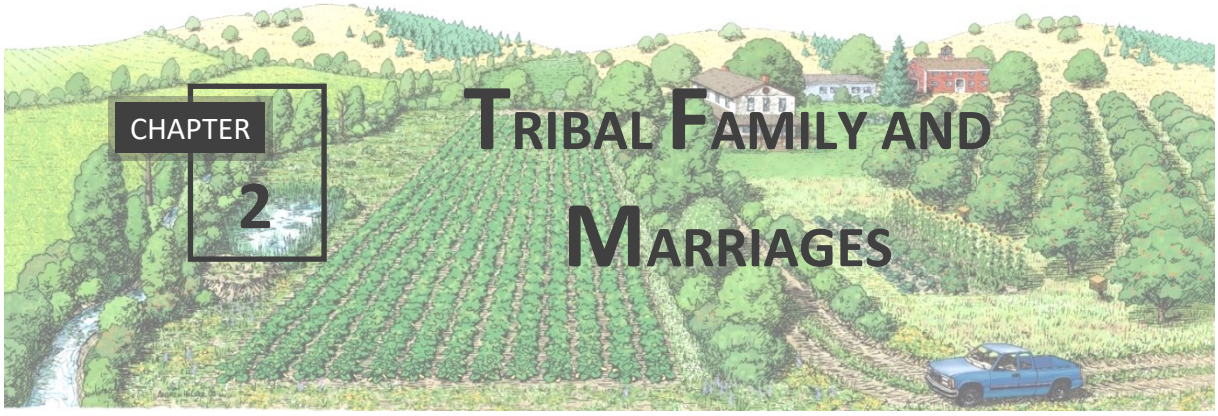
- The tribe is a collection of families bearing a common name, a common living homeland, members of which speaking the same languages and observed certain taboos regarding marriages and occupations.
- A tribe is a group speaking a common dialect and inhabiting a common territory.
- A tribe is a small isolated, closely-knit society.

The term 'tribe' is derived from the *Latin* word '*tribus*' which is used by the Romans for a social group of poor people among its citizens.

1.2 CHARACTERISTICS OF THE INDIAN TRIBE

- *Definite territory* - members of a tribe occupy a common and well-defined territory, *i.e.*, the Bharia tribe of MP lives in the Patalkot (Chindwada district).
- All the members of a tribe *speak a common language* or dialect but *usually lack script*, *i.e.*, Koru by the Korku tribe, Gondi by Gonds, etc. [The Santhali has its own script called C*hikiscript*].
- The members of a tribe are claimed to be *originated from a common ancestor* and blood related to each other.
- Have *common folk arts* & culture, *common religion*, beliefs, customs, Taboos, and myths.
- Names have *common types of surname*.
- *Common occupation* primarily *depends upon the forest* for their livelihood. Hunting and food gathering are common practices.
- Shows *strong social and political unity*. Govern by their own laws through tribal assembly to maintain peace, justice and punish if someone violates customs. Generally, Mukhia commands the tribe with the help of the body of warriors and tribal assembly, and his decisions are final.
- Habitation in *remote and inaccessible forest areas*, Illiteracy.

Tribal prefer to live in thatched house



CHAPTER 2

TRIBAL FAMILY AND MARRIAGES

A family is a small social unit consisting of fathers, mothers, and their children who are related to each other by kinship relationships based on marriage, blood, or adoption. A tribal family is the nucleus of all social structures and still continues to be the most stable association and institution of human society. It plays a vital role in the development of an individual's personality and the process of socialization.

2.1 CHARACTERISTICS OF A TRIBAL FAMILY

- The family has a limited size (usually 4 to 6 members), and all are emotionally attached with a sense of responsibility amongst their members.
- Have common language, surname & male have the same gotra.
- The husband and wife are permanent sexual partners.
- Some members of a family are bread earners, and some are dependent.
- Family is the center of education for children.

The term '***family***' has origin from the ***latin*** word '***Famulus***', which means a ***servant***.

2.2 TYPES OF TRIBAL FAMILIES

► **Based on the form of marriage**

(a) Monogamous : 1 husband and one wife

(b) Polygamous : 1 husband and > 1 wife, *i.e.,* Bhil

(c) Polyandrous : >1 husband and one wife, *i.e.*, Toda* of Nilgiri, Khasa* of Jaunsar (UK).

► **Based on the nature of ancestry and property inheritance**

(a) Patrilineal family : The ancestry of a family is determined by the male line or father and property rights inherent and distributed among the males, *i.e.*, most of the tribal communities in India.

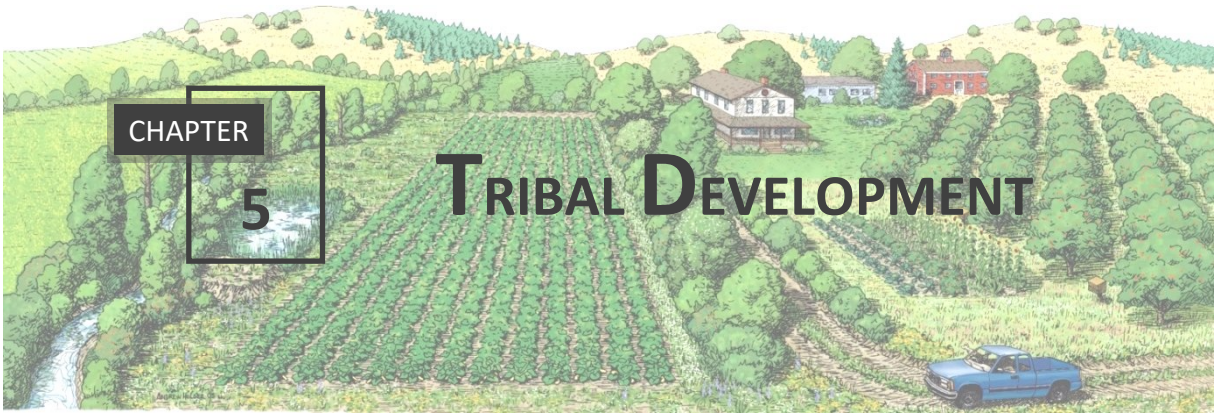
(b) Matrilineal family : when the ancestry of a family is determined by the female line or mother and property rights inherent and distributed among the females, *i.e.*, Khasi tribe*.

► **Based on the inheritance of the name**

(a) Patronymic family : when the children inherit the name of their father

(b) Matronymic family : when the children inherit the name of their mother, *i.e.*, Khasi tribe*.

► **Based on nature, the couple moved after marriage**



CHAPTER 5

TRIBAL DEVELOPMENT

Tribal communities continue to be vulnerable even today, not because they are poor and illiterate compared to the general population, but their inability to negotiate and cope with the consequences of their integration with the mainstream economy, society, cultural and political systems. The requirements of planned development brought with them the dams, mines, industries, and roads, all located on tribal lands. Tribal institutions and practices were forced into an uneasy coexistence.

► SOCIO-ECONOMIC AND CULTURAL PROBLEMS OF TRIBALS

- Problems related to the forest – rapidly decreasing natural resources, climate change and erratic rainfall, misuse of rights, and concessions by some.
- Agricultural still in primitive phase & irrigation issue
- Illiteracy and Poverty
- Health issues & alcoholism
- Inadequate employment opportunity and Bondage labor
- Lack of credit and market facility = Indebtedness.
- Land alienation
- Exploitation of tribals by Middle-man, Traders, contractors, and NGO gang.
- Migration for employment
- Poor governance & corruption
- Displacement due to developmental programs.

► SOLUTION

- To save their rights : give special status to the tribal area and socio-cultural linked programs, promoting the proper implementation of forest right act.
- Economic development through -
  - IPR and bio-prospecting
  - Geotagging of their produce
  - fair and festivals like Bhagoria haat, Hornbill festival of Nagaland, etc., to promote cultural tourism, ecotourism, etc.
  - Joint forest management & promotion of cottage industry.
  - Marketing their products through Flipkart/Amazon.
  - Promotion of social forestry and agroforestry on their own land.
  - Promotion of forest-based cottage industry, collection of MFP in a sustainable manner.
  - Agriculture development programs like solar pumps for irrigation.

CHAPTER 1

JOINT FOREST MANAGEMENT

Chapter outline

Joint Forest Management (JFM) is an approach and program initiated by the *National Forest Policy of 1988*. Under this, the state forest departments support local forest-dwelling and forest fringe communities to protect and manage forests by sharing the costs and benefits of the forests with them. Communities organise themselves into a JFM Committee to preserve and manage nearby forests, guided by locally prepared guidelines and micro-plans.

JFM is a *participation of the local community* in the management of forest

1.1 HISTORICAL BACKGROUND

In 1931, Van Panchayats in Uttarakhand started participating in forest management, as the remote Himalayan region where creating hardness to the forest department because of the poor Cost-benefit ratio.

Later, the Forest Department of West Bengal successfully started a pilot project in the Arbari*** village (hilly area) during 1971–72, and it was a major success.

Followed by Haryana and Odisha, but all these (WB, HR, Odisha, etc.) were pilot projects or individual efforts of some dedicated forest officers and had no forest policy or legal back-ups.

Other similar efforts, *i.e.*, Forest Cooperatives in the Madras Presidency (the 1900s) and cooperative Forest Societies in Kangra (1940s, earlier Punjab, now Himachal Pradesh). Woodlots on panchayat lands under Social Forestry (the 1980s - with Revenue sharing agreements).

The actual initiative by MoEFCC on JFM started with the ***National Forest policy – 1988***** on its past experiences, followed by the ***Guideline of 1990***** to utilize forest wealth to improve local livelihoods. This guideline explains how the forest committee was formed, its powers & functioning, NWFP sharing %, etc. *This guideline forms the basic foundation of JFM in India. That's why most Academicians consider this as the year of initiation of JFM in India*.

CHAPTER 2

PARTICIPATORY RURAL APPRAISAL (PRA) AND RAPID RURAL APPRAISAL (RRA)

Chapter outline

Collection of information for planning rural development activities, including JFM, involves detailed surveys, data collection, and extensive field visits. In the past, the staff of the department or project used to collect information on their own. However, this method had the following drawbacks

- High time, money, and workforce-consuming.
- Most of the time proved to be beyond the capacity of the staff resources.
- The data generated was not very reliable (and sometimes forged)
- The local communities were not involved in this process, resulting from which their views did not get adequately reflected.
- The efforts by the staff were prone to be biased, leading to severe distortions.
- Often the information was not reliable.

As a result, many schemes launched after detailed planning could not achieve the desired results despite the best intentions of those who planned and implemented it. The perceptions of staff could be different than that of the participating local communities. Planners realized that participation of the communities in plan formulation was essential. To collect information and enhance the level of communities involvement, the following two processes have been evolved.

A. Participatory rural appraisal (PRA)
B. Rapid rural appraisal (RRA)

IFoS 2019 : Why are participatory rural appraisal (PRA) techniques important for planning and execution of Joint forest management (JFM) Activities? Explain the tools and techniques of PRA (15 m).

2.1 PARTICIPATORY RURAL APPRAISAL (PRA)

Participatory Rural Appraisal (PRA) is a tool to facilitate the collection and analysis of information by and for community members. It emphasizes local knowledge and involves communities in the

CHAPTER 3

Non-Governmental Organizations (NGOs)

Chapter outline

- Need of NGOs IN JFM
- Activities undertaken by NGOs
- Issue with NGOs

Non-governmental organizations (NGOs) refer to not-for-profit organizations that pursue activities to relieve suffering, promote the interests of the poor, protect the environment, provide essential social services, or undertake community development.

- These organizations are not a part of the government, have legal status, and are registered under the specific Act (Societies Registration Act, 1860 in India).
- In India, based on the law under which they operate and the kind of activities they take up, civil society groups can be classified into the following broad categories -
  - Registered Societies formed for specific purposes
  - Charitable Organizations and Trusts
  - Local Stakeholders Groups, Microcredit, and Thrift Enterprises, Self Help Groups.
  - Professional Self-Regulatory Bodies
  - Cooperatives
  - Bodies without having any formal organizational structure

- **NEED OF NGOs IN JFM** : NGO's plays a significant role in JFM. They are members of VFC. They are involved in all the conservation and preservation activities. They improve the relationship between the department and the village people. They act as a moderator.
  - NGO acts as a *buffering layer* between the forest department and local peoples.
  - NGO's *promote awareness* about the importance of forests among the people.
  - They improve the *confidence-building* between the people and forest department officials.
  - They provide beneficial *information to forest officials* for the protection and improvement of forests.
  - They conduct many *awareness and training camps* in forest villages.

CHAPTER 4

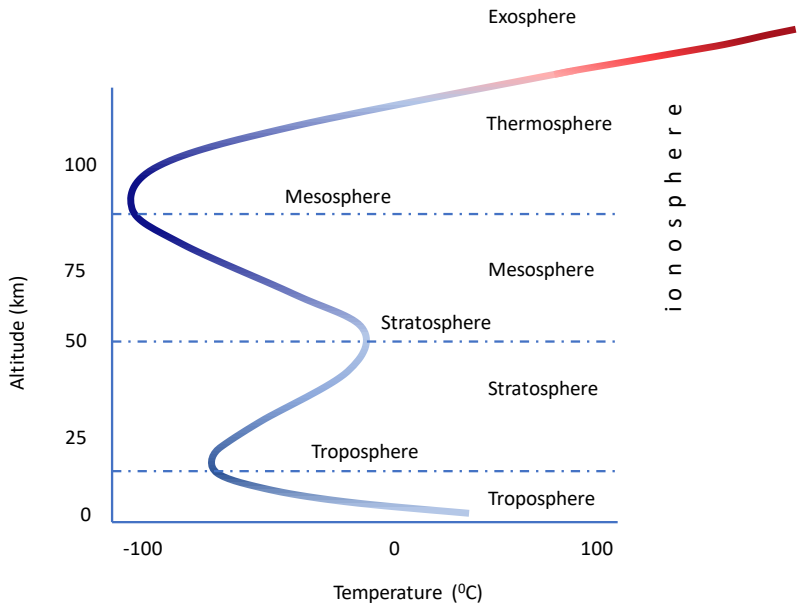
CLIMATE CHANGE & GLOBAL WARMING

Chapter outline

The word 'environment' is most commonly used to describe Nature and means the *sum of all living and non-living things surrounding an organism or group of organisms*. The environment includes all elements, factors, and conditions that impact the growth and development of certain organisms. The environment includes biotic (all surrounding living organisms) and abiotic factors (light, temperature, water, atmospheric gases combine with biotic factors) that influence observed organisms.

4.1 STRUCTURE AND COMPONENT OF ENVIRONMENT

There are four main spheres of the environment : the lithosphere, the hydrosphere, the atmosphere, and the biosphere. These correspond to the rocks, the water, the atmosphere, and the life. Environment therefore refers to the study of Earth, air, water, living creatures, and their mutual relationships.

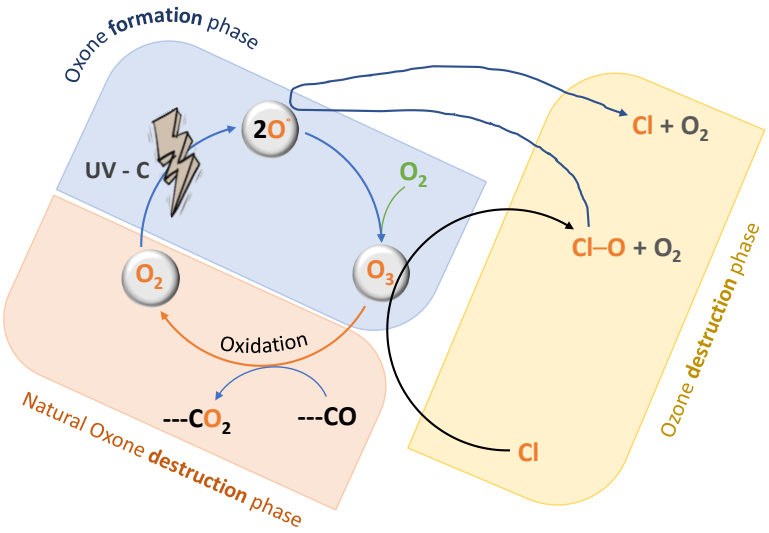


Note : In the chapter locality factors, we already refer to various environmental factors. It is unnecessary to go into more detail here. Any traditional book can be used for more information.

IFoS 2015 : Write the *chemistry of ozonosphere* and list the adverse effects of ozone layer depletion (10 m).

Hints : Ozone occurs both in Earth's upper atmosphere and ground level. Majorly, it is found naturally in stratosphere (11-50 km from earth surface) at altitude of 17 to 25 km called ozonosphere.

Reactions for the *formation* and *destruction* of ozone



Effect of ozone layer depletion

- Effects on Human Health : Ozone layer depletion increases the amount of UV-B that reaches the Earth's surface and causes non-melanoma skin cancer and cataracts.
- Effects on Marine Ecosystems – reduced survival rates of planktons.
- Effects on Biogeochemical Cycles
- Effects on Materials

4.2 CLIMATE CHANGE & GLOBAL WARMING

The term *"climate change" refers to long-term changes in temperatures and weather patterns*. Shifts may occur naturally, for example, due to variations in the solar cycle. Since the 1800s, humans have been the main driver of climate change, primarily due to burning fossil fuels such as coal, oil, and gas. Burning fossil fuels has worsened the atmospheric balance since the industrial revolution.

PRINCIPLE

The global warming in the atmosphere is based on the same principle on which the greenhouse work (a heat-trapping shade used in temperate and cold countries to grow the vegetable). This greenhouse traps the solar energy from the Sun in the form of a short wave and keeps the greenhouse warm through the night by stopping the escape of heat energy and thus protecting the vegetation in the greenhouse.

The greenhouse effect is the naturally occurring phenomenon in which gases occurring in the atmosphere traps the terrestrial heat, thus keeping the Earth warm enough for the survival of living things.

Gases that can potentially trap heat energy are called *greenhouse gases*. Some of these gases are as follows :

CHAPTER 5

SUSTAINABLE FOREST DEVELOPMENT

Chapter outline

In recent years, environmental issues have attracted a tremendous amount of attention worldwide. It was the Brundtland Commission report in 1987 and the Rio summit in 1992 that sparked major motivation. This interest is focused mainly on sustainable ways to better management of resources and carry out the development in a harmonious fashion in relation to the environment. Although, the world needs new development to run its economies and to make progress. This puts pressure on us to think about how we can manage our resources in a sustainable way. This resulted in the institution of new legislation originating from national and international sources where potential adverse effects of future development activities are tried to mitigate or avoid at the planning stage. Environmental impact assessment (EIA) is such an example that assesses the impacts in advance.

5.1 DEFINITION

Sustainable forest management (SFM) is defined as a *dynamic and evolving concept*, which aims to *maintain and enhance the economic, social, and environmental values* of all types of forests, for the benefit of present and future generations. Forests and trees, when sustainably managed, make vital contributions both to people and to the planet, bolstering livelihoods, providing clean air and water, conserving biodiversity, and responding to climate change (F.A.O.)

'Sustainable forest management is the process of managing forests to achieve one or more clearly specified objectives of management with regard to the production of a continuous flow of desired forest products and services, without undue reduction of its inherent values and future productivity and without undue undesirable effects on the physical and social environment.' (ITTO, Criteria, and Indicators for Sustainable Management of Natural Tropical Forests, 1998)

CHAPTER 6

CONSERVATION

Chapter outline

The term 'conservation' was coined by *Dr. Gifford Pinchot*[***] in 1908 from two Latin words – con (=together) and servare (=guard). Conservation is one of the major applications of ecology to ensure scientific and sustainable utilization of resources.

Wildlife conservation : The practice of protecting endangered flora and fauna and their habitat to ensure the existence of wildlife and wilderness areas and their values for future generations

► **OBJECTIVES OF CONSERVATION** : Conservation is chiefly concerned with the protection, preservation, propagation, and judicious control of population for rare species of plants and animals in their natural habitats and can be achieved through intelligent exploitation of nature keeping all its biological and physical components in its original form as far as practicable.

- To study the interrelationship of plants and animals in their natural habitat.
- To protect and preserve the rare species of plants and animals from extinction.
- To preserve the breeding stock of wildlife.
- To prevent deforestation.
- To maintain the balance of nature.

► **CONSERVATION APPROACH**

- Conservation through laws
- Establishment of protected areas
- Species preservation scheme
- Prevent deforestation
- Habitat improvement
- Preservation of breeding stock
- Periodic census
- People's participation Inclusion of conservation biology in school/ college curricula.

CHAPTER 7

PROTECTED AREAS

Chapter outline

Protected Areas (PAs) are one of the most important *in-situ* conservation strategies to reduce deforestation and sustain the ecological integrity of forest ecosystems.

- *Wildlife sanctuary* : Protected areas that provide protection and optimum living conditions to wild animals, where conservation focus is mainly species-oriented and may be formed by executive order.
- *National parks* : enjoy a higher status than wildlife sanctuaries (List of National parks and wildlife sanctuaries given at the end of this unit)
- *Biosphere reserve*
- Wetland
- Community reserves
- Conservation reserves
- Wildlife corridors

Note : Wildlife (Protection) Act, 1972 was amended in 2003 when two new categories of protected areas, namely '*Conservation Reserve*' and '*Community Reserve*' has been included to facilitate peoples' involvement in establishment and management of such protected areas.

7.1 BIOSPHERE RESERVES

The idea of "Biosphere Reserves" was initiated by UNESCO in 1973-74 under its Man and Biosphere (MAB) Programme (The MAB, launched in 1971 by UNESCO). Later broadly adopted under the Convention on Biological Diversity (CBD) 1993.

DEFINITION : BRs are thus particular environments for both people and nature and are living examples of how human beings and nature can co-exist while respecting each other's needs. Biosphere Reserves are protected areas of land and/or coastal environments wherein people are an integral component of the system

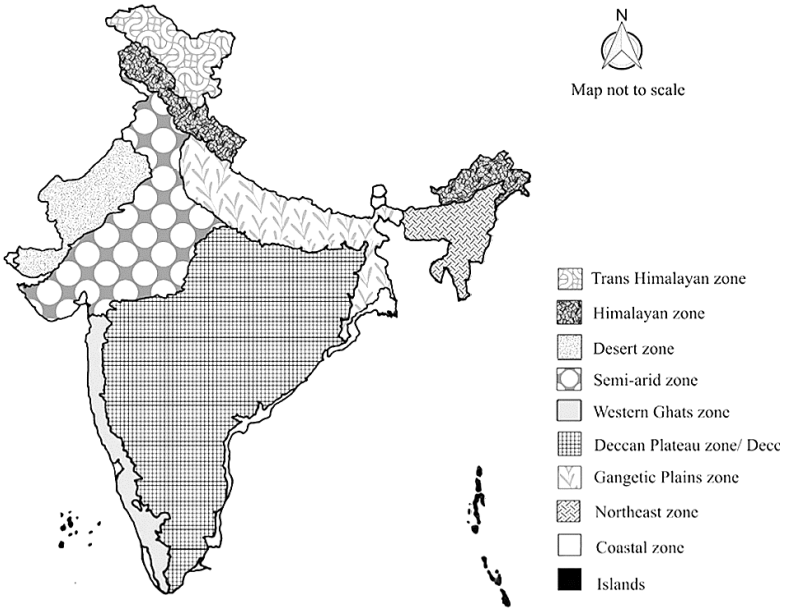
CHAPTER 8

BIOGEOGRAPHIC ZONES OF INDIA

Chapter outline

Biogeography is the study of the distribution of species and ecosystems in geographic space and through geological time. The biogeographic zone is a large distinctive unit of similar ecology, biome representation, community, and species. A *biotic province* is a secondary unit within a biogeographic zone, giving weight to particular communities separated by dispersal barriers or gradual change in environmental factors. A wide range of latitudes and longitudes and varied climatic regimes have resulted in an astounding range of biophysical environments, ecosystems, and habitats in India.

The biogeographic zones of this country are –



1. Trans-Himalayan zone
2. Himalayan zone
3. Desert zone
4. Semi-arid zone
5. Western ghats zone
6. Deccan plateau zone (or Deccan Peninsula)
7. Gangetic plains zone
8. Northeast zone
9. Coastal zone and
10. Islands

CHAPTER 9

FOREST CERTIFICATION

FOREST CERTIFICATION

Forest certification is a process that involves *monitoring*, *tracing*, and *labelling* of *timber, wood, pulps, and non-timber forest products*. The objective of forest certification is to evaluate the quality of forest management practices from environmental, social, and economic perspectives against a set of agreed standards.

HISTORY

- The first forest certification scheme, the *Smart Wood* program, was launched by the *Rainforest Alliance* in 1989. This program aimed to promote Sustainable Forest Management (SFM) practices in tropical forests, particularly in *Indonesia*. However, this concept of forest certification gained wider recognition and popularity after the Earth Summit, held in Rio de Janeiro, Brazil, in 1992. At this conference, many countries and organizations recognized the importance of SFM and agreed to work towards promoting it.
- In 1993, the *Forest Stewardship Council* (FSC) was established as an international, non-governmental organization in *Bonn, Germany* with the aim of promoting responsible forest management worldwide via timber certification. The FSC developed a certification scheme that included *Environmental*, *Social*, and *Economic* criteria to ensure that forests were managed in a sustainable way. Its present director is Kim Carstensen. Council was developed 10 Principles and 56 Criteria for forest stewardship.

  10 FSC Principles (here, only 7 given)

  - *Comply with all applicable laws*, regulations, treaties, conventions and agreements together.
  - Maintain or improve the social and economic *well-being of workers*
  - Uphold *Indigenous Peoples' right* of ownership and use of forest resources
  - Manage their products and services in a way that maintains or improves their *long-term economic viability, social benefits, and environmental benefits*.
  - Monitoring and assessment – to *demonstrate progress towards management objectives*.
  - Maintenance of *high conservation value forests* – to maintain or enhance the attributes which define such forests.
  - To make sure that plantation and management activities are in accordance with FSC Principles and Criteria

CHAPTER 10

ENVIRONMENT IMPACT ASSESSMENT

Chapter outline

Environmental impact assessment (EA) evaluates both progressive and harmful environmental impacts of a proposed plan, strategy, program, Or any project previous to its execution. In EIA, plans, policies, and programs are used for state departments and projects for individuals and private companies. EIA is a decision-making tool used to compare different alternatives for any new assignment and further seeks to recognize the one that produces minimum environmental impact and brings maximum economic and social benefits.

10.1 HISTORICAL DEVELOPMENT OF EIA

During the 1960s, people understood that undertaking development projects disturbed the environment, resources, raw materials, and people. Due to this, pressure groups formed to develop a tool that can be used to ensure the environment in any growth. To counter this issue, the USA decided to establish a National Environmental Policy Act in 1970 for environmental protection. Hence, the *USA became the first country to enact legislation on EIA*. After that, Australia adopted EIA in 1970, Canada and New Zealand in 1974. Afterward, EIA was formalized and established in the world at the United Nations Conference on the Environment in Stockholm in 1972; Presently, all developed countries have enacted legislation on ETA.

10.2 NEED FOR ENVIRONMENT IMPACT ASSESSMENT

Modern economic activity thrives on growth and development, and any development-related activity is bound to have an impact on the environment this impact may vary from sector to sector, and this impact may be positive and negative. There is a long-drawn debate on environment and development with the assumption that development and environment conservation are antithetical to each other. National economic perspective demands development and growth, *e.g.*, Infrastructure, employment generation through various projects like industry,

CHAPTER 11

OZONE DEPLETION

11.1 WHAT IS OZONE LAYER

Ozone is *naturally occurring gas* found throughout the atmosphere, with maximum mixing ratio at the altitude ranging from *15 to 30 km, above the earth.* This region is frequently known as ozone layer. Ozone concentration differs by about *10 ppm* in the atmosphere compared to *0.05 ppm* in the troposphere.

The presence of ozone layer in the stratosphere is of vital importance to the because harmful solar radiation, such as ultraviolet rays which are lethal to life on the earth are not allowed to enter earth's atmosphere by ozone layer or ozone umbrella. In the absence of this layer, all the ultraviolet rays of the sun will reach the earth's surface and consequently the biosphere will turn into blast furnace. Thus, ozone layer strongly absorbs or blocks the *short-wave ionising UV rays* and so protect the life on the earth from the severe damages.

There are three spectrum of UV ray theses are

- UV-A, of wavelength 315 to 400 nm (near the ultraviolet ranging into the visible). It forms about *7% of solar flux* and is not particularly harmful to living species.
- UV- B of wavelength 280 to 315 nm (*1.5 %* of the total solar flux.) it can be harmful to both plant and animal species, especially after prolonged exposure. These are partially absorbed by the
- UV-C, of wavelength < 280 nm (0.5% of total flux) which *rapidly damages biota of all type.*

The small solar flux of UV-C radiation penetrates into the upper atmosphere but is efficiently and completely absorbed by the ozone and other atmospheric species before it reaches the earth's surface.

11.2 HOW OZONE IS FORMED AND DISTROYED

In the lower mesosphere, the atmospheric oxygen absorbs UV radiation < 240 nm and photo dissociate into two oxygen atoms

Chapter Outline

CHAPTER 12

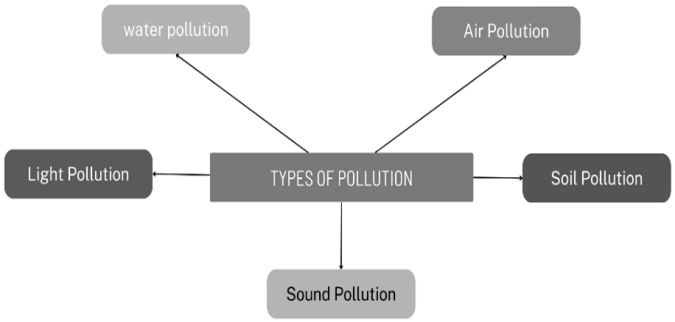
POLLUTION & RELATED ISSUES

12.1 POLLUTION

Environmental *pollution* is defined as the presence of any substance in the environment in such a concentration that it may tend or it may tend to be injurious to humans, plants, property, animals and the environment itself. The word 'such a concentration' is important because if some substances are present at a very low level, then it may not be harmful or injurious. Usually, the value of this concentration above which it is harmful is given in guidelines and standards. These substances whose presence causes pollution is called an *environmental pollutant.*

According to the Indian Environmental Protection Act (EPA), 1986, environmental pollution is defined as the 'presence in the environment of any environmental pollutant' Environmental pollutant can be defined as a solid, liquid, or gaseous substance present in such concentration as may be, or tend to be, injurious to the environment

TYPES OF POLLUTION



12.2 AIR POLLUTION

Definition : *The presence of one or more contaminants such as dust, gas, odor, smoke, smog, or vapor in the outdoor atmosphere, in quantities, of characteristics and of duration so as to be injurious to human, plant, or animal life or to property or which unreasonably interferes with the comfortable enjoyment of life and property is known as air pollution.*

Chapter Outline

CHAPTER 13 CARBON CYCLE

13.1 EXERCISE

IFoS 2021 : What is the role of forest plantations in *Carbon Sequestration*? (10 m)

- Discuss the role of forest for *carbon sequestration* [Odisha Civil (Main) 2015 | 20 Marks]

IFoS 2020 : Why is *carbon cycle important* ? How do human activities affect carbon cycle? (10 m).

IFoS 2018 : What is *carbon sink* ? How do forest soils act as important carbon sinks? (8 m).

IFoS 2015 : Why is *carbon recycling important* ? What are its influences on climate? Discuss your points for or against (10 m).

IFoS 2012 : Write short notes on - *Source-sink relationship* with respect to carbon cycle (5 m).

- Explain the role of *afforestation* in *carbon sequestration* [Odisha Forest Service (Mains) 2015 | 20 Marks]

13.2 CARBON CYCLE

Carbon is the foundation of all life on Earth, required to form complex molecules like proteins and DNA. This element is also found in our atmosphere in the form of carbon dioxide (CO_2). Carbon helps to regulate the Earth's temperature, makes all life possible, is a key ingredient in the food that sustains us, and provides a major source of energy to fuel our global economy.

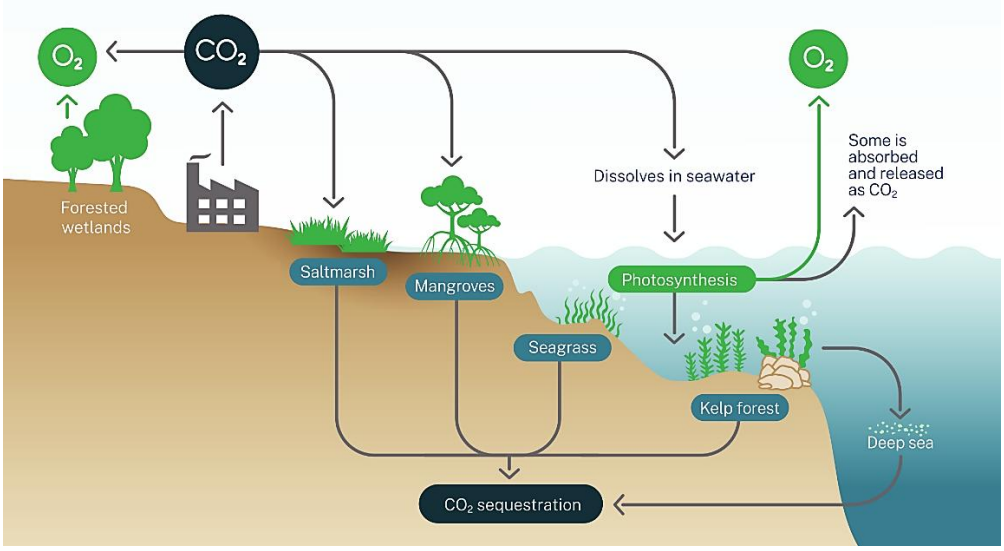
The carbon cycle describes the *process in which carbon atoms continually travel from the atmosphere to the Earth and then back into the atmosphere*. Since our planet and its atmosphere form a closed environment, the amount of carbon in this system does not change.

On Earth, *most carbon is stored in rocks and sediments*, while the rest is located in the ocean, atmosphere, and in living organisms. These are the reservoirs, or sinks, through which carbon cycles. Carbon is released back into the atmosphere when organisms die, volcanoes erupt, fires blaze, fossil fuels are burned, and through a variety of other mechanisms. In the case of the ocean, carbon is continually exchanged between the ocean's surface waters and the atmosphere or is stored for long periods of time in the ocean depths.

IMPORTANCE OF CARBON CYCLE

- The carbon cycle is *vital to life on Earth*. Studying the movement of *carbon energy* helps us to understand the *working of forest ecosystems* and the factors that influence it.
- Carbon dioxide *traps the long-wave radiation* from the Earth, *causing temperatures to rise*. Understanding the absorption and release of carbon dioxide is crucial in comprehending climate dynamics and predicting global warming.

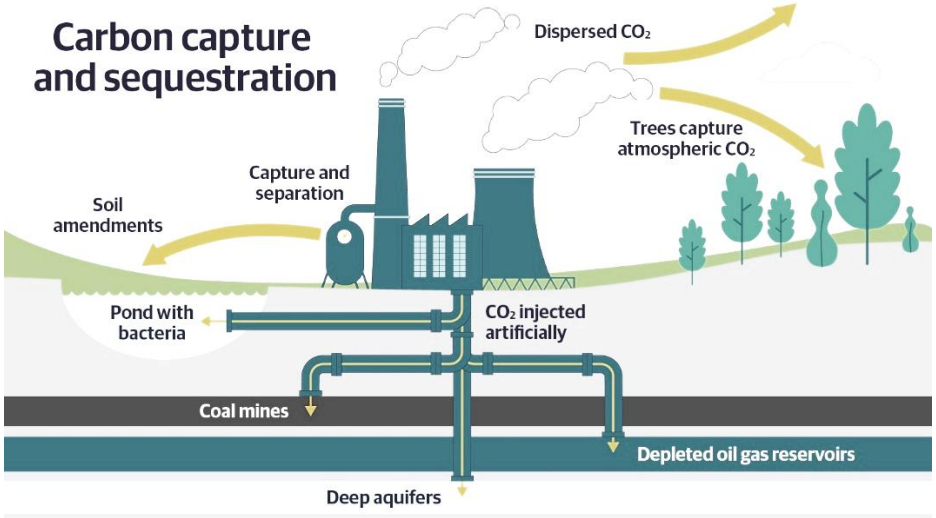
- *Blue Carbon Sequestration* : Mangroves, seagrasses, and tidal marshes capture and store significant amounts of carbon in their soils and vegetation. Colder and nutrient-rich parts of the ocean are able to absorb more carbon dioxide than warmer parts. Therefore, the polar regions typically serve as carbon sinks [*Ocean fertigation*]



GEOLOGICAL CARBON SEQUESTRATION

The process of storing carbon dioxide in underground geologic formations or rocks. Typically, carbon dioxide is captured from an industrial source, such as steel & cement production units, Power plants, and natural gas processing facilities, and injected into porous rocks for long-term storage.

- *Carbon Capture, and Storage* : This method involves capturing CO_2 emissions from industrial sources, such as power plants, cement & Steel production units. This CO_2 is then compressed and transported to deep underground geological formations, such as depleted oil and gas reservoirs or deep saline aquifers for permanent storage



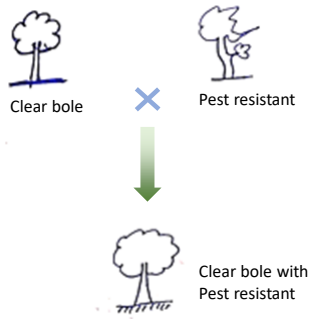
- *Direct air capture* (DAC) : This Technology involves capturing CO_2 directly from the atmosphere by using chemical processes or sorbents. The captured CO_2 can be stored in deep geological formations.

CHAPTER 14

TREE IMPROVEMENT INTRODUCTION

Tree improvement is the process of improving the genetic quality of a tree species. It is also referred to as genetic improvement. The process involves selecting the best trees in a population and using them as parents for the next generation of trees. The goal is to produce trees that are better adapted to their environment and have desirable characteristics such as faster growth, better form, and resistance to pests and diseases.

- *Genetics* is a branch of biology that deals with the study of heredity and variation.
- *Heredity* : It is the transmission of genetic characteristics from parents to the offspring. It deals with the phenomenon of 'like begets like', *i.e.*, human babies are like human beings in overall traits.
- *Variation* : Individuals of the same species have some differences; these are called variations, *i.e.*, Dogs come in many different sizes, People have many different hair colours, etc.
- *Forest Genetics* : Branch of forestry deals with the study of heredity and variation in a forest tree.
- *Tree Breeding* : Tree breeding is the application of genetic, reproductive biology, and economic principles to the genetic improvement and management of forest trees.
- *Tree Improvement* : Improvements in overall yield & quality of forest produce by combining silviculture, tree breeding, and forest management [The *Silvicultural tool* deals with the *genetic makeup* of trees]



► *Heritability* : it is a statistic used in the fields of breeding and genetics that *estimates the degree of variation in a phenotypic trait in a population due to genetic variation between individuals in that population*.

- Heritability is the degree to which progeny resemble their parents. Heritability is the proportion of the total phenotypic variation controlled by genetic rather than environmental factors.
- Values come in between 0 (Zero) to 1. "0" indicates the sampling population has only environmental variations, and there are no genetic variations in the inbreeding population. In contrast, "1" Indicates absolute genetic variations without any environmental effects.

IFoS 2023 : Define *heritability* and its types. How does Narrow Sense Heritability differ from Broad Sense Heritability? [10 M]

IFoS 2019 : Define - (iv) *Heritability* (2.5 m).

IFoS 2018 : What is the importance of *heritability* and how can *genetic gain* be estimated in tree improvement programme? (10 m).

Types of heritability

CHAPTER 15

VARIATIONS

Variation refers to the variability in a species that includes genetic and morphological variances, *i.e.*, Dogs come in many different sizes, People have many different hair colours, etc.

► **CAUSES OF VARIABILITY** : Variability arises in a population due to the following –

- The trees grow in *differing environments*, *i.e.*, in foothills *v/s* coastal areas.
- When the trees have *different genetic makeups* due to mutation, polyploidy, genetic drift, natural selection, interbreeding depression, mating systems, man-made variations, etc.

► **IMPORTANCE OF VARIATIONS** : variations mean species of the same genus have different adaptation mechanisms and survival strategies to similar growing conditions, or members of the same species have this under different growing conditions due to changes in their genotypes and phenotypes, *i.e.*, leaf variations in *Dalbergia sissoo* and *Dalbergia latifolia*.

These variations provide us with vast genetic resources linked with particular insect-pest resistance, quality or quantity of wood, or any specific characteristics to easily select them and choose to develop a species of desired characteristics.

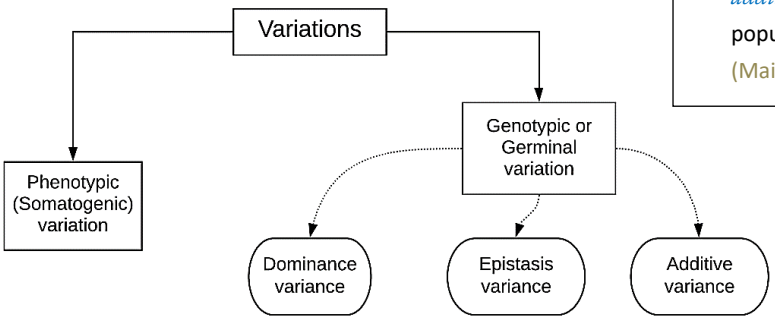
IFoS 2023 : Discuss the *significance of variation* in tree improvement [10 M]

IFoS 2019 : Define - (i) *Variation* (2.5 m).

IFoS 2015 : How can *magnitude and type of variability* be manipulated to obtain good gains in some tree characteristics ? (8m).

- Differentiate between (a) *Genotypic* and *phenotypic* variations [Himachal PSC Civil (Main) 2011; UPPSC (ACF) 2018].
- What are the *additive* and *non-additive* genetic variations in a tree population? [Arunachal PSC Civil (Main) 2015-16].

► **TYPES OF VARIATIONS**



1. **PHENOTYPIC (SOMATOGENIC) VARIATION** : when trees grow under different environmental conditions, they will alter various physiological mechanisms, the colour of leaves, shape, and size of

CHAPTER 16

INTRODUCTION OF EXOTICS

METHODS OF TREE IMPROVEMENTS

①	②	③	④
EXOTIC TREE INTRODUCTION	**SELECTION**	**HYBRIDIZATION**	**BIOTECHNOLOGICAL INTERVENTION**
To gain specific products / Quality, *i.e.*, Casuarina	Because they have already adopted the local environment	By breeding	By Tissue Culture, Somatic hybridization, etc.

Exotic plants refer to plant species that are not native to a particular region or ecosystem but have been introduced from other parts of the world. These plants are often sought after for their unique characteristics, aesthetic appeal, or potential economic value, *i.e.*, Teak is exotic in UP. But, for practical purposes, an exotic is defined as an introduction of a species from a foreign country.

FACTORS GOVERNING THE INTRODUCTION OF EXOTICS

IFoS 2020 : What are the different factors governing the successful introduction of an exotic tree species ? (10 m).

- Economic importance
- Invasive potential : Their aggressive growth, lack of natural predators or diseases, and ability to adapt to new environments make them difficult to eradicate or control once established. Now they start disrupting native ecosystems, threatening biodiversity, and causing ecological imbalances.
- Management challenges [Requirement of Technical skill]
- Availability of fund
- Aesthetic value : often chosen for their distinctive features, such as vibrant flowers, unusual foliage, or striking growth habits. They are commonly used in gardens, parks, and landscaping projects to enhance visual appeal.

ADVANTAGES OF EXOTICS

- Exotics *Provide a much wider choice of species* suited to the site and other requirements, especially when there are no suitable indigenous species.
- *R & D of 1 country* can be shared and utilized by other countries.
- Some may *perform well in exotic land* than their natural habitat due to the *absence of pests* & diseases outside of their natural habitat, at least for some rotation, *i.e.*, The leaf-eating insect in Eucalyptus species is quite common in Australia, whereas in India, it is absent.
- *Fast-growing* + higher quality of product = increase *productivity and production* of our forest.
- It can also help to meet the immediate requirements of our industry.

CHAPTER 20

SEED ORCHARDS MANAGEMENT

20.1 PLANNING OF SEED ORCHARDS

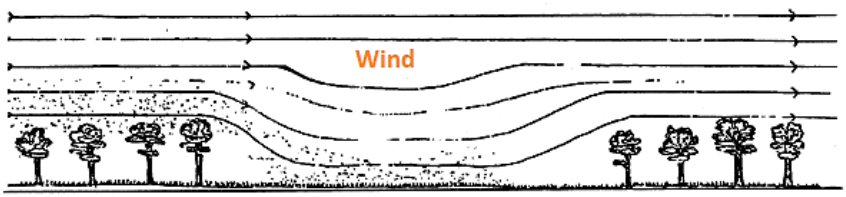
Seed orchards are a major source of high-grade propagation material and tree breeding programs. Therefore, before setting it up, we have to consider some important factors while planning –

- **Location** : Important for the production of high genetic and physiological quality seeds as well as isolation from contamination sources.
  - It should be well connected with temporary/permanent forest roads for easily carried out protection, transportation, and management work.
  - To secure against – wind, frost, fire, and insect-pest damages. It is better to replicate the seed orchard in two or more sites.
  - To safeguard against outsider pollen contamination, an isolation zone of 300 to 500 m width is developed around it.
  - Use govt owned area (to avoid legal rights issues).

IFoS 2014 : Discuss the important factors while planning of *seed orchard* (10 m).

- **Climatic factors** : Proper matching of climate, altitude, rainfall, and temperature is required according to the species, *i.e.*, low temperature-induced female flower formation in Oaks.
- **Soil and Topography** : Good site quality favours the production of early, abundant, regular, and good-quality seeds. Heavy soil with poor drainage is considered unfavourable for flowering.
- **Pollen dilution zone (PDZ)** : an orchard must be protected from contamination by outside pollen. Generally, the width of it is around *300 to 500 m,* but it will increase up to 1000 m for wind and insect-pollinated plants or even below 100 m in self-pollinated & sporadic flowering plants, *i.e.*, in conifers, PDZ should be around 500 to 600 m width to prevent pollen contamination.

IFoS 2013 : Write a note on *pollen dilution zone* in seed orchard. Discuss various factors affecting their effectiveness. What are the options available in lieu of pollen dilution zones? (10 m).

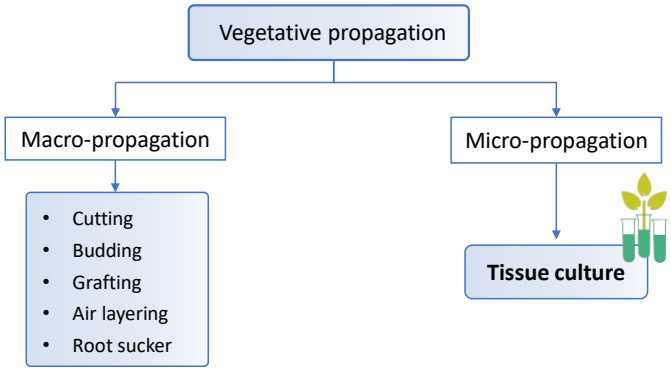


- **Size of seed orchard** : depends upon the availability of land on location, importance of species, seed production capacity per tree, total seed quantity requirement, and the purpose of establishment of seed orchard. In most cases, it is around *2.5 to 5 hectares*[*].
- **The biology of the species,** *i.e.*, sexual behaviour, mating system, degree of selfing, pollination, response to stimulation by hormones, etc. flowering habit, flowering and environment, ease of vegetative

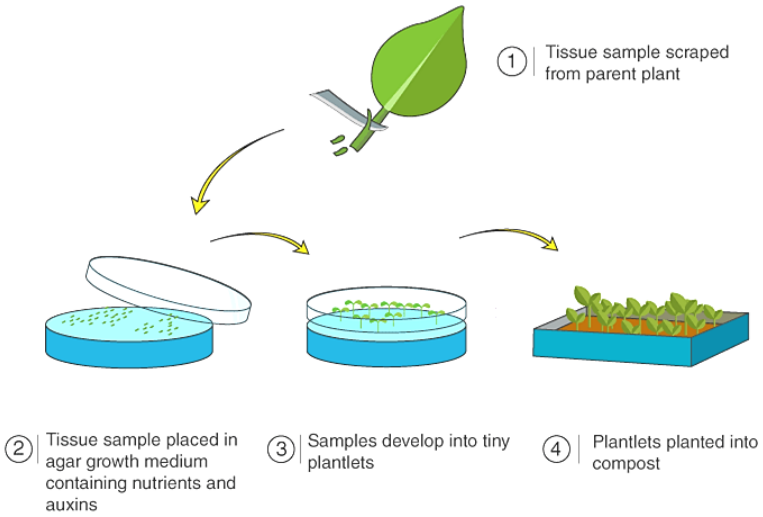
CHAPTER 22

BIOTECHNOLOGY IN TREE IMPROVEMENT

Due to rapid deforestation and depletion of genetic stocks, concerted efforts must be made to evolve new methods for mass propagation and production of short-duration trees with a rapid turnover of biomass and induction of genetic variability for the production of novel fruit and forest trees, which are high yielding, resistant to pest and disease associated with increased photosynthetic efficiency. Tissue culture techniques have already revolutionized the mass-scale propagation of many horticultural crops.



TISSUE CULTURE : In vitro culture of the plant cell, tissue, or organ under ascetic and controlled environmental conditions.



IMPORTANCE OF MICRO-PROPAGATION / TISSUE CULTURE TECHNIQUES

- A relatively large number of clones can be preserved in a small space and for a long time.
- Rapid and large-scale multiplication of clones is possible in a small space.
- Transportation is more accessible because plants can be stored, preserved, and transported in small culture flasks, and quarantine is easy.

CHAPTER 1

FOREST SOIL

[INTRODUCTION]

1.1 WHAT IS SOIL ?

Soil is the *unconsolidated mineral material on the immediate surface of the earth* that serves as a natural medium for the growth of land plants.

Forest soil is a portion of the earth's surface that serves as a medium for the growth and sustenance of forest vegetation.

PEDON ?

A *pedon* is a 3-dimensional smallest unit or volume of soil that contains all the soil horizons of a particular soil type with 1 m^2 at the surface and extends to the bottom bedrocks of the soil.

Term Soil is derived from the *Latin* term – *Solum*, which means *Floor****

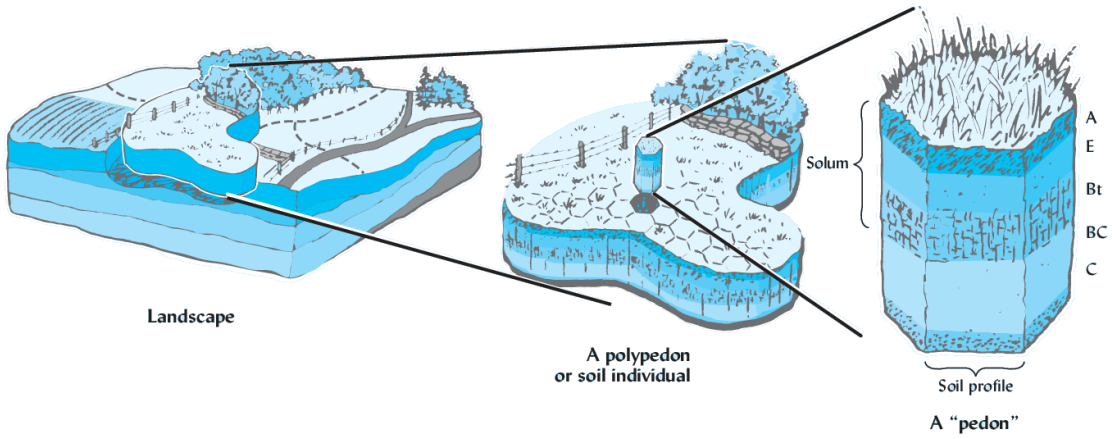


Figure 1.1 : Pedon is a natural body of soil that is large enough to allow classification of the soil.

PEDOLOGY : Pedology = Pedon + Logos = Greek word

↓ ↓

Soil/Earth Study

Pedology is the study of *soil genesis*, *classification*, and *mapping*/description of soil for land use planning. Therefore, it is helpful in forestry, forest road construction, and land capability classification.

- *Soil genesis* : the mode of origin of soil with particular reference to the processes and soil-forming factors responsible for the development of solum or true soil.
- *Soil survey* : consists of morphological examination, description, classification, and mapping of soils in their natural environment.
- *Soil classification* : is the process of logical grouping based on the properties and characteristics of representative units (pedon).

CHAPTER 2

ROCKS & THEIR FORMATION

2.1 INTRODUCTION

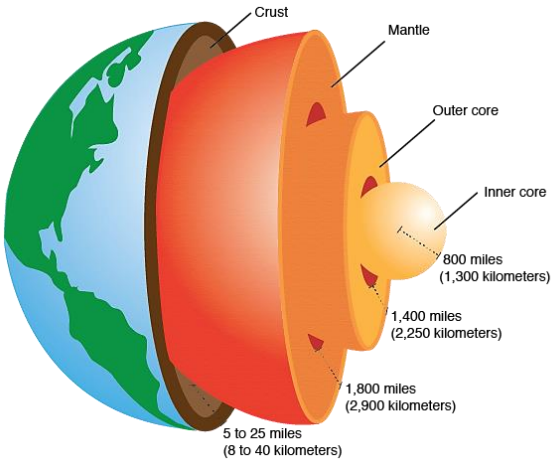
Earth formed about *4.6 billion years* ago from a mixture of gas and dust around the sun. The dust particles were drawn together by drag, forming clumps of rock called *planetesimals*. These planetesimals collided with each other, growing into Mars-sized *protoplanets*. Earth's final size was achieved through a major collision with another Mars-sized object, known as the *moon-forming impact*.

EARTH STRUCTURE

The structure of the earth is divided into four major components: the crust, the mantle, the *Outer Core (Liquid)*, and the *Inner Core (Solid)*. Each layer has a unique chemical composition and physical state.

COMPOSITION OF *Earth Crust****

Non-Metal	***Oxygen*** (O^{2-})	46.6% (***Highest***)	≈ ¾ of total
	Silicon (Si^{4+})	27.7 %	
Metal	***Aluminium*** (Al)	8.1 %	≈ ¼ of total
	Iron (Fe)	5 %	
	Calcium (Ca)	3.6 %	
	Magnesium (Mg)	2 %	
	Others	1.4 %	



✍ ***O–Si–Al, Fe–Ca–Mg***

2.2 WHAT ARE ROCKS

Rocks are a ***hard mass of mineral matter*** *comprising one or more rock-forming minerals.* Rocks are the materials that form the essential part of the Earth's solid crust.

BASED ON THE MODE OF FORMATION

► **IGNEOUS ROCKS** : Cooling and consolidation of molten magma within or on the surface of the Earth.

Characteristics

- Crystal formation = ✓
- Layers = ✗
- Porous = ✗

✍ Rocks are formed from the molten material known as *Magma*.
✍ *Petrology* = The study of rocks (in Greek, Petra means rock, Logos means science).
✍ *Petrogenesis* = Study of the origin of rocks.

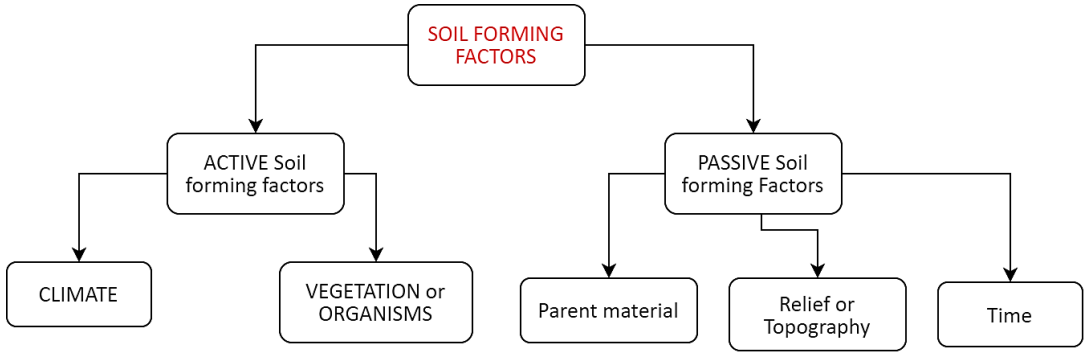
CHAPTER 4

SOIL FORMATION

4.1 SOIL FORMATION ?

Soil formation is the *evolution of true soil from regolith* taken place by the combined action of ① soil-forming factors and ② Processes.

SOIL FORMING FACTORS



- **Climate** : Impact of rainfall, heat, cold, wind, etc., over rocks.
- **Vegetation** or **Organism** : Many organisms play an active role in breaking down rocks and minerals and transforming them into fertile soil, *i.e.*, Wild animals, Fossorials, Plants, Fungi, Man, etc.
- **Parent material** : Soil is the result of the weathering and pedogenic process of Rocks. So, types of rocks and their composition indirectly (Passively) influenced the soil properly like Soil texture, Structure, pH, water holding capacity, the dominance of specific minerals, etc.

SN	Soil Group	Predominant vegetation
1.	Lateritic soil	Xylia xylocarp (Irul wood)
2.	Basaltic rocks (pH 6.5 to 7.5)	Teak - prefer to grow in lime-rich soil and generally avoid growing below and above this pH
3.	Acid rocks contain Iron Ores	*Shorea robusta*
4.	Quartzite rock	Chir-pine and Pterocarpus santalinus (Red sanders) grow very well. However, Dendrocalamus strictus (Male bamboo) avoid to growth on this rocky soil.
5.	Mica schist rock	Blue pine

  - *Dipterocarpus* prefer to grow on conglomerate and hard metamorphic sandstone.

- **Time**
- **Relief or Topography** : topography refers to the differences in the elevation of the land surface. As per FAO guidelines –

CHAPTER 8

AFFORESTATION OF DIFFICULT SITES

CONTENT

1. Hot desert and shifting sand dunes
2. Acidic soil
3. Saline alkaline area
4. Ravine land
5. Cold desert
6. Coastal land
7. Wetland
8. Mined area

8.1 HOT DESERT AND SHIFTING SAND DUNES

► **DISTRIBUTION** : The total area of hot desert in India is ~~*31.7 million hectares*~~, 61 % of which lies in Rajasthan.

Types	2008 - 09	2015 – 16 (% to TGA)
Ravines Sand	3165 km^2	3121 km^2 (0.09)
Coastal Sands	709 km^2	671 km^2 (0.02)
Desertic sand	8323 km^2	8191 km^2 (0.25)

(*Source* : Westland Atlas of India 2019)

► **LOCALITY FACTORS** : Mean annual rainfall = 100 mm to 450 mm. The rainfall in these regions is irregular, and droughts are frequent.

- **Temperature** : 48 °C in may-June to 15°C during winter, even sometimes it goes below freezing point at several places.
- **Wind** : 100 to 150 km per hour are experienced during summer.
- **Soil** : Sandy in character with a well-developed *hardpan* of *calcium carbonate* at varying depths. Desert soils are purely mineral soils obtained by the mechanical disintegration of rocks. Characteristics : (i) Very low organic matter, (ii) High percentage of soluble salts, (iii) Low nutrient status, particularly nitrogen, (iv) High pH and calcium carbonate, (v) Structureless and coarse-textured,

IFoS 2022 : Discuss the components of desert ecosystem. Write steps to control shifting of sand dunes (15 m)

IFoS 2017 : Describe the technique of *sand dune fixation* in the thar desert. Also mention the choice of species for plantation (15 m).

IFoS 2013 : What are the specific problem of the following wasteland ? suggest at least 3 species for planting in each of them – (a) Hot desert.

IFoS 2012 : Describe the technique of Sand Dune Fixation in the Thar Desert. Also mention the choice of species for planting (15 m).

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