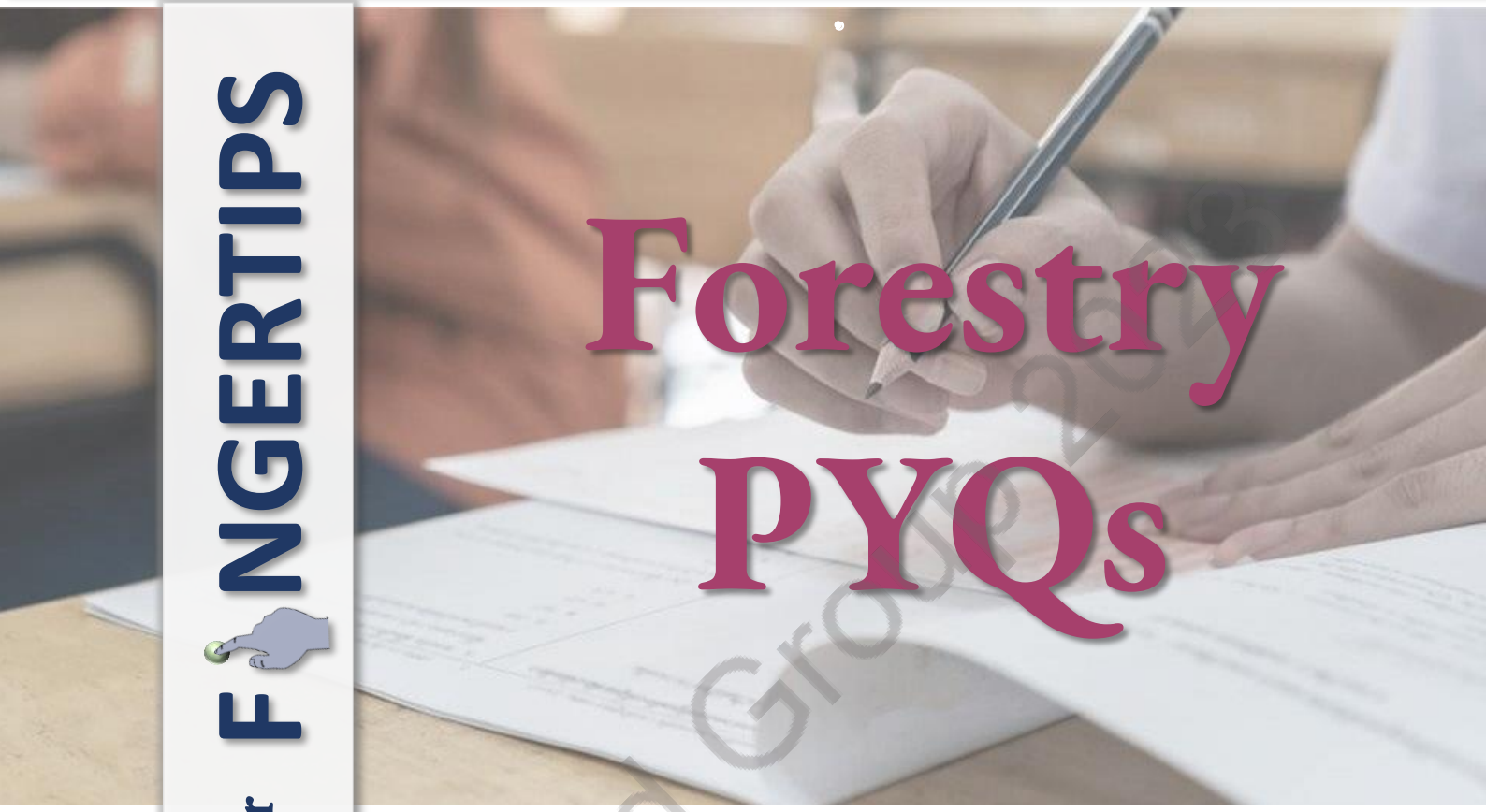
Hornbill classes

PAPER 1 & 2

FORESTRY at your FINGERTIPS



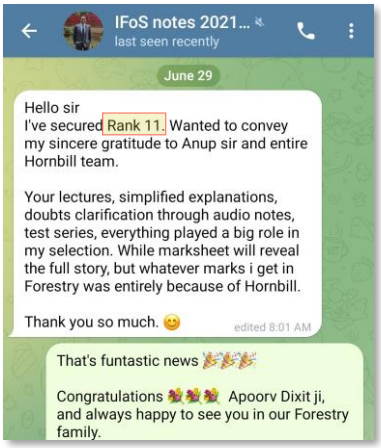
Forestry PYQs

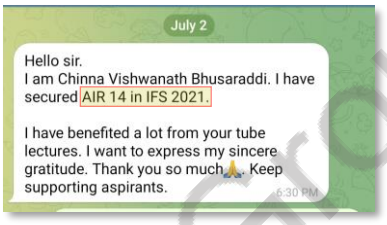
INDIAN FOREST SERVICE MAIN EXAMINATION 2023

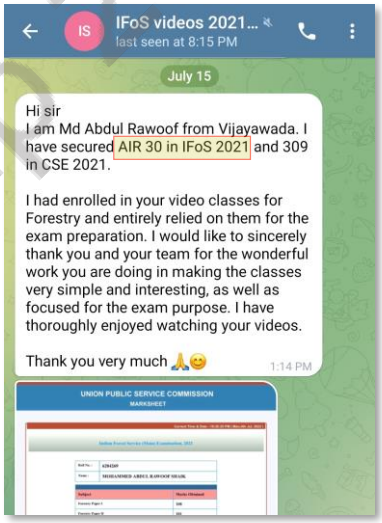
2023

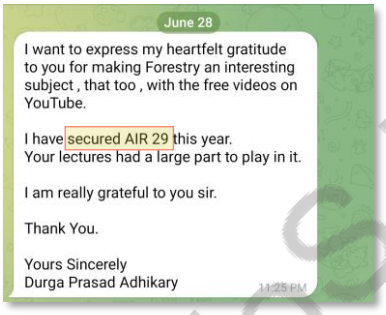
ASPIRANTS FEEDBACK

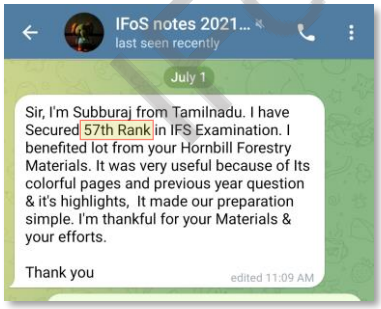
Indian Forest Service (IFoS) 2021

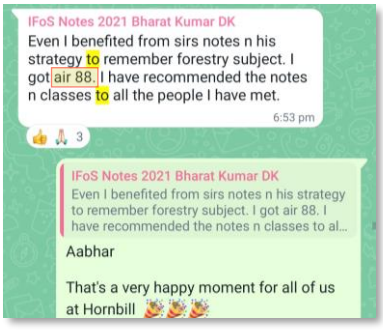












INDIAN FOREST SERVICE (MAIN) EXAM 2023

FORESTRY PYQs

INDEX

1

Chapter

SILVICULTURE

IFoS 2022 : What is *precision silviculture*? Explain the silvicultural techniques for the following. [Paper – 1 | 15 m] – (a) *Dalbergia Sissoo*, (b) *Eucalyptus tereticornis*

Approach : (1) Introduction – a few lines about *precision silviculture*.

(2) Draw a flowchart about its importance in the forest and wildlife sector [Points 1 & 2 should cover about 1/3 of the answer area].

(3) Write down the Silvicultural techniques of *Dalbergia sissoo* and *Eucalyptus tereticornis* with at least a figure [Cover about 2/3 area of your answer].

Precision silviculture means that *every variable in the tree farming system*, such as site preparation, identification of suitable tree species, the number of seedlings planted per unit area, quality of the planting material used, control of surrounding vegetation, fertilization, etc., is precisely matched to a site's soil and weather conditions (*site-specific silvicultural prescriptions*) with *modern digital techniques*. This approach improves operational efficiency and promotes sustainable extraction of forest produce.

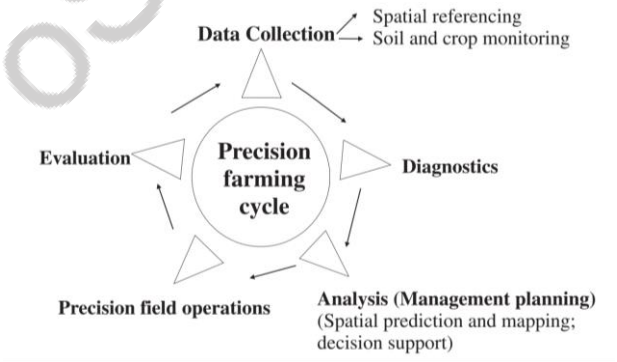


Figure : Precision farming cycle and its components

Precision silviculture ensures the following –

- Selecting and planting the appropriate tree species based on the unique characteristics of each site, leading to improved survival

Precision Farming, or ***Precision Agriculture***, or *Information – intensive agriculture*, or *Prescription farming*, or *Target farming*, or *Site-specific crop management*

Precision Farming is a holistic and environmentally friendly strategy in which farmers can vary input use and cultivation methods – Including application of seeds, fertilisers, pesticides, and water, variety selection, planting, tillage, and harvesting — to match varying soil and crop conditions across a field.

Farmers employ GPS technology, which integrates satellite and ground sensors, along with sophisticated information management and field operation tools. This enables them to comprehensively comprehend and efficiently manage soil and landscape resources. As a result, cropping inputs such as fertilisers, water, and other resources are applied with greater precision, moving beyond conventional "one-fits-all" approaches and leading to a substantial increase in crop production.

rates of seedlings.

- Variable rate application of nutrient supplements, herbicides, and pesticides, based on site-specific needs and guided by GPS.
- Regularly monitoring the health of trees in a timely manner.
- Automating site operations to enhance efficiency.
- Conducting forest valuation and tracking wood during transport.
- Utilizing spatial data on tree growth, yield, and environmental conditions to develop growth and yield models for future management strategies.

DALBERGIA SISSOO

Shisham is a *medium size*, *deciduous tree* with a *relatively well-developed crown* and *dimorphous root system* (both horizontal and vertical roots). *Pan India distribution* except in temperate and alpine climates.

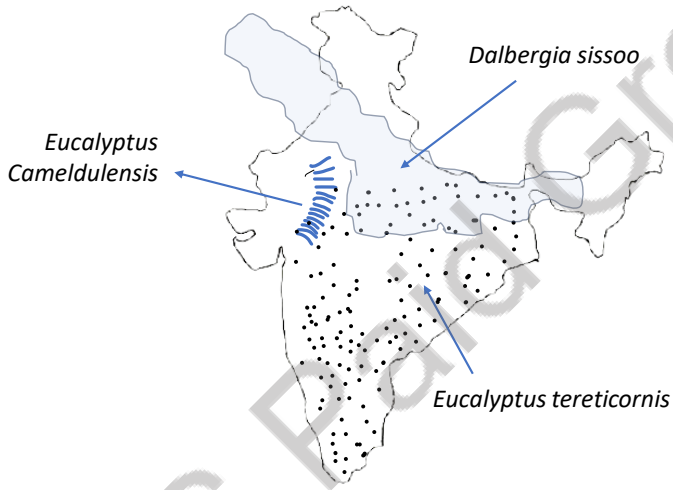


Figure : *Dalbergia sissoo* natural distribution range and artificial plantation of *Eucalyptus tereticornis*

Silvicultural techniques for supplementing natural regeneration or plantation projects

- *Site Selection* : Opt for well-drained loamy and alluvial soils.
- Regeneration : (a) gather seeds from healthy mature trees between February and March for *artificial regeneration*. Plant them in containers with appropriate nutrients, moisture, shade, and protection. Stump planting is also commonly practised. (b) Encourage *natural regeneration* by damaging roots (root suckers) and inducing coppice formation.
- *Planting* : Typically carried out in linear or square patterns during the rainy season.

PRECISION FORESTRY?

Precision forestry is defined as planning and conducting site-specific Forest management activities and operations to improve wood product quality and utilisation, reduce waste, increase profits and maintain the quality of the environment.

Precision forestry is analysing spatial and temporal variability based on natural biology and environmental resources (for instance, soil properties, topography, soil moisture content, microclimate, outbreak of diseases and insect pests etc.). This information is used to plan and conduct site-specific forest management operations to minimise forest outputs. Now precision forestry is used in almost every aspect of forestry production, from soil management to yield modelling.

This question pertains to *Silviculture techniques*. In other words, we need to discuss how to apply different methods of Silviculture, from site preparation, regeneration, and tending operations to harvesting, rather than focusing on the properties of Silviculture properties that we study in the Silviculture system topic.

- *Tending & Pruning* : *Dalbergia sissoo* is a light-demanding species. Light pruning is necessary to promote straight stem growth.
- *Pest Management* : Control *Plecopera reflexa* using gunny bag traps.

EUCALYPTUS TERETICORNIS

Eucalyptus tereticornis is a tall *evergreen tree* that is native to Australia. It requires direct overhead light for proper growth. This tree is found throughout India, except in alpine and arid regions. It has two cycles of flowering and fruiting annually. Since it is an evergreen, Eucalyptus tereticornis sheds and renews its leaves throughout the year.

- Regeneration : through seed and coppice
- Tending operations :

IFoS 2022 : How do *Sacred groves* help in the conservation of biodiversity?
[Paper – 1 | 8 m]

Approach : (1) Introduction – what are *Sacred groves*?
(2) Draw a diagram/figure
(3) Its role in the Biodiversity Conservation
(4) Conclusion : Regarding climate change and current policies

Sacred Groves are forest patches that are owned, protected and managed by the *rural communities* as abodes of specific deities, *i.e.,* The Gompa forest in Arunachal Pradesh.

- It is our ancient tradition of nature conservation.
- Hunting and logging are usually strictly prohibited within these patches

Role in forest and wildlife conservation are –

- It *serves as a haven* for a diverse range of plant and animal species. They act as an undisturbed habitat for the native flora and fauna, including endangered and rare species.
- It acts as a *natural buffer*. Protecting the surrounding forest ecosystem from encroachments, logging, and other forms of human disturbance [**Ecosystem Conservation**]
- Sacred groves act as *natural watersheds*, helping to regulate water flow and prevent soil erosion. Preserving these groves helps maintain local microclimates, nutrient cycling, and overall *ecosystem stability*.

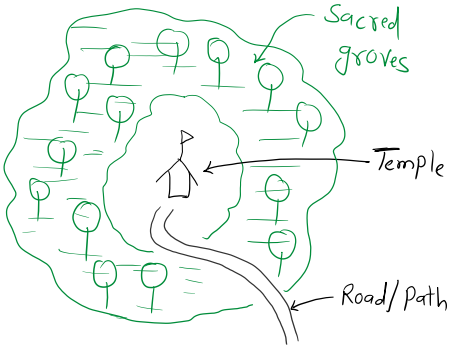


Figure : A Sacred grove

CHALLENGES IN ITS CONSERVATION

- Lack of recognition & legal status
- Increasing people's apathy
- Increasing plastic and chemical pollution
- Climate change impact

- Often harbour ancient and rare species of plants and trees, including those with unique genetic traits [**Genetic Preservation**]
- It holds immense ***cultural and spiritual importance*** for the communities that consider them sacred. These groves are often associated with religious, cultural, rituals, and traditional medicine practices.
- It also serves as an *outdoor classroom* for learning about biodiversity, forest ecology, and traditional ecological knowledge [**Education and Awareness**].

With the recognition of sacred groves as unhindered carbon capturing and watershed recharge units, the government has begun promoting and safeguarding them under 'community reserves' as per the Wildlife (Protection) Amendment Act, 2002.

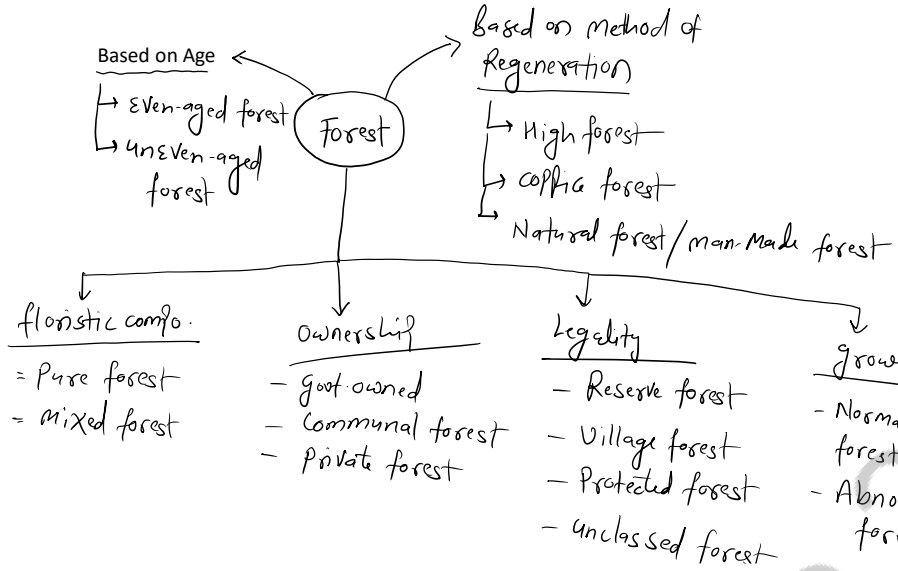
IFoS 2022 : What is the *purpose of classifying forests* ? How are the forests classified for silvicultural management? [**Paper – 2** | 8 m].

Approach : (1) Introduction – Purpose?
(2) Flow chart : few other classification (In very short, Optional)
(3) Purpose of classification

Purpose / objectives of classifying forest can include

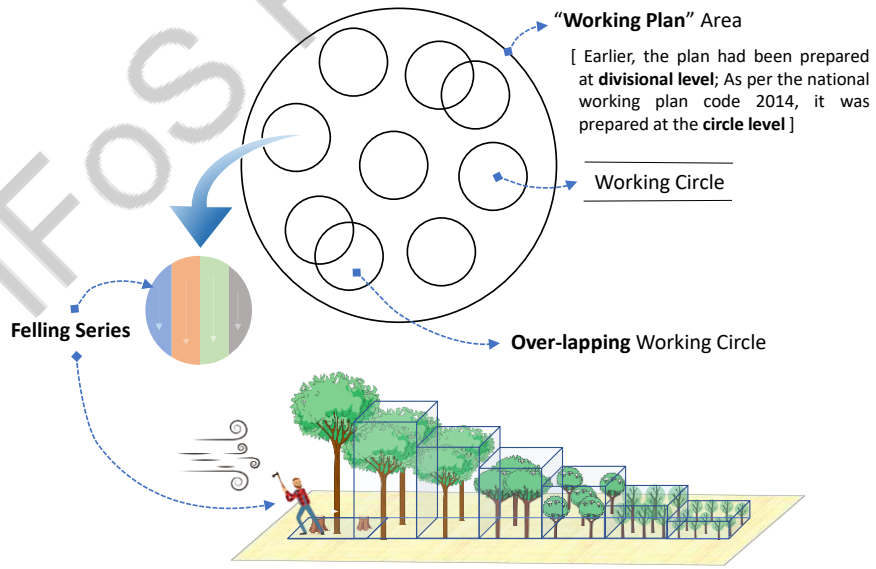
- To provide a *standardized system for identifying, describing,* and *mapping* different types of forests based on their characteristics, such as tree species composition, canopy structure, and ecological function. This information can be used in decision making process related with *conservation*, *management*, *administration*, *research*, *land-use planning* and *record-keeping*.
- Identifying the *areas of high biodiversity* or *ecological significance* for conservation and sustainable management.
- *Developing sustainable management plans* : By understanding the characteristics of different forest types, managers can develop plans that are tailored to the specific needs of the forest ecosystem.

FOREST CLASSIFICATION ON VARIOUS BASIS (FLOW CHART)



From the point of view of Silvicultural management, forests are classified into – (a) Working circle, (b) Felling series, (c) Cutting section, (d) Coupes, (e) Periodic blocks.

- **Working Circle** : The forest management unit is a **working plan**, which is prepared at the Forest Division level. As the area covered by the Working Plan is often large and heterogeneous in sites conditions and crop compositions, different silvicultural treatments may have to be given to the different parts of Working Plan area, and different working rules, called prescriptions are created for each part. Such parts are known as **Working Circles** (W.C).



- **Felling series** : When working circle areas are diverse, we usually divide them into several **felling series** to ensure efficient and effective control and distribution of work (silvicultural treatments) in different areas, as well as preserving the socio-economic interests of tribals, the eco-system, and sustainable yield.
- **Coupe** : in clear-felling system, a Felling series is divided into a number of Annual coupes (Annual felling areas), equal to the number of years in the rotation
- **Cutting section** : Sometimes it may be desirable to avoid fellings in contiguous coupes in successive years for silvicultural considerations, such as danger from fire and/or insect attack. In such cases, a felling series is divided into a number of cutting sections

IFoS 2022 : Explain the silvicultural practices that help in the *modification of site factors* in forestry [Paper – 1 | 15 m]

Approach : (1) Introduction – about site / locality factors?
(2) why necessary to modify
(3) Silvicultural practices that use as a tool in modifying these locality factors

Site or *locality* or *Habitat* factors are the sum of all effective climatic, edaphic, topographic, and biotic conditions of a particular area where 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.

Modifying habitat factors can be done for different reasons, such as preventing habitat degradation, supporting regeneration and growth of local vegetation, increasing production and productivity from a unit area, helping animals adapt to their environment, or restoring ecosystem functions.

Silvicultural practices that are used as a tool for habitat modification

- *Site Preparation* : Altering soil conditions involves tasks like levelling, tilling, weeding, and clearing the planting area. This includes removing gravel, incorporating Bio-fertilizers (FYM), and managing the watershed.
- Using the availability of *light as a tool* to regulate the decomposition of organic matter, promote the growth of new crops, and secondary growth and check weed growth.
- *Cultural operations like Weeding, cleaning and climber cutting* are used for cleaning the surface area, removing undesirable and poor-performing species, problematic lianas, vines and climbers. Additionally, this practice

reduces the risk of potential outbreaks resulting from diseases or pest infestations.

- *Girdling of unwanted growth*
- *Mulching* : A layer of material spread over the soil's surface is known as mulch. Mulch serves various purposes, such as preserving soil moisture (to decrease runoff and evaporation), controlling weed growth, offering thermal insulation to the soil, and enhancing soil fertility and health by promoting microbial activities.
- *Fencing* : preventing damaging agencies from entering the forest area.
- *Afforestation & Enrichment plantation* : Open site with little or no vegetation is vulnerable to soil erosion and evaporation loss, thus necessitates site cover, which can be afforestation etc.
- *Fire management* : Introducing evergreen tree species along firebreaks, clearing and controlled burning of forest debris, and other fire management strategies.

IFoS 2022 : "Success of commercial forest plantations depends on *site-specific and strategic planning*" Justify the statement [**Paper – 2** | 8m].

Approach : (1) Introduction – about commercial plantations?
(2) Map : Important commercial plantation areas with species name (Scientific name)
(3) Issues and challenges of these commercial plantations and site-specific planning.

Commercial forestry plantations involve the planting and growing of trees, mainly exotics, on a large scale with the primary aim of producing timber or other forest products. These production systems, characterised by high input and high output, are typically managed for profit. Their failure results in significant economic losses, in addition to socio-economic and environmental complications such as biodiversity loss, allelopathy, over-exploitation of soil resources, watershed damage, and harm to the local forest ecosystem.

There are several key factors that directly influence the outcome of forest plantation projects.

IFoS 2022 : Describe the *adverse climatic factors* causing damage to forests [**Paper – 2** | 15 m].

Approach : (1) Introduction – about climatic factors?
(2) Types of damages caused by these factors (in detail in the figure)
(3) precautionary measures or Solutions to these factors (In short)

The climatic factors are the various weather phenomena like light, atmospheric temperature, humidity, wind, etc., prevalent in any forest locality and influence its vegetation in occurrence, distribution, and growth. Adverse climatic factors can significantly harm forests, leading to ecosystem disruptions, biodiversity loss, and Socioeconomic challenges. Some of the key adverse climatic factors that cause damage to forests include

High temperature :

Frost & Snow :

Drought :

07223970423 Hornbillclasses@gmail.com

Flood :

Snow :

IFoS 2022 : What are the *biotic and abiotic stresses* on trees? Explain the responses of trees to these stresses [**Paper – 2** | 8 m].

Approach : (1) Introduction – about biotic and abiotic stresses
(2) A flowchart
(3) Physiological, Chemical, and morphological responses

Living (Biotic) and Non-living (abiotic) stresses are two categories of environmental factors that can affect forest vegetation.

Biotic tresses : living organisms such as pests, pathogens, and other organisms that directly affect tree health.

- Insects like beetles, borers, caterpillars, and aphids can attack trees, feeding on leaves, stems, or roots and causing damage.
- Fungal, bacterial, and viral pathogens can infect trees, leading to diseases such as pink disease in Eucalyptus and teak defoliation.
- Competing vegetation, commonly referred to as weeds, can compete with trees for nutrients, water, and sunlight, potentially affecting tree growth and health.
- Larger organisms like deer, rabbits, or rodents can browse on tree foliage or bark, causing damage or hindering growth.

Abiotic stresses : non-living environmental factors that can impact trees. These stresses are often related to unfavourable physical or chemical conditions. Examples include –

- Extremely high or low temperatures - can affect tree physiology and metabolism, leading to stress or damage.
- Lack of water availability - can cause drought stress in trees, impacting their ability to carry out essential functions and leading to wilting or even death in severe cases.

- Flooding - Excessive water saturation in the soil can suffocate tree roots, causing oxygen deprivation and root damage.
- Salinity - High salt levels in soil or water can be detrimental to tree health by affecting water uptake and causing toxicity symptoms.
- Poor soil quality, such as compacted soil, nutrient deficiencies, or imbalanced pH levels, can limit tree growth and Vigor.
- Pollution : Air pollution, including high levels of ozone, sulfur dioxide, or heavy metals, can negatively impact tree health and vitality

Trees have evolved various responses to cope with both biotic and abiotic stresses. These responses can be categorised into physiological, morphological, and biochemical adaptations.

➲ **Physiological Responses**

- *Sunken Stomata* to reduce water loss through transpiration.
- *Adjusting Leaf Angle* to minimize exposure to excessive sunlight, reducing the risk of overheating.
- *Altering Growth Rates* : During periods of stress, trees may adjust their growth rates by slowing down or redirecting resources to prioritize essential functions or areas of the tree that are less affected.
- *Shedding Leaves* : Trees may shed leaves prematurely in response to stress and reducing water loss.

➲ **Morphological Responses**

- *Deep Rooting* : In dry or nutrient-poor soils, trees may develop deep root systems to access water and nutrients from deeper soil layers.
- *Lateral Root* Proliferation
- *Thicker Bark* : to provide a physical barrier for protection against insect pests, pathogens, and forest fire
- *Epicormic Shoots* : After disturbances like fire or pruning, trees may produce new shoots called epicormic shoots, which can help regenerate foliage.

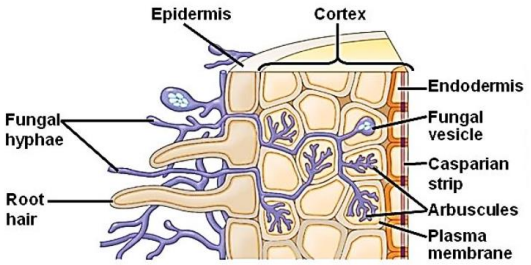
➲ **Biochemical Responses**

- *Production of Stress Proteins* : Trees synthesise specific proteins called stress proteins or heat shock proteins that help protect cells from damage caused by stress.
- *Antioxidant Production* : In response to oxidative stress caused by pollutants or other environmental factors, trees increase the production of antioxidants to counteract the harmful effects.
- *Altered Metabolic Pathways* : Trees can modify their metabolic pathways to adapt to stress conditions, enabling them to continue essential processes even under adverse circumstances.

IFoS 2022 : Explain the *role of mycorrhizae* in plant growth and development of forest trees [Paper – 1 | 10 m].

Approach : (1) Introduction – about Mycorrhiza?
(2) Structure/Figure
(3) Role of 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*).



Endomycorrhizae

Role of Mycorrhiza

- *Better absorption of soil moisture and minerals* by increasing net water absorption surface area as fungal filaments work as root hairs that also help plants for increasing *drought tolerance*.
- *Increase availability of unavailable minerals* to the plant : Some minerals become unavailable or unabsorbable, called fixation (*i.e.*, phosphate fixation), to the plant because of soil pH. Fungal hyphae release organic acids that make it in available form, so the plant can sustain itself even under harsh/unfavourable soil conditions, especially when the soils are deficient in phosphorus.
- *Nitrogen Fixation* : Some fungi also fix atmospheric nitrogen and make it available to the plant = The plant can grow in nitrogen deficit soil where other plants cannot.
- *Produce some growth hormones*, *i.e.*, Auxin, gibberellin that further boost up the plant's root & shoot growth
- *Phosphate reservoir* : Nearly 80–90 per cent of the absorbed phosphate remains in the fungal sheath. Thus, the fungal sheath may act as a reservoir of nutrients (especially phosphate) and release them as the occasion demands under adverse conditions.

IFoS 2022 : Explain the role of mycorrhizae in plant growth and development of forest trees (10 m)

IFoS 2017 : Discuss in detail, the kind of mycorrhiza and the benefits derived by the plant from them (8m)

IFoS 2010 : How are Ecto-mycorrhizal fungi beneficial in managing soil born diseases of forest nurseries ? gives examples (10 m).

IFoS 2008 : Explain Mycorrhiza and their importance in forest Nursery (10 m).

Advantage with mycorrhizae fungi inoculation [Karnataka PCS

- *Mycorrhiza-induced resistance* (MIR) – Mycorrhiza provides systemic protection against a wide range of attackers by inducing systemic resistance (ISR) after pathogen infection through -
    - Improvement of plant nutrient status will help plants to fight competition, and biotic - abiotic stresses.
    - Changed root morphology and structure to promote root colonization by non-pathogenic rhizobacteria & other microbial flora.
    - Decreasing space for attachment to other fungi groups, *i.e.*, dumping off fungi.
    - Inter-plant signaling : Plants Use Mycorrhizal Fungi (*hyphal networks*) to Warn each other of incoming threats through defensive proteins like Allelochemicals.

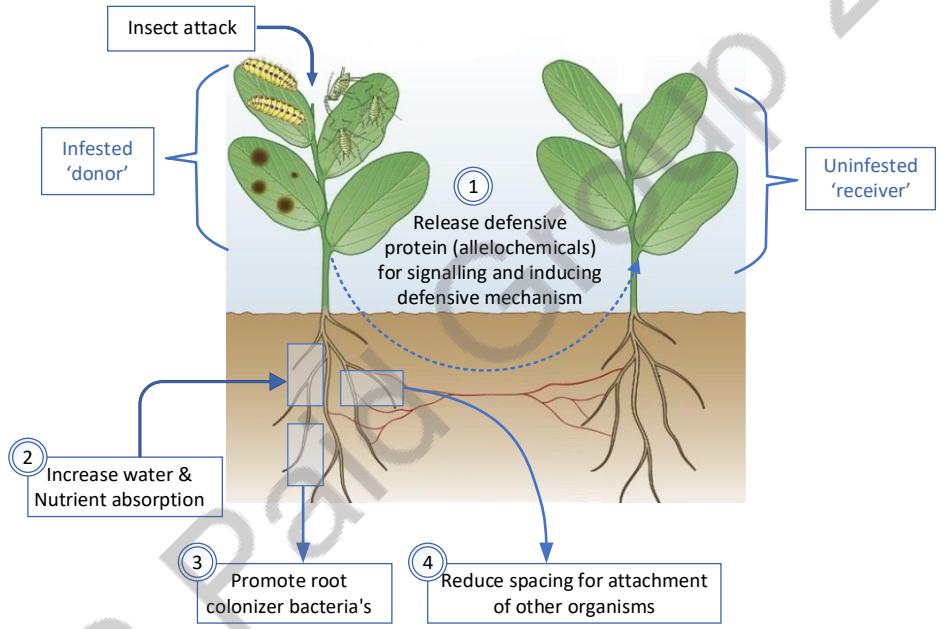


Figure : Role of mycorrhiza in plant's defence

IFoS 2022 : What are *commensalism*, *Amensalism*, *Mutualism* and *symbiosis*? Write the function of an ecosystem [**Paper – 2** | 10 m]

Approach : (1) Introduction – about interactions and these terminologies with examples + 1 or 2 figures
(2) Function of an ecosystem

In a forest ecosystem, a plant species influences the growth, progress, and distribution of other plant species, wild animals and microbes through a variety of mechanisms.

- **Commensalism** : a type of interaction between two species where one species derives benefits such as shelter (Protection), moisture, nutrients, or

space (light), while the other remains unaffected in terms of harm or benefit, *e.g.*, Orchid

- **Amensalism** : is the interaction between two different species, in which one species is harmed, and the other is neither benefitted nor harmed, *e.g.*, Eucalyptus causing Allelopathy to the wheat food crop.
- **Mutualism** : a type of symbiosis where both species involved benefit from their interaction, leading to advantages for their survival or reproduction. If they are separated from each other, then they will not die
- **Symbiosis** : involves a close interaction between two distinct species residing in close proximity. Lichen is a symbiotic association between an alga and a fungi. Both of these live together for their mutual benefit. Within this interaction, the fungus retains water, offers protection, and serves as a suitable habitat for the algae. In return, the alga provides the fungus with carbohydrate nourishment. Moreover, the algae have the ability to convert atmospheric nitrogen into a usable form, which they supply to the fungus. This kind of mutual interdependence helps lichens to grow on dry, barren rocks where other plants fail to survive. Thus, if algal and fungal partners are separated from each other, then they will die.

FUNCTION OF AN ECOSYSTEM

- Regulating the essential ecological processes, supporting life systems and rendering stability. Soil and water conservation (Watershed recharge), improve water quality.
- Cycling of nutrients between biotic and abiotic components.
- Maintaining a balance among the various trophic levels.
- Flow of energy from one trophic level to another.
- Decomposition of organic matter and production of biomass.
- Climate regulation
- Biodiversity conservation
- NTFP/Timber production = Tribal economy

Why does ecology matter to a forester? Describe the various ecosystem services accruing from the terrestrial forest ecosystem and the mangrove forest ecosystem [GPSC RFO (Main) 2021 | 10 m]

IFoS 2022 : Discuss the *significance of bamboo flowering* [Paper – 1 | 8 m]

Approach : (1) Introduction – about flowering in bamboo?
(2) Flowchart : Types of flowering with examples
(3) Significance of bamboo flowering – *Stakeholder* analysis

Bamboo is a type of grass of the *Poaceae family*. Unlike others, it has three types of flowering.

- **Continuous (Annual) flowering** : under which species keep flowering year after year without dying. *Arundinaria falcata* (a bamboo species growing in

Shivalik and the inner Himalayan region from Himachal Pradesh to Arunachal Pradesh) and *Ochlandra travancorica* (bamboo species growing in the Malabar region) are showing this type of flowering.

- **Gregarious flowering** : When a patch of forest is mainly made up of one species of bamboo, and all start flowering roughly at the same time. *Most of the bamboo species* show *gregarious flowering* after a long period and usually die after it.
- **Sporadic flowering** : When a bamboo forest starts flowering at different times without showing any flowering pattern, even individual stems (culms) of the same clump bloom at different times. it seems that it may be induced by environmental factors such as drought or cold instead of genetics. Example – *Gaudua angustifolia* (Columbian timber bamboo).

IFoS 2010 : Differentiate between the *gregarious* and *sporadic* flowering in bamboo (4m).

Bamboo flowering after 40 years may push Tadoba to the brink.

A secretion of bamboo, a fine, siliceous matter, called 'tabasheer', found in the stem of bamboos like Phyllostachys bambusoides, is used in Ayurvedic medicines as a cooling tonic, to treat cough and asthma and even as an aphrodisiac.

Culturally, bamboos are close to the Assam tribal people. A flute called '*eloo*', made from the bamboo species *Dendrocalamus tulda*, is played by the priest during the 'Dree festival' to drive away evil spirits.

SIGNIFICANCE OF BAMBOO FLOWERING

- *Ecological impact* : massive flowering events provide a massive food source for various animals, including rodents, birds, and insects, which feed on bamboo seeds and flowers. The increased availability of food can lead to population booms of these animals.
- Death and destruction of large swaths of land = clearing space for new vegetation and growth.
- This would also lead to food scarcity since several animals depend on this plant = Animal deaths and migration due to the plague = reduce population pressure on an area.
- *Reproductive Strategy* : During "masting" or "gregarious flowering, a large number of bamboo plants within a given species will flower and produce seeds simultaneously. This increases the chances of successful pollination and seed dispersal = *increases species survival changes*.
- *Boost tribal economy* : Plays a vital role in providing raw materials for various products (Bamboo rice), construction, and crafts.
- *Scientific Research* : Bamboo flowering events allow researchers to study various ecological and evolutionary processes. Studying these events can help scientists understand the mechanisms behind the long flowering intervals, the ecological impacts of masting, and the role of bamboo in maintaining biodiversity

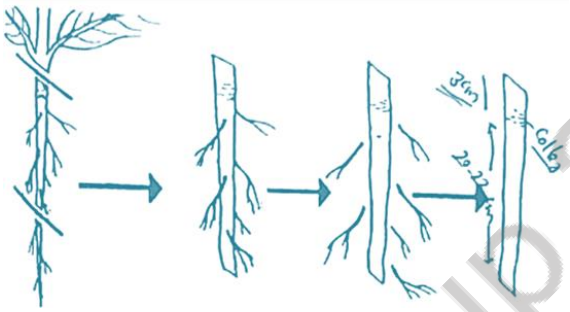
IFoS 2022 : What is *root : shoot cutting*? Write the names of five tree species which are propagated by this method [Paper – 1 | 10 m]

Approach : (1) Introduction – about stump with its significance

(2) Procedure with diagram

(3) Scientific name of 5 tree species [follow ICBN rules]

A Root-Shoot cutting or Stump is a vegetative propagating material comprising the lower part of the stem (2-3 cm in length) and a taproot that is 20 to 30 cm long, devoid of lateral roots. It is employed for species characterised by robust tap root formation, heightened coppicing ability, and actual challenges in regenerative establishment due to poor site quality and the presence of local weed growth.



For making a stump, plants are taken out of the bed with naked roots. Plants with a collar diameter equal to the thumb's thickness (1.5-2.0 cm) and tap roots not less than 30 cm long are selected to prepare stumps. After plant selection, the *shoot* is trimmed to a 3 cm portion using a sharp knife or pruning scissors. All lateral roots are pruned. The taproot is cut around 20-22 cm from the collar. In moist areas, the root length may be reduced to 15 cm, and in dry areas, it may be increased to 30 cm.

Species that can be propagated by this method are as follows

1) *Tectona grandis*
2) *Dalbergia sissoo*
3) *Gmelina arborea*
4) *Acacia catechu*
5) *Pterocarpus santalinus*

IFoS 2022 : Explain the techniques for upgradation and *hardening of nursery seedlings* of *Lagerstroemia lanceolata* [Paper – 1 | 8 m]

Approach : (1) Introduction with need of hardening

(2) Upgradation & Hardening techniques

Upgrading and hardening of nursery seedlings of *Lagerstroemia lanceolata*, are essential steps to ensure their successful transition from the controlled nursery environment to the more challenging conditions of the outdoors. These techniques help the seedlings adapt to water and temperature stresses,

develop stronger structures, and become better equipped to thrive in their intended harsh local conditions.

Techniques for upgrading and hardening nursery seedlings

- *Gradual Exposure* : Gradually expose the seedlings to outdoor conditions over a period of time. Start by placing them in a sheltered spot with indirect sunlight and minimal wind. Then, their exposure to sunlight, wind, and temperature fluctuations progressively increases. This process helps the seedlings acclimate to the changing environment without causing shock.
- *Reduced Irrigation* : Gradually decrease the frequency of irrigation as the seedlings develop. This encourages the seedlings to develop a more extensive and robust root system as they search for water deeper in the soil. However, ensure that the seedlings do not become overly stressed due to drought.
- *Transplantation* from small containers to larger pots before moving them outdoors. This gives the roots more space to grow and prevents them from becoming root-bound.
- *Fertilization* : Apply a balanced and diluted fertiliser during the hardening phase for healthy growth as the seedlings adapt to new conditions.
- *Pruning* : Lightly prune the seedlings to encourage branching and denser growth. This can help the plants develop a sturdier structure and prevent them from becoming too leggy or top-heavy.

IFoS 2020 : Describe the term – Hardening

IFoS 2015 : Explain the term *Hardening off*. What are the internal factors affecting forest resistance? (10m)

IFoS 2009 : Write short notes on the Grading and hardening of seedlings

Write short notes on - Hardning of seedlings [UPPSC (ACF) 2020]

Hardening off : The natural process by which plants gradually adapt to drought, cold or heat by exposing them to a particular stress. This term is also used for preparing seedlings in a forest nursery or greenhouse for planting out by gradually reducing watering, shade and/or shelter resulting in the hardening of plants.

IFoS 2022 : How are *nurseries classified* in India? What is a clonal nursery? Explain the nursery technique for *Casuarina equisetifolia* [Paper – 1 | 15 m]

Approach : (1) Introduction – About nursery & its types
(2) Upgradation & Hardening techniques

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

1) Based on Duration/management

- *Permanent Nurseries* : These nurseries are usually centrally located and conveniently situated by the roadside for supplying planting material for plantations over a large area. Permanent nurseries have a suitable

layout, road, inspection paths, beds for sowing and transplanting, irrigation and drainage facilities, seed store, labour hut, etc.

- *Temporary Nurseries* : Established to meet the requirement of one or two years of plantation work and generally established near or inside the plantation area

2) Based on the availability of moisture

- *Dry Nurseries* : maintained without irrigation or artificial watering. Usually inside the forest area.
- *Wet Nursery* : If the water source is available

3) Based on Ownership

- *Government nurseries* : owned and managed by the forest department
- *Private nurseries* : run by individuals, families, or corporations
- *Cooperative nurseries*

4) Based on Specialization / Uses

- *Ornamental Nurseries* : These nurseries primarily focus on growing ornamental plants, including decorative trees.
- *Vegetable Nurseries* : grow various types of vegetable plants.
- *Medicinal Plant Nurseries* : These nurseries focus on growing medicinal plants and herbs that are used in traditional medicine.
- *Forest Nurseries* : propagation of trees specifically for afforestation and reforestation.

5) Based on Purpose

- *Commercial Nurseries* : the primary goal of generating a profit by selling seedlings
- *Research and Demonstration Nurseries* : research centres where new plant varieties, cultivation techniques, and agricultural practices are tested and showcased
- *Conservation Nurseries* : focus on propagating and conserving rare, endangered, or indigenous plant species.

CLONAL NURSERY

A clonal nursery is a specialised enclosed facility that focuses on propagating plants through asexual reproduction methods, such as cuttings, budding, grafting, Air layering or tissue culture, to produce genetically identical offspring (clones).

This type of nursery is designed to produce disease-free, higher genetic planting material of uniform quality at a large scale in a short time.

NURSERY TECHNIQUE FOR *Casuarina equisetifolia*

Casuarina is a *light-demanding*, *medium-sized* (10-15 m in height), *exotic evergreen* tree with a *conical-shaped crown* and an extensive *deep tap root system*.

- Seed Collection : harvest cones from healthy mid-age parent trees.
- Seed treatment : Scarification : Casuarina seeds have hard seed coats that may require scarification to break dormancy.
- Transplanting :
- Light and Temperature :
- Hardening off : Before transplanting the seedlings outdoors, gradually expose them to outdoor conditions to acclimate them. Start with a few hours of indirect sunlight and gradually increase exposure over a week or two.

IFoS 2022 : Differentiate between *thinning cycle* and *thinning intensity*. Why is thinning essential for the management of *forest stand*? Describe the *merits and demerits of French thinning* [Paper – 1 | 15 m]

Approach : (1) Introduction – *thinning cycle* and *thinning intensity*?
(2) Need/Requirements of thinning
(3) Merits & Demerits of French Thinning

Thinning cycle and thinning intensity are two concepts often utilised in tending operations to describe the management practices related to the selective removal of trees from a forest stand, aiming to achieve specific objectives.

Thinning Cycle	Thinning intensity
It is periodic in nature and generally constant	It depends on the site conditions and the level of thinning required.
It is the time interval between two successive thinning operations	It is the number of trees that fell in a single thinning operation
It aims to organise the forest in consonance with the working plan	It aims to remove deformed, diseased, old trees along with thinning operations.
It facilitates secondary growth in tree species like diameter growth	It reduces site vulnerability against possible pathogen attacks, improving

THINNING OPERATIONS ARE ESSENTIAL FOR THE MANAGEMENT OF FOREST STANDS BECAUSE OF –

- *To remove dead, dry, diseased*, and weakened trees that may become a source of infection to the remaining healthy ones
- *To obtain a desirable crop composition*
- To reduce the number of trees in the stand so that the remaining ones get *more space for crown and root development*
- To remove trees of poor forms, such as crooked, forked, roughly branched, or moribund form, so that all future increment is concentrated only on the best trees
- *Provide intermediate financial return*

FRENCH THINNING

Under this, the *less promising trees of the top crown are being removed in the best available individuals' interest*. The dominated and suppressed stems are retained to help in natural pruning unless they are dead, dying, or diseased.

ADVANTAGES

- As lower canopy retained = Checks soil erosion + Weeds & shrubs growth + damaging effect of frost, snow etc.
- Shade-bearing trees are also protected.
- The side branches are naturally pruned due to the presence of lower crown classes.

DISADVANTAGES

- Dominant trees may be adversely affected due to tough root competition for moisture and nutrients with a lower canopy.
- It requires experience and skill.
- Lower tree classes also created difficulties while carrying out silvicultural operations, e.g., marking, felling, logging, and extraction of the thinned material.
- The diseased and insect-infested trees of lower crown classes are always sources of infection for the main crop.

IFoS 2021 : How are *forest sites* classified on the basis of vegetation?
[Paper – 1 | 10 m]

Approach : (1) Introduction
(2) Flowchart : Classification
(3) Classification in detail

Various methods and criteria are used to classify forest sites based on vegetation, including dominant plant species, density, structure, and ecological characteristics. These classifications help researchers, ecologists, and land managers better understand and manage different types of forests.

Flaw chart

CLASSIFICATION

- *Very dense species vegetation* : in these forests, the canopy density is more than 70 %. In this vegetation, generally dominant and dominated species are found, and the grass growth is minimal owing to less sunlight penetration to the ground.
- *Dense species vegetation*- in these forests, the canopy density is between 40-70%. In this type of vegetation dominant and suppressed species are found.
- *Open forest* : A forest where canopy density is less than 40% but more than 10 per cent is considered an open forest. here generally suppressed trees are found along with few dominated tree species.
- *Scrubland* : Those areas where forest cover is less than 10 % are considered scrubland. Here few suppressed species are found along with scrubs.
- *Non- forest* : a forest that does not lie in the above criteria is considered a non-forest area.

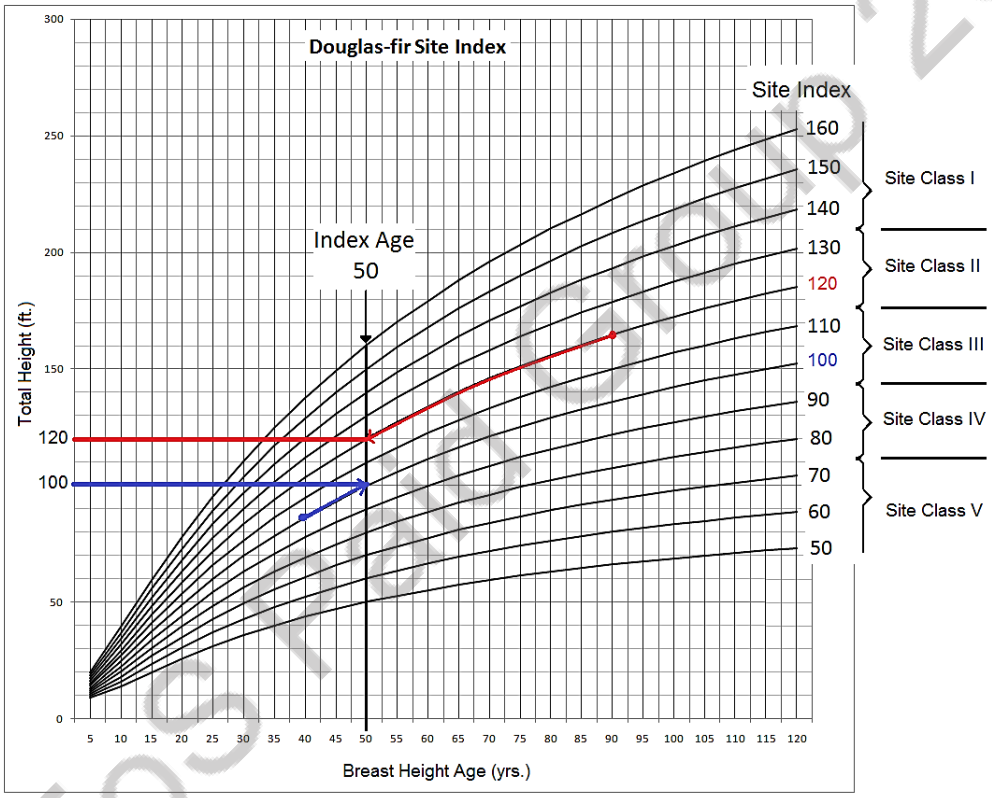
IFoS 2021 : What is the *Site Quality* Index? How does it differ from fractional site quality? Explain any one method used for developing site quality classes with the help of a neat diagram [**Paper – 2** | 15 m]

The site quality index is the average height of the *dominant* and *co-dominant trees on the site at a given age (base age). Typically, the base age for hardwoods is 50 years, and for softwoods is 25 years. Whereas the Fractional site quality* is defined as the site quality expressed as a decimal subdivision of the height range of half a quality class, the figures running 0.0 to 2.0 within the whole quality class.

For example, a SI of 75, base age 50, means that the average height of the dominant and co-dominant trees on a site will be 75 feet when they are 50 years old (SI_{50} = 75). The higher the SI, the higher the site productivity (which means trees will grow faster than on a site with a lower SI). To calculate SI, count their numbers, Total height, and ages of these trees.

The site Index approach is the most common method used for accessing site-quality classes

Site Index is determined by measuring the height of dominant or codominant trees (usually one of the economically important species) at a standard reference age. The reference age is typically 50 years, although it can vary depending on the tree species and local conditions.



Steps :

- Height Measurement : Measure the height of dominant or codominant trees of the target species on the site.
- Reference Age : Choose a standard reference age (*e.g.*, 50 years) for the calculation.
- Site Index Calculation : Calculate the Site Index using the formula –
  Site Index = (Height of Trees at Site / Height of Trees at Reference Age) × 100
- Quality Classes : Once you have the Site Index value, you can classify the site into quality classes. For example :

Class I: Site Index > 120

Class II: 100 < Site Index ≤ 120

Class III: 80 < Site Index ≤ 100

Class IV: 60 < Site Index ≤ 80

Class V: Site Index ≤ 60

The classes can be adjusted based on species-specific requirements and local conditions

IFoS 2021 : Do the trees of the same species have different responses to *light conditions* at different ages? [Paper – 1 | 8 m]

Trees of the same species may respond differently to light based on their age, due to changes in physiological traits, growth patterns, and developmental stages as they mature.

Draw a figure

For example, **Sal** (*Shorea robusta*) can *persist under moderate shade*, but its best development is obtained under a complete *overhead light*. During their initial growth phases, a certain degree of partial shade is essential for optimal development. Deodar trees can tolerate moderate shade during their early growth stages, but they require unobstructed overhead light to achieve robust progress in later phases.

Why trees of the same species might have varying responses to light conditions at different ages?

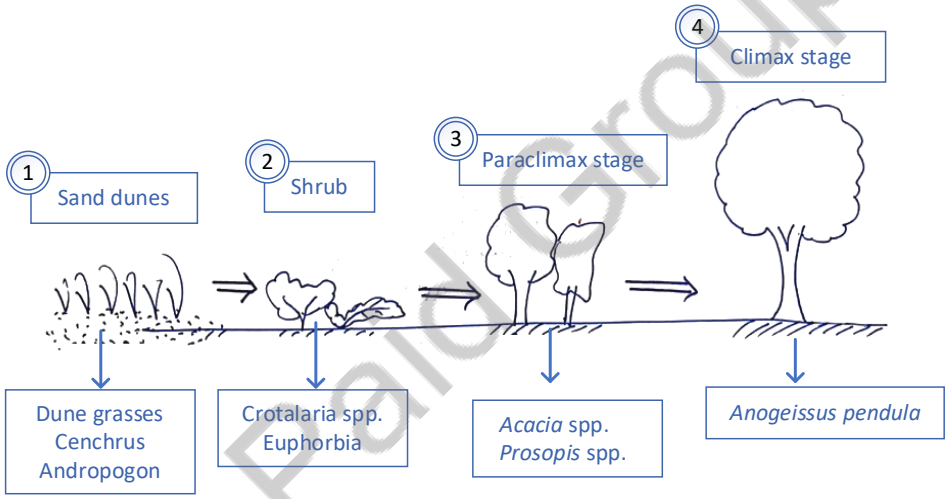
- *Developmental Stage* : Young trees are typically more sensitive to changes in light conditions because they are actively growing. As trees age, their growth rate may slow down, and they might become more acclimated to their specific light environment.
- *Competition* : Young trees might be more susceptible to competition with other plants for sunlight, water, and nutrients. Older trees that have established themselves might be better equipped to handle such competition.

- Trees can adapt to their specific light conditions over time. This can include changes in leaf morphology, physiology, and growth habits.

IFoS 2021 : What is meant by *climax* in ecological succession? Give an example and describe types of ecological succession [**Paper – 2** | 8 m]

In ecological succession, the term "climax" refers to the stable and final stage of a succession process in a specific ecosystem or habitat. It represents the point where the community of plants and animals has reached a state of balance and equilibrium with the environmental conditions of that particular area. If external disturbances are minimal, species composition and environmental conditions remain consistent over time. The climax community is thus considered the endpoint of ecological succession.

Figure :



Example : *Anogeissus pendula* (Dhok or button tree) forest around Aravali mountain range

DIFFERENT TYPES OF ECOLOGICAL SUCCESSION

(a) On the basis of previously available organic matter

- **Primary succession**: When the process of succession starts on land, there is no previously available organic matter, which means succession starts on freshly opened soil. *Example* : Succession in alpine areas after nudation of land by a heavy landslide.
- **Secondary Succession** : When the succession process starts on the field, there was previously available organic matter present, which means succession starts on the old site. So the rate of succession is faster than primary succession. *Example* : development of forest vegetation after forest fire incidence.

(b) Based on the cause of succession

- **Autogenic succession**: After the succession has begun, the community modifies itself and its own environment and replaces its own with a new community. It means there was no external interference, *i.e.,* the Amazon rainforest.
- **Allogenic succession**: the replacement of one community by another due to external forces.

(c) On the basis of the nature of substratum

- Xerarch succession: when succession (especially primary) starts on dry rock material, windblown send and mineral matter under extremely dry conditions.
- Mesarch succession: when succession begins on moist and well-aerated soil material.
- Hydrarch succession: when the succession process starts in water or very wetlands, *i.e.,* ponds, lakes, marshes, etc.

IFoS 2021 : What factors are considered important while *choosing a species* under avenue plantation? [Paper – 1 | 8 m]

Choosing a species for road-side (avenue) plantation involves considering several important factors to ensure the success, aesthetics, and sustainability of the planted trees.

- Local climate and Soil Conditions
- Species growth behaviour : Fast-growing species might provide quicker shade and visual appeal, but they can also require more maintenance and pruning.
- Canopy Size and Shape : Trees with well-defined canopies can create a uniform and aesthetically pleasing appearance.
- Brittleness of branches
- Root System : Some trees have invasive root systems that can damage sidewalks, roads, and underground utilities.
- Pest and Disease Resistance : Trees that are resistant to local pests and diseases will have a better chance of thriving without the need for constant interventions.
- Aesthetics : Choose species that align with the desired visual aesthetics of the avenue. Consider factors like flower colour, leaf texture, fall foliage, and overall appearance.

- Wildlife Value : Some trees provide habitat and food for local wildlife
- Cultural or historical significance to the local community.
- Local Regulations : Be aware of any local regulations or guidelines that pertain to tree planting

IFoS 2021 : Are *non-native* tree species an option or a threat in forest ecosystems / Plantation under climate change? [Paper – 1 | 8 m]

Exotic (Non-native) tree species can be both an option and a threat in forest ecosystems and plantations under climate change, depending on various factors including their adaptability, potential invasiveness, Socio-economic implications, and the specific goals of forest management.

As an option

- It *Provides 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 better in exotic land* than in their natural habitat due to the *absence of pests & and 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 totally absent.
- *Fast-growing* + higher quality of product = *increased productivity and production* of our forest.

Disadvantages of exotics

- They are considered *ecologically less valuable than indigenous species*; they do not have any linkage with the local ecosystem for the next few years. Even in the absence of insect pests (Controlling biotic factors), this species can *become obnoxious*.
- Become susceptible to *new insect pests*, *i.e.*, Pink disease in *Eucalyptus* spp.
- *The introduction and acclimatization process took a long time* and may not serve the purpose of immediate needs.
- *Unable to produce viable seeds*, *i.e.*, after more than 200 years of introduction, Eucalyptus is still unable to produce viable seeds outside of Nilgiri.
- The health issue of Russian poplar in Kashmir valley. *Prosopis cineraria'* issue in Telangana.

IFoS 2021 : Why is the *grading* operation of nursery seedlings essential for successful forest plantations? [Paper – 1 | 10 m]

Success in plantations largely depends on the quality of the seedlings and transplants used for planting. It is, therefore, necessary that the seedlings be graded in the Nursery before these are prepared for transport to the plantation site.

The criteria that may be adopted for grading the seedlings may include the seedlings' age, size of the seedlings, root-shoot characteristics, vigour, infection of insect pests and diseases, etc.

In nurseries, the height of the seedlings and their age is usually considered for grading the seedlings. For conifers, the seedling height of 25 to 50 cm and broad-leaved species, a height of 50-100 cm, is considered the optimum size.

Several categories of seedlings need to be rejected. These include –

- Undersized seedlings,
- Seedlings with poor root growth,
- Seedlings infested with insect pests and diseases and
- Damaged seedlings

Why essential for successful plantation

- It helps us segregate poor-quality plants and healthy plants.
- In forest plantation the seedling to subjected to varying degrees of stress. Grading operation helps us in finding out which species has the ability to survive in such condition
- Grading of seedlings helps in determining the performance of seedlings in the longer run.
- Seedling grading helps us in providing desired characteristics to the crop

IFoS 2021 : What do you mean by *tending* operations? Enumerate various tending operations carried out in forest crops. Discuss improvement feeling [Paper – 1 | 15 m]

Tending operations refers to those methods that help in the growth of plants by providing them sufficient sunlight, removing unnecessary competition between tree species, and removing weak and diseased trees which might become the source of epidemic in the forest.

- Weeding : It involves the removal of weeds from the forest.

- Cleaning : It involves cleaning the site by removing leaf litter, and tree branches and it also involves soil working
- Pruning : it involves the removal of live or dead branches from the tree. It helps in facilitating light movement which helps in stem increment.
- Thinning : It involves the removal of trees from the forest stand. The trees removed here are generally weak, diseased, or deformed in shape. It helps in limiting competition between trees.
- Girdling : It is usually adopted where the felling of a tree is not possible. Thus here the bark of the tree is removed which facilitates the death of trees.
- Climber cutting : Climbers are those species which use other plants for their growth. It results in the deformation of the bole of the parent tree, thus prompting them to cut the climber in order to achieve the desired shape.
- Improvement felling : It is usually carried out in the uneven-aged forest where the less valuable species or inferior species is cleared from the forest in order to pave the way for healthier ones to grow with minimum competition. In this felling, multiple other tending operations are also included like Thinning, Climber cutting, cleaning operation etc.

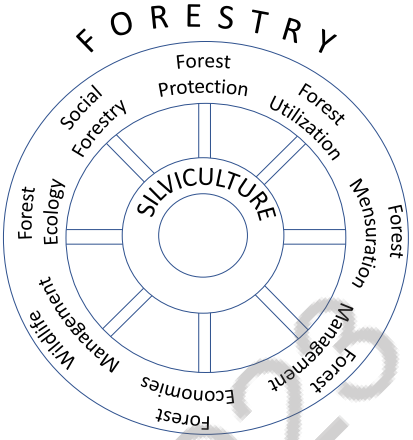
IFoS 2020 : Define *silviculture*. Relate the applications of silvicultural to different branches of forestry [Paper – 1 | 8 m]

Approach : (1) Write down the definition of silviculture as an introduction part.
(2) Now, start writing some 2/3-line para about this relationship (Silviculture *v/s* other branches of forestry), and then draw a flowchart / Diagram.
(3) Write down the remaining part related to the relationships in a point-wise format

Silviculture is the art and science of cultivating forest crops. It works as a hub (Backbone) of the forestry wheel, where other forestry branches, *i.e.*, Forest protection, Forest Management, Forest Mensuration, etc., are supported by Silviculture.

- **Silviculture & Forest Protection**: Under forest protection, we direct the activities that prevent & and control the damages caused by humans, insects, pests, animals, forest fires, etc. Here, Silvicultural principles would help us to - (a) mix the crop composition to increase insect/pest resistance, (b) introduce evergreen species for controlling forest fires, and (c) grow live fencings to prevent animal damage.

- **Silviculture and forest Utilization** : Here, silviculture helps in – (a) the cultivation of economically more valuable and high-grade forest produce. (b) Sustainable harvesting and extraction of forest products with reducing impact over local watershed and ecosystem.



- **Silviculture and Forest mensuration** : Silviculture deals with raising forest crops and forest mensuration to determine the result of applied applications or methods of silvicultural treatments to decide the best treatment to be given for commercial timber production.
- **Silviculture and Forest Management** : Silviculture deals with the techniques and operations that result in the improvement of forest regeneration, productivity, reduction in crop rotation period, and improvement of wildlife habitat, including the production of minor forest produce. Whereas, Forest management prescribes the time and place where the silvicultural techniques and operations should be carried out so that the objectives of management are achieved.
- **Silviculture and Forest economics** : to interrelate with silvicultural operation costs with the cost-benefit ratio of the resultant crop, management cost, and investment opportunities in the forest enterprises.
- Silviculture and wildlife management
- Silviculture and Forest Ecology

Note : A question can be written in many ways and here is a small attempt to do it. However, we believe you can write an even better answer than this.

IFoS 2020 : ***Frost resistance*** in trees depends on internal and external factors. Explain [Paper – 1 | 8 m].

Approach : (1) Write down a few points about frost as an introduction.
(2) Now, start writing about frost resistance due to Internal factors with diagrams or Flowcharts.
(3) Write down external factors
Note : Remember the page/Text limits

Frost means the chilling of air below the freezing point. This Sub-frizzing temperature might be lethal to the plants. However, due to few specific mechanisms many temperate and sub-tropical species easily thrive under this condition.

INTERNAL FACTORS THAT MAKE THEM RESISTANT TO FROST

- **Water content in the cell** : On average, Water makes up about 70 % volume of a plant cell. A Higher amount of cell water = more increment in the volume of water during freezing inside the cell = damages the cell wall

and its organelles, and also blocks its metabolic process. It means more water = Low resistance and *vice versa*.

- **Osmotic concentration of cell colloids** : water-binding colloids like Sugar, mucilage, pectin substance, and Antifreeze proteins (like ***dehydrin***) increase osmotic concentration and leave a very small amount of water free to freeze on one side; on another side, they also reduce its freezing point. It means Higher osmotic concentration = less chance for the cell to freeze
- **Permeability of cell to water** : in the high permeable cell wall, during the freezing process inside the cell, the excess water moves out quickly, so less possibility of rupturing the cell membrane and cell walls.
- **Cell size** : Smaller cells are harder than larger cells due to their small volume surface ratio and more readily bind their water molecules with their colloids

EXTERNAL FACTORS THAT MAKE THEM RESISTANT TO FROST

- **Temperature** : Sudden fall in temperature is much more injurious than its gradual fall even for partially hardy plants because rapid fall increases the danger of internal ice formation.
- **Season of growth** : Plants that can withstand extremely cold conditions during winter may be killed by slight frost during spring.
- **Light** : lesser the duration of light = poor new growth = greater frost-hardiness.
- **Mineral nutrients** : Nitrogen stimulates vegetative growth and therefore reduces frost-hardiness. Whereas, a higher dose of Phosphorus and potassium increases resistance.
- **Water availability in the soil**

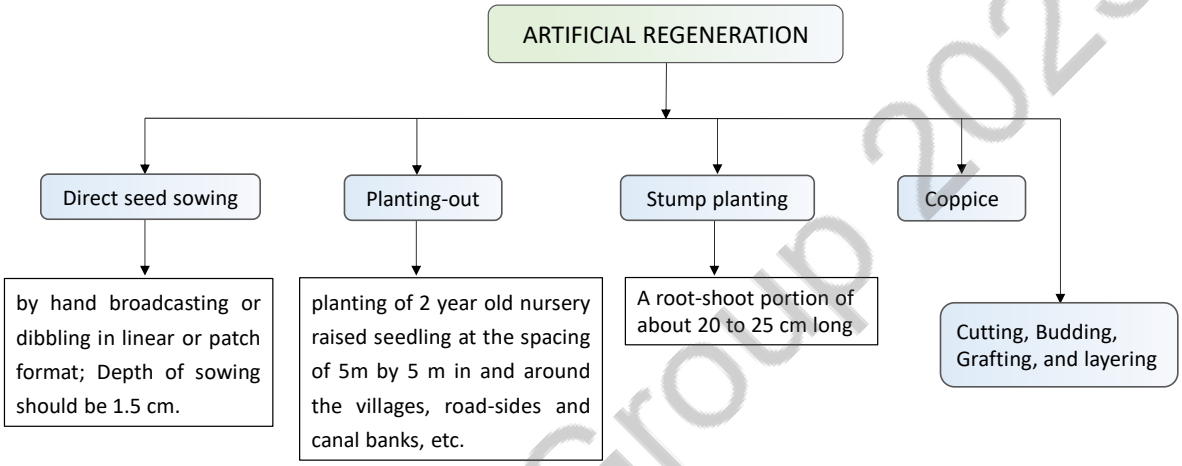
IFoS 2020 : Describe the methods of ***artificial regeneration*** of ***Tamarindus indica*** [Paper – 1 | 8 m]

Approach : (1) Introduction : few lines about tamarind and its distribution or on artificial regeneration
(2) Body : Draw a flow chart of various artificial regeneration methods and describe them one by one.

Tamarind (Imli) is a medium-sized deciduous tree of *dry savanna* (Tropical Africa), and in ancient times, it was introduced to Asia by *Arab traders*.

ARTIFICIAL REGENERATION

- Direct seed sowing – by hand broadcasting or dibbling in linear or patch format; Depth of sowing should be 1.5 cm.
- Planting-out : planting of 2-year-old nursery-raised seedlings at the spacing of 5m by 5 m in and around the villages, road-sides and canal banks, etc.
- Stump planting : A root-shoot portion of about 20 to 25 cm long
- Cutting, Budding, Grafting, and layering
- Coppice

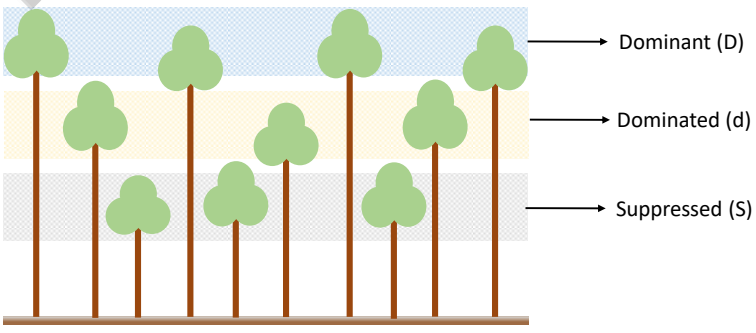


[Note : When you do not have much to write, use flowcharts, diagram and graphs to fill the gap, instead of writing things in a paragraph mode].

IFoS 2020 : Describe the following terms (10 m) – (a) Dominant, (b) Dominated, (c) Crop height, (d) Top height, (e) Hardening [Paper – 1 | 8 m]

Approach : Write-down their definitions, and if possible add some diagrams/flowcharts as well

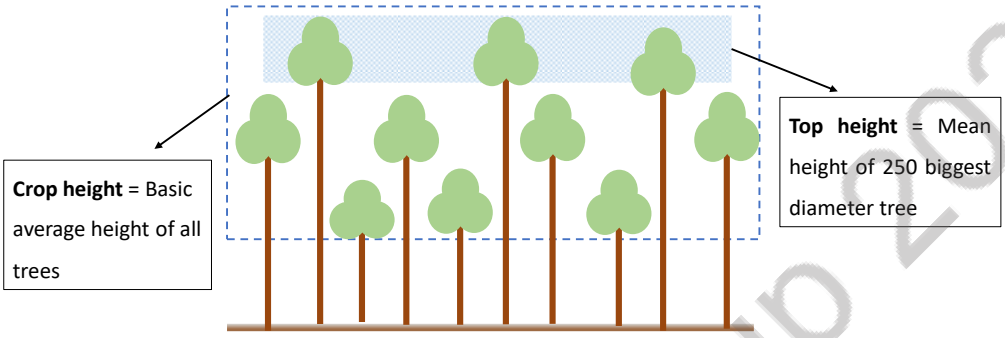
(a) **Dominant** [D] : All those trees forming the uppermost leaf canopy, and represented by the symbol 'D'. These may be sub-divided into – Predominant (D_1) and Co-dominant (D_2)



(b) **Dominated** [d] : Trees that do not form part of the uppermost leaf canopy, but definitely have the leading shoots that are not overtopped by neighbouring trees; and height of about ¾ of the tallest trees.

(c) **Crop height** : It is the average height of a regular crop as determined by Lorey's formula.

(d) **Top Height** : the height corresponding to the means basal diameter of the 250 biggest diameters per hectare as read from the height diameter curve.



(e) **Hardening** : Hardening is the process of exposing transplants (seedlings) gradually to outdoor conditions. It enables them to withstand in actual environmental conditions they will face when planted outside of the nursery. It encourages a change from soft, succulent growth to a firmer, harder growth.

IFoS 2020 : What are *Orthodox and Recalcitrant seeds*? Give five examples for each of these categories of seeds [Paper – 1 | 10 m].

Approach-1 : (1) Introduction : few lines about seed and then (2) define both terms with 5 examples of each,

Note : *Always underline the scientific name*

Seeds are the **mature ovule** with contains **embryo**, **seed coat** and **food reserve** in the form of cotyledons. On the basis of storage behaviour seed could be sub-divided into

- **ORTHODOX SEEDS**: All those seeds that *can be dried up* to low moisture content (≈ 5%, wet basis) and can be stored for low or sub-freezing temperatures for a long time *without losing their viability*. Orthodox seeds are mostly hard-coated.

  Examples : *Acacia nilotica, Acacia catechu, Albizzia lebbeck, Prosopis juliflora, Cassia siamea*, etc.

- **RECALCITRANT SEED** : Seeds that *do not survive under low moisture content* stresses (below 20 to 30 %) and *lose their germination capacity*.

These seeds are primarily large and have high moisture content, which cannot be dried without causing injury.

Example : Seeds of *Azadirachta Indica, Syzygium cumini, Shorea robusta, Dipterocarpus turbinatus, Mangifera indica,* etc.

Approach-2 : Write down the two-column difference between orthodox and recalcitrant seeds with examples

ORTHODOX SEEDS	RECALCITRANT SEED
All those seeds that *can be dried up* to low moisture content (≈ 5%, wet basis) and can be stored for low or sub-freezing temperatures for a long time *without losing their viability*. Orthodox seeds are mostly hard-coated.	Seeds that *do not survive under low moisture content* stresses (below 20 to 30 %) and *lose their germination capacity*. These seeds are primarily large and have high moisture content, which cannot be dried without causing injury.
Examples : *Acacia nilotica, Acacia catechu, Albizzia lebbeck, Prosopis juliflora, Cassia siamea*, etc.	**Example** : Seeds of *Azadirachta Indica, Syzygium cumini, Shorea robusta, Dipterocarpus turbinatus, Mangifera indica,* etc.

IFoS 2020 : Write down the ***pre-sowing seed treatments*** for the following tree species [Paper – 1 | 15 m | *Linked Q*] –

(a) *Tectona grandis,* (b) Santalum *album,* (c) *Dalbergia sissoo,* (d) Albizia *lebbeck,* (e) *Acacia nilotica.*

Approach : (1) Introduction : few lines about Pre-sowing treatments and its objectives
(2) Body : write down them One – by – One.

Before seed-sowing, we treated them with various physicochemical processes – (1) to remove seed dormancy, (2) to avoid being consumed by insect pests, birds, and rodents, (3) to improve uniformity in size, and (4) ensure its successful germination and establishment by supplementing growth stimulating hormones.

(a) ***Tectona grandis*** : Large size seeds with Hard & thick seed-coat prevented the reaching of moisture and oxygen to the embryo.
Removing Exogenous seed coat dormancy – by (i) Alternate wetting and drying treatment – 24 hours each for the next 15 days, (ii) Partial fermentation with animal dung pastes treatment, (iii) Light fire treatment,

(iv) Mechanical scarification, (v) immersion of seeds in cold water for several days, etc.

(b) ***Santalum album*** : Seed dormancy, Consumption by bruchids & rodents and availability of host plants are the most limiting factors for seed germination and establishment. Resulting, in low and prolonged germination and poor establishment of seedlings.

Removing seed dormancy : Gibberellic acid, cow urine, cow dung slurry and chemicals such as HNO_3, and H_2SO_4.

Seed pelleting : with paste of fertilizers, Insecticides ~~(and fungicides)~~, and Mycorrhizal spores.

(c) ***Dalbergia sissoo*** : (i) Soaking in water for 24 hours, (ii) Hot water treatment (80 to 100°C for few minutes).

(d) ***Albizzia lebbeck***

(e) ***Acacia nilotica***

To remove Exogenous seed dormancy – (i) Soaking in water for 24 hours, (ii) Mechanical Scarification damaging the seed coat by rubbing the seeds on sandpapers or seed or (iii) Acid treatment (Chemical scarification) – pouring seeds in H_2SO_4 solution, (iv) Hot water treatment (80 to 100°C for few minutes).

Seed pelleting with Insecticides, fungicides, growth hormones and fertilizers - To avoid Insect-Pastes and rodent attack + ensure germination.

IFoS 2020 : What are the different factors governing the successful *introduction of an exotic* tree species? [Paper – 1 | 10 m]

Approach : (1) Introduction : few lines about exotics
(2) Body : Factors

To meet the increasing industrial demands, our plantation forestry has heavily shifted toward exotic due to higher production and productivity, faster growth rate, disease-free production as well and its ability to withstand under some adverse conditions as compared to indigenous species.

However, Successful introduction of an exotic largely depends upon the -

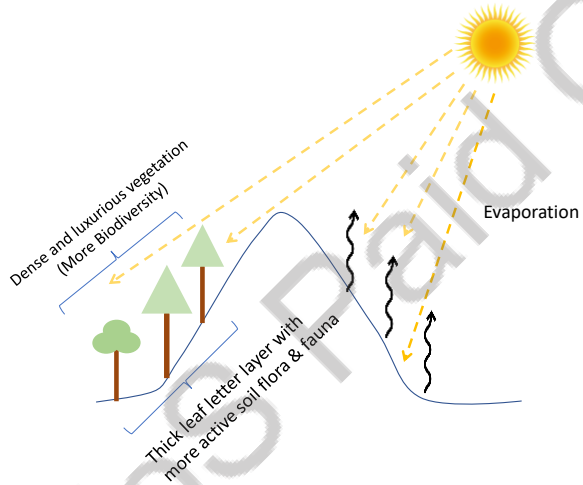
- Local climatic factors –which we are willing to introduce. And it should be similar.
- Edaphic factors -
- Ecological factors - exotic should not cause any allelopathic effect or produce chemicals like Mimosine which is dangerous for herbivores, or should over-exploit our soil and water resources and make them non-fertile.

Exotic or Non-native species are those that grow in areas outside of their natural geographical range; or species growing in areas where they do not naturally occur, *i.e.,* Eucalyptus in India.

- Should be fast growing to increase production + Disease free (Absence of natural pastes)
- Availability of skilled workforce, Infrastructure and funds for procurement, acclimatization and distribution of germplasm. Acclimatization time and cost should be minimal.
- Community and market Acceptance
- Availability of sanitary and phytosanitary measures – to avoid introduction of new insect-pastes.

IFoS 2020 : How does *slope aspect impact forest stand* characteristics and soil properties ? [**Paper – 2** | 10 m]

Aspect is the direction of the slope of the land with respect to the geographical North or the position of the sun (*i.e.*, the Northern face of the Himalayas). Which directly controls the availability of soil moisture, solar radiation intensity, Wind pressure and local temperature. As a result, they also indirectly control the characteristics of local vegetation and soil properties.



EFFECT ON CHARACTERISTICS OF FOREST STAND : Sunny slopes keep less moisture because of stronger solar radiation and higher evaporation. Therefore, *plants growing on sunny slopes are mainly grasses and scrubs, and having fibrous roots*, they are more likely to be *drought- and radiation-resistant*. In comparison, shade-loving plants such as forbs are dominant on shady slopes with deep tap root systems, and biodiversity-rich.

* Despite being on the same latitude in the middle Himalayan valleys, the dense forests of Deodar are growing in the southern aspect, while the Fir and Spruce forests at the northern aspect. However, the difference in

insolation in the southern and northern aspects near the equator is small. That is why this difference is not felt in the south Indian hills.

* Similarly, the Eastern aspect is cooler because it gets insolation in the morning when the air temperature is low, and often Dews is still on the vegetation's surface. Whereas, in the western aspect, Sunstrike is when the air temperature is higher and hot winds have already been generated. This causes a more desiccating effect on vegetation.

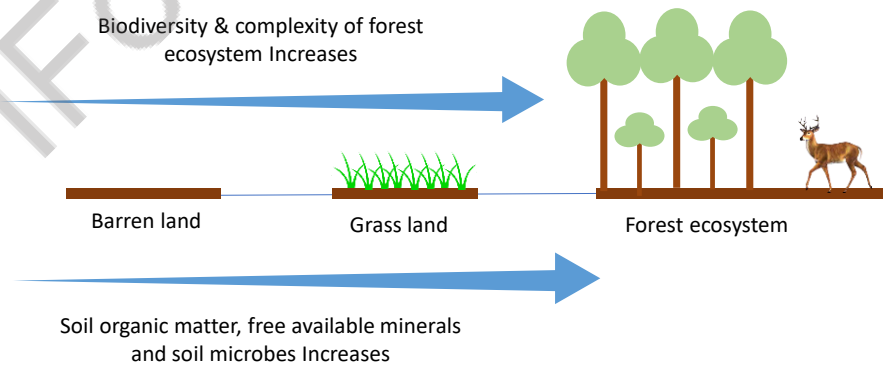
EFFECT OF ASPECT ON SOIL PROPERTIES : Plant biomass is high on the northern slope, resulting in high organic carbon in the soil, better nutrient cycling, and higher activity of the microbial community. However, high temperatures in sunny aspect areas in cold alpine areas lead to higher microbial activity and better soil nutrition status.

IFoS 2020 : What are the structural and functional changes that occur in a forest ecosystem during succession? [**Paper – 2** | 15 m]

Succession is the process of replacing one set of biotic communities with another set of more advanced and different natural biotic communities.

STRUCTURAL CHANGES DURING SUCCESSION

- Vertical stratification of species - This includes the development of different canopy layers
- Species composition- due to succession the species composition changes from herbs to shrubs and trees
- Species diversity- due to succession, the diversity in the flora and fauna increases
- Biomass accumulation- the relative biomass of the site is increasing in succession



FUNCTIONAL CHANGES DURING SUCCESSION

- Nutrient cycling- the succession also helps in increasing soil nutrient increase due to nutrient cycling and nutrient retention.

- Productivity- the site productivity increase which can be witnessed due to increasing tree density.
- Ecosystem services provided by forests also improve during succession which can be seen in terms of moisture availability, air quality etc.

IFoS 2019 : Write the scientific names of four major tree species in each of the ***Southern Tropical Semi-Evergreen Forest*** and ***Northern Tropical Wet-Evergreen Forest*** [Paper – 1 | 8 m].

- **Southern tropical *semi-evergreen* forests** are Predominantly evergreen forests with few deciduous species and distributed over western ghats and Andaman & Nicobars region. Examples (1) *Dipterocarpus terbinatus*, (2) *Xylia xylocarpa*, (3) *Hopea parviflora*, (4) Mangifera *indica,* etc.
- **Northern Tropical Evergreen Forest** : primarily distributed in the Assam Valley region with dominant species like (1) *Dipterocarpus*, (2) *Mesua ferrea*, (3) *Shorea assamica*, (4) *Bamboosa bamboo, etc.*

IFoS 2019 : Explain the ***modern nursery techniques*** for production of quality planting stock [Paper – 1 | 8 m].

With increasing demands of nursery raised seedlings due to increasing government-led plantation work like the Green Highway project, Green India mission, Bamboo mission, etc. provide boos-up and investment opportunities for private sectors to invest in modern nursery technology.

Some advanced technologies for the production of planting stock are as follows:

- *Tissue culture /micropropagation* : For the production of *disease-free high-quality clonal stock* in large numbers in relatively shorter periods. *Artificial Seed* production through tissue culture now replacing our issue of unavailability of good quality seed with specific insect/pest or climatic factors resistance power.
- *Propagation structures* : Growing planting stocks in highly controlled conditions such as in playhouses, mist chambers, glass houses or green net areas enhances the vigour and survival rate of the seedlings.
- *Seed treatment* : Proper adoption of seed treatment helps in improving the germination percentage and storage period of treated seeds. Example : Gamma-ray treatment
- *Root trainers* : Root coiling can be reduced considerably by using root trainers and it also improves the root structure of the planting stock.

- *Automated sensors* : By incorporating automated sensors giving timely reading on soil temperature, soil water level, soil nutrient content, soil pH, humidity etc. timely and effective management can be undertaken.
- Increasing use of *cutting-edge technology* like Sensors for auto-detection of soil Humidity, soil temperature, pH, insect-pest attacks and automatically spraying the required fertilizer and pesticide.

IFoS 2019 : Discuss the factors which influence the ***choice*** between ***natural*** and ***artificial regeneration*** [Paper – 1 | 8 m].

Regeneration or **Reproduction** is the act of replacing the old crop with younger ones, either naturally or artificially (Man-made plantation).

FACTORS AFFECTING THE CHOICE BETWEEN ARTIFICIAL AND NATURAL REGENERATION

- **Availability of Funds and time** – for the regeneration project. Natural regeneration is a time-consuming process compared to artificial once which takes hardly a few months. However, artificial requires a huge **skilled labour workforce, infrastructural support, and financing**. We generally prefer Artificial regeneration in commercially viable projects like CAMPA, Industrial buffer plantation, etc.
- **Marketing and pricing support** : If the main purpose of raising the plantation is the production of either firewood timber or pulpwood market support should be needed to absorb this production cost.
- **Social and cultural factors** : They also affect the rate of development of the plantation. Local demands adversely affect industrial plantations.
- our **INDC** or **national/international obligations**.
- Availability of new technology and accessibility to the forest areas

IFoS 2019 : What are the different ***types of grafting*** ? Explain 'Cleft Grafting' with neat sketches [Paper – 1 | 8 m].

Grafting is the Art of joining plant parts together in such a way that they will readily unite and continue to grow as one plant. Grafting can be done in many ways and some important types of grafting are as follows –

- ***Approach grafting or Inarching*** : The stock plant is bought near the mother plant and the branches of comparable diameter are severed and joined together to form a union.

- ***Side grafting or veneer grafting*** : A grafting method in which the scion is attached on the sides of the stock and the aerial head of the stock is permitted to grow until the formation of union between stock and scion.
- ***Bridge grafting*** : Mainly undertaken as a technique to repair the girdling in trees.
- ***Bark grafting*** : Scion is inserted into the portion of wood (stock) where the bark separates the wood.
- ***Saddle grafting*** : A graft made by fitting a deep cleft at the end of the scion over a wedge at the end of a stock of similar diameter so that the two cambiums can form a union.
- ***Whip/ splice/ Tongue grafting*** : Grafting in which a tongue-shaped cut is made both in scion and stock and joined at the severed portion to form a union.

CLEFT GRAFTING

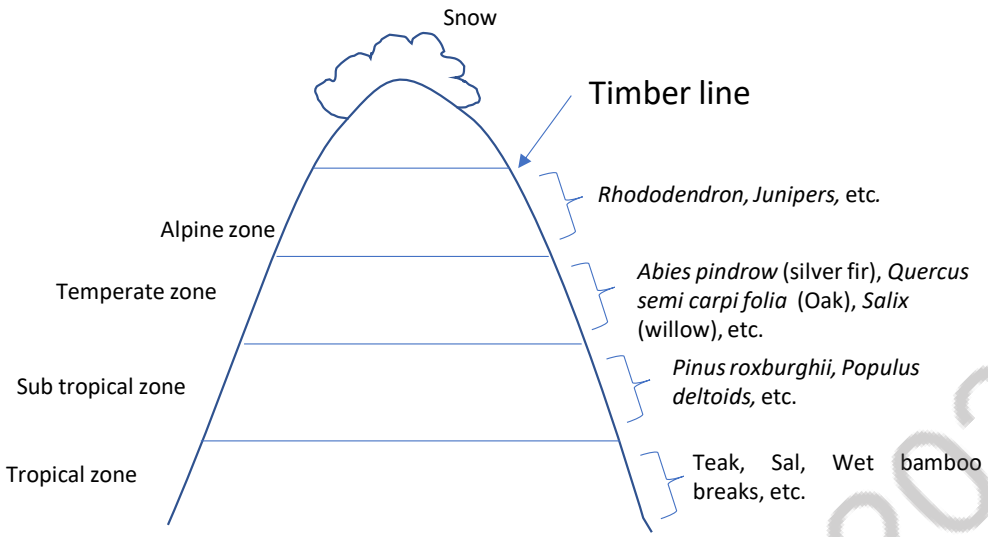
Under this, we joined the small-size scion's piece (the upper portion of a plant with desired characteristics) with the comparatively much larger size rootstock (the lower portion with a well-established root system). This method allows for the combination of desired traits from both the scion and the rootstock, resulting in a stronger, more resilient, and potentially faster-growing plant.

Steps

- Choose the Right Time
- Select the Site
- Prepare the Scion
- Insert the Scion
- Secure the Graft
- Seal the Graft
- Monitor and Care
- Post-Graft Care

IFoS 2019 : Draw a schematic diagram showing *altitudinal zonation of forest vegetation* [Paper – 1 | 10 m]

Altitude is the height of a place from mean sea level. With increasing altitudes, we generally experience a decrease in temperature, pressure, rainfall and the soil fertility; whereas wind velocity and solar radiation increase and all these result zonation of vegetation.

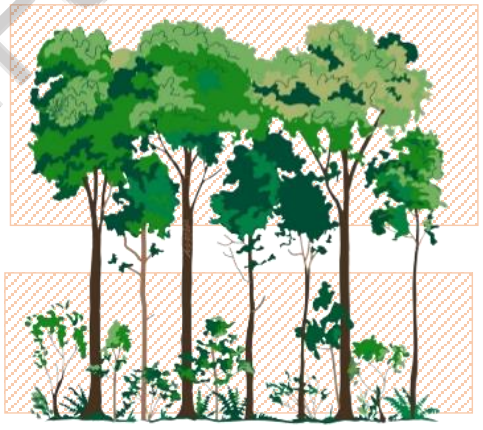


IFoS 2019 : Explain different *grades of thinning*. Discuss in brief the *thinning practices adopted for teak plantations* [Paper – 1 | 15 m]

Thinning are the felling operations made in an *immature even-aged stand* for the purpose of *improving the growth and form* of the trees that remain, *without permanently breaking the canopy*.

GRADES OF THINNING

- **Mechanical thinning** : Under this, we cut the trees by using some thumb rules like cutting off alternate trees in each row or removing alternate rows. it may be by using a stick (So-called stick thinning).
- **Ordinary thinning (Also known as Low thinning and German thinning)** : Under this, we remove inferior individuals starting from the suppressed class, and then taking the dominated class and ultimately some of the dominant class. it is further divided into A, B, C, D, and E grades.



CROWN THINNING

Also known as ***Thinning from above***

or ***French thinning*** or ***High thinning***.

ORDINARY THINNING

Low Thinning or **German thinning**

or **thinning from the below**.

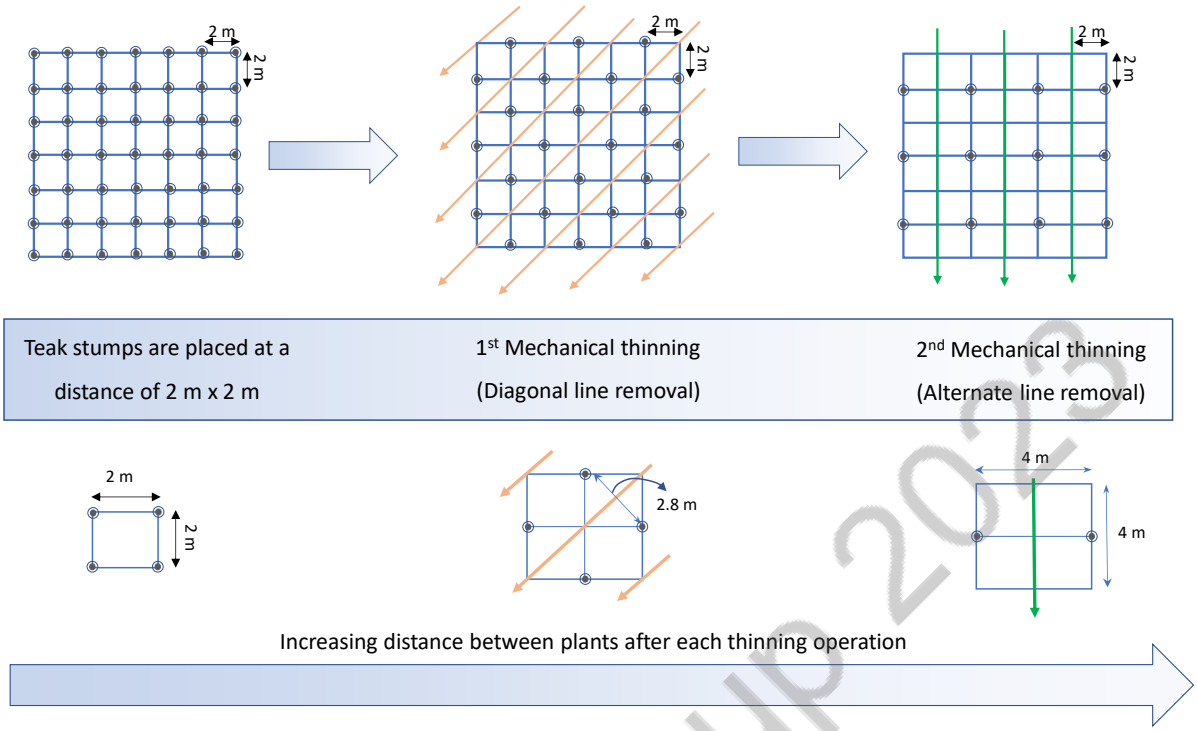
- **Crown thinning (French thinning or high thinning)** : Under this, the *less promising trees of the top crown are being removed in the best available individuals' interest*. The dominated and suppressed stems are retained to help in natural pruning of them in natural pruning unless they are dead, dying, or diseased. It is further divided into (a) light crown thinning and (b) heavy crown thinning.
- **Free thinning** (Also known as *Elite Thinning* or *Single Stem Silviculture*) : Under this, 'elites' are first selected in numbers appropriate to the crop's size or age with particular regard to their stem form and uniform spacing. Once the elites are identified, the remaining crop is considered from the point of view of their effect on the elites, if their removal is likely to help the elite will remove it or if it helps in site protection or no effect of the elite can leave them to avoid unnecessary labour cost.
- **Advance or Craib's thinning** : 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.
- **Numerical thinning** : Thinning is carried out according to the stand density index.

THINNING PRACTICES IN TEAK PLANTATION

Teak plantations by large are managed under mechanical thinning, however, we can also adopt

- **Ordinary thinning**
- **Crown thinning**
- **Elite thinning** at some places.

Under mechanical thinning : teak initially planted at 2 m × 2 m spacing; the 1st mechanical thinning is done when the crop attains a height of ≈ 8/9 meters (4th year after plantation). In this thinning, alternate plants are removed in each row resulting 50 % reduction in the number of plants. 2nd mechanical thinning is carried out after the next 4/5 years in which we remove alternate lines.



IFoS 2018 : Justify that the study of ***silvics*** is essential for the successful afforestation program in India [Paper – 1 | 8 m]

Silvics deals with the **life history** and biological characteristics of individual trees and communities. This includes how trees grow and reproduce and how the physical environment influences their phenological behaviours and physiological character. In general, silvics translates scientific knowledge into practical information about the habitat or site requirements for the successful establishment and development of forest stands.

The study of Silvics, or the ecological and physiological characteristics of trees and forests, is essential for the successful afforestation program in India for several reasons.

First, *understanding the specific needs and growth patterns of different tree species* is crucial for selecting the appropriate species for a particular location and soil type.

Second, silvics can inform *decisions on planting density, spacing, and pruning for optimal growth* and survival of the trees.

Third, silvics can provide information on the *potential for invasiveness of certain species*, as well as their potential to provide ecosystem services such as carbon sequestration and wildlife habitat.

Overall, incorporating knowledge of silvics into afforestation programs can improve the success rate and long-term sustainability of reforestation efforts in India.

IFoS 2018 : Explain *different kinds of thinning* and its application in the forest
[Paper – 1 | 8 m]

Thinning is the felling operations made in an *immature even-aged stand* for the purpose of *improving the growth and form* of the trees that remain, *without permanently breaking the canopy*.

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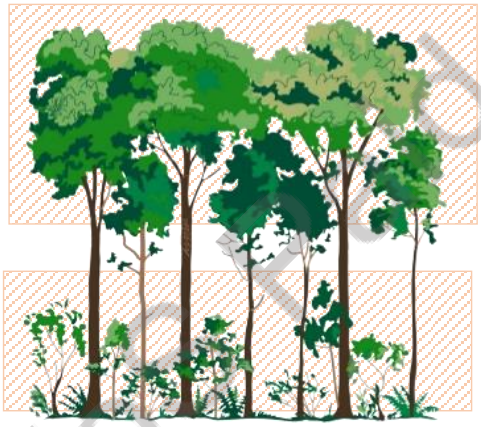

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APPLICATION OF THINNING IN FORESTRY

* Thinning operations help in the production of both, large-size and small-size timber as per market requirements, *i.e.,* Nilambur teak production.
* Helps in managing forest's composition, structure and diversity by harnessing its tangible and intangible benefits.
* It helps in the successful introduction of exotics in Indian forests as well as managing and enriching of forest.
* helps in Removing unnecessary competition b/w forest vegetation, proper development of soil and carbon sink.
* It also helps in improving the carbon-capturing capability of the forest.

IFoS 2018 : Explain the *Eco-physiological factors* that are more concerned to the silviculturist [Paper – 1 | 15 m]

The effects and responses of forest to the various silvicultural operations depend upon the various local eco-physical factors, therefore the Silviculturist have to know what they are. how they affect forest vegetation and how vegetation shows the effect of silvicultural operation when these factors are active

FACTORS

- Climatic factors : enlist various factors that you read in silviculture notes
- Edaphic factors : Do the same with it
- Biotic factors : do the same with it as well
- Topographic factors : same

The success or failure of our silvicultural operations and the plantation work depends upon these factors

IFoS 2018 : Can '*climate change*' change the period of **phenology**? share with examples [Paper – 1 | 10 m]

Phenology is the seasonal changes in the plant behaviours over a year, it shows when it has flowering, fruiting, leaves shedding etc.

Plants' physiological and phenological behaviours are linked with the seasonal pattern, and their biological clock is adjusted with it as an evolutional adaptation. Example - Flowering and fruiting in *Acacia nilotica* are adjusted with our Indian monsoon and start from December – January, so its fruit matures at least before the onset of Monsoon.

Now climate is changing with increasing global warming, so our weather also shifting accordingly affecting our forest vegetation throughout -

- For induction of flowering in the plant's particular temperature (High or Low) and duration of light required *i.e.,* Apple required snowfall for its flowering and often *failed to flower in the year where there was no or negligible snowfall* occurs and *vice versa*.
- Evergreen temperate forests (*i.e.*, forests in the middle Himalayan region) now *start showing deciduous character* gradually.
- Raising temperature *increased leaf-shedding period* in tropical dry deciduous vegetation of central India.

IFoS 2018 : Write in detail about the ***influence of parent rock*** in the ***distribution of tree species*** [Paper – 1 | 8 m].

Parent rocks are the main source of base material for the soil formation and the mineral nutrition of the plant. Therefore, its composition and distribution also affect the plant's distribution like –

- In the western Himalayas, Chirpine occurs mainly on *quartzite rocks*, while blue pine occurs on *mica schist*. As the Kashmir and Kulu valleys have practically no quartzite formation, Chir is conspicuous by its absence in these valleys; if quartzite occurs at higher altitudes, Chir appears there, *i.e.*, In Parbatti valley (H.P.), deodar occurs at lower altitudes on old and fresh alluvium. In contrast, Chir occurs above deodar at higher altitudes on quartzite.
- *Cupressus torulosa* occurs mainly on limestone rocks, as in the Chakrata hills of Uttarakhand.
- While teak grows on lime-rich rocks, Sal usually avoids them. Teak is absent from quartz and black cotton soil and often avoids laterite sand where found. It is usually stunted.
- *Xylia Xylocarpa* occurs gregariously in laterites.

- *Dendrocalamus strictus* is practically absent in Orissa from quartzite soils.

However, the influence of parent material/Soil on a particular species or forest type is, sometimes, due its effect on depth of soil, moisture retentivity, and availability of nutrients and not because of its own chemical composition.

IFoS 2018 : Write the problem and prospects of *exotic tree species* in India with suitable examples [Paper – 1 | 15 m]

Exotics are the trees that are growing outside of their natural habitat. Despite having some good production property and market value, several exotic species create some problems like -

- They are ecologically less valuable and do not have any linkage with the local ecosystem and sometimes become obnoxious, *i.e.*, *Prosopis juliflora* in Telangana – Andhra region.
- Become susceptible to new insect pests, *i.e.*, Pink disease in Eucalyptus spp.
- The introduction & acclimatization process took a long time and heavy initial investment.
- Unable to produce viable seed to sustain them shelve after introduction.

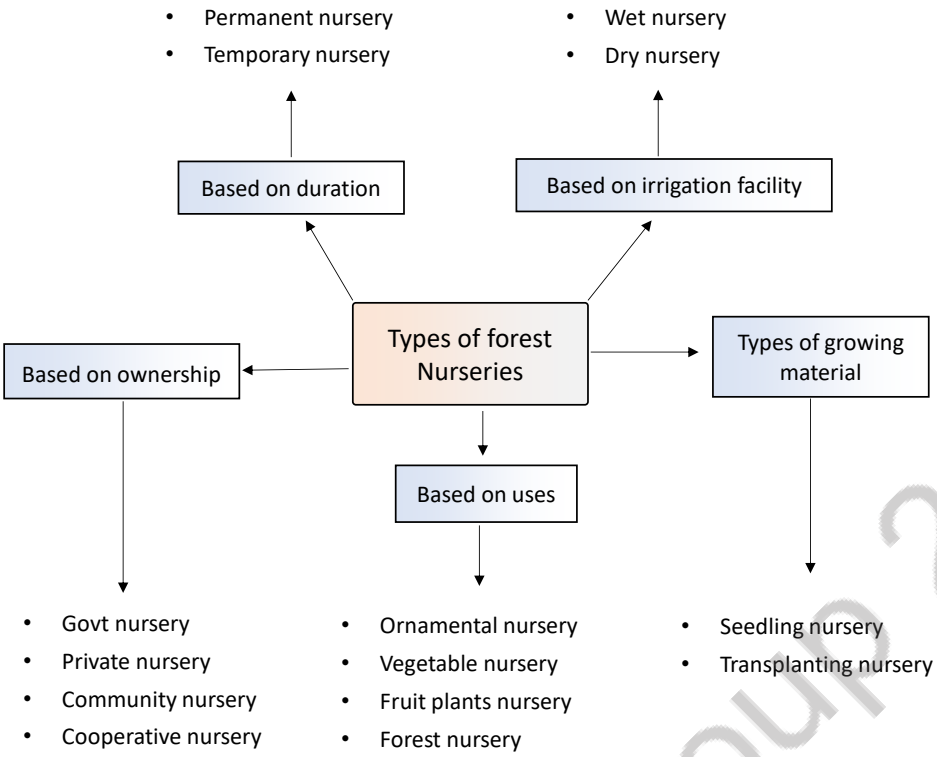
FUTURE PROSPECT

Now, with the increasing issue of global warming and climate change, our native vegetation facing serious phonological disturbances and has not started failing to regenerate itself naturally. Maybe the exotics and tree breeding become the only source to make our forest more climatically resilient.

IFoS 2018 : Enlist different *types of nurseries* and write different types of nursery beds used in a nursery [Paper – 1 | 7.5 m]

Nurseries are enclosed or partially enclosed areas where we raise planting material artificially under controlled conditions for plantation and conservation purposes.

TYPES OF *Nurseries*



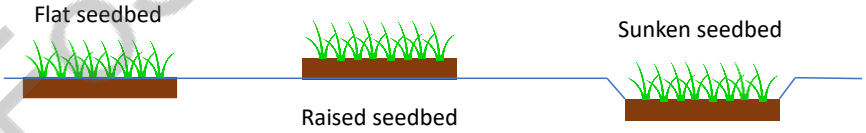
TYPES OF *Nursery Beds*

(a) Based on the level of platform

Level or flat beds : Platform at an equal level with the surface. In Normal rainfall areas, *i.e.*, Teak.

Sunken bed : In Dry localities, where water loss is an issue. It takes about 10 to 30 cm deeper. The prime aim for making this type of bed is to avoid water flow outside the bed, *i.e.*, Khejari Nursery in Arawali.

Raised bed : made in high rainfall areas, about 10-15 cm above ground level with the support of bricks, stones, or bamboo culms. Suitable for seeds that do not require too much moisture.



(b) Based on uses

Seedling beds : used for raising seedlings

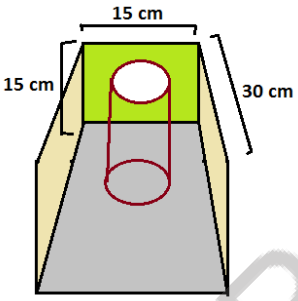
Transplanting beds : seedling is transplanted for further development and easy transportation.

IFoS 2018 : Enlist different *types of containers* used in a forest nursery and explain different methods of seed sowing followed in a nursery [Paper – 1 | 7.5 m]

Nursery containers are the structural frame that we used to raise planting material outside of the traditional nursery bed or for transplantation purposes.

TYPES OF CONTAINERS

- *Brick container* : prepared with a mixture of local soil, sand, and, Farmyard manure (in 1 : 1 : 1 ratio). A 10 cm deep cavity is created at its top for plantation. A most suitable method of plantation in sandy areas.
- *Dona or cup* : cups made by leaves of *Bauhinia vahlii* were sometimes used in Madhya Pradesh to plant teak seedlings.
- *Bamboo basket* & Bamboo tubes
- *Earthen pots* made locally have been used for planting in some areas.
- *Polybag* : most commonly used material in recent times because – (a) are light in weight (b) have greater strength and durability (c) comparatively cheaper (d) Available in abundance with any size/shape/dimension, (e) Negligible weight.
- *Root trainers* : Root Trainers are an excellent growing system for seeds seedlings. To remove your plants easily without any damage to their root system.



Brick container

Polybag

Roots trainer

METHODS OF SEED SOWING IN NURSERY

- **Hand broadcasting** : The desired quantity of seeds is sown directly by hand. However, it required that the seed should be larger in size. In the case of minute seeds of species, *i.e.,* Eucalyptus spp. It should be mixed with earth or sand before broadcasting.
- **Dibbling** : Both space and depth can be maintained.
- **Drilling** : With the help of a board, trenches are made and then seeds are 'Sown in the trenches made by the board

IFoS 2018 : What is *succession* and *climax*? Give the causes of forest succession [**Paper – 2** | 10 m]

Succession is the process of replacing one set of biotic communities by another set of most advanced and stable communities in a progressive manner. The *Climax* stage is a mature final and stable community of this succession process which maintains itself for a long period in equilibrium with that particular environmental condition.

CAUSES OF SUCCESSION

- ***Initiating Causes*** : to make the bare area (NUDATION) to the new succession process by destroying the existing one, through climatic or biotic factors, *i.e.*, Land sliding, soil erosion & deposition, volcanic eruption, long-term waterlogging, deforestation, Forest fire, coastal and estuarine deposition.
- ***Continuation Causes*** : that continue the movement of the succession process through various seral stages, *i.e.*, Migration, ecesis, aggregation, competition, reaction, etc.
- ***Stabilizing Causes*** : They finally established the colony according to the local area climate, soil or complex of factors.

IFoS 2018 : Write the *soil-water relationship* of any forest area. Describe the influence of the water table in the growth and development of tree species [Paper – 1 | 10 m]

The soil-water relationship in a forest area is a critical factor that significantly influences the growth and development of tree species. This relationship encompasses the interaction between soil properties, water availability, and the water table level. The water table refers to the underground level where the soil and rock are permanently saturated with water. It plays a crucial role in determining the health and distribution of tree species within a forest ecosystem.

Positive relationship

- Water plays an active role in the weathering of rocks thus helping in the formation of soil
- Different soil particles play an important role in water purification
- Water helps in the deposition of valuable silt which helps in increasing the fertility of the soil
- Soil plays an important role in groundwater deposition.

Negative relationship

- Water is an active geomorphic agent which plays an important role in erosion, *e.g.*, Chambal ravines

- Waterlogging in any area results in anaerobic soil condition

Role of the water table in forest development

- high water table result in growth of trees that have superficial root system which is not wind firm.
- Lower water table area requires special measures for earlier growth of any tree species.
- Low water table causes capillary action in soil which results in the presence of salts in the upper layer of soil, which decreases fertility.

IFoS 2018 : What is hydrology? Describe the role of hydrology in the planning and management of watershed development. Do tree species improve the infiltration rate, soil temperature, water level, and hydrological cycle? Justify with a few examples [Paper – 1 | 15 m]

Hydrology refers to the study of water on the Earth's surface and beneath the Earth's surface. Further, it includes water movement, its distribution, and physical and chemical properties.

Role of hydrology in watershed development

- Sedimentation and erosion control
- Flood and drought management
- Help in water resource planning
- Modelling and stimulation of the watershed region
- Environmental protection by understanding the ecology around the watershed, thus helping in preparing riparian buffers and other measures to conserve ecology in the region.
- Help us in forming integrated watershed management which helps us in sustainable development in the region.
- Management of water quality in the region

Tree species play an important role in the management of infiltration rate by inducing stem flow. Further, their roots also help in the percolation of water downwards thus helping in increasing the infiltration rate.

Tree species influence soil temperature by preventing direct insolation from falling in the ground, thus reducing temperature. Further due to decomposition of organic matter, the temperature of soil is also influenced.

Water level - Some tree species like Eucalyptus extract more water which affects the water level of the site adversely.

Hydrological cycle – Tree species play an important role in the hydrological cycle by moderating evaporation loss, and increasing infiltration of water.

IFoS 2017 : Give four examples of uses of *Pollarding* in Indian forestry [Paper – 1 | 8 m]

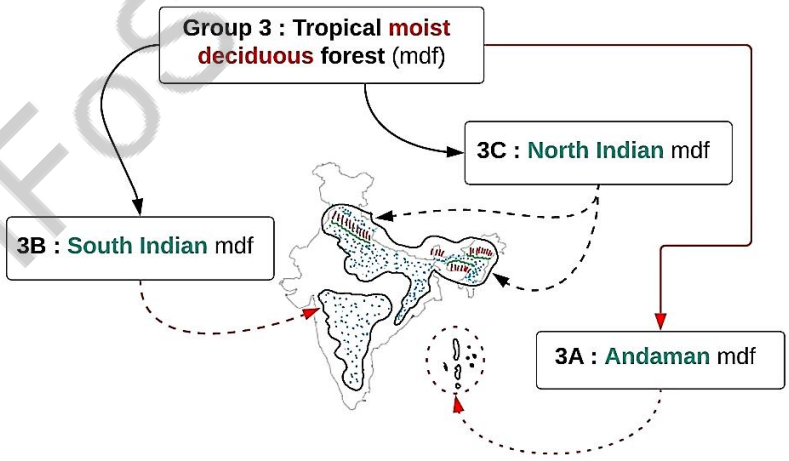
Pollarding is the act of cutting trees at a height (usually about 2m to 2.5m from the ground), to protect the new shoots from grazing and browsing animals.

Uses of Pollarding

- For the production of cottage industries linked small-size timber, *i.e.*, *Salix alba* (willow) in Kargil and Kashmir valley for cricket bat manufacturing.
- *Hardwickia binata* : in Kurnool (A.P.), for bast fibre production.
- *Cotoneaster bacillaris* is pollarded to obtain walking sticks.
- Pollarding provides fodder and fuelwood as intermediary products, *i.e.*, *Grewia oppositifolia* is pollarded in UK & foothills in UP to get shoots for fibre and fodder.

IFoS 2017 : Enlist *four groups* of forest types under the **moist tropical forest** as per the Champion and Seth classification of forest types [Paper – 1 | 8 m].

Champion and Seth classified moist tropical forests into *3 Sub-Groups*. **[3A]** Andaman moist deciduous forest, **[3B]** South Indian moist deciduous forest, and **[3C]** North Indian moist deciduous forest.



- *Andaman Moist Deciduous Forest* : These forests are predominantly found in Andamans and are associated with evergreen forests. Important species

include *Cannarium euphyllum, Pterocarpus delbergiodes, and Salmelia* spp., *etc*.

- *Southern Tropical Moist Deciduous Forest* : Distributed over mountain region and plains of entire south India (From MP to Tamil Nadu) having moderate rainfall. Forests of Tectona grandis belongs to this. Other important species of this forest type includes *Terminalia*, *Lagerstomia* and *Pterocarpus*.
- *North Indian Tropical Moist Deciduous Forest* : Excluding the dry North-West region, moist deciduous forests can be found throughout North India. The annual rainfall of this region varies from 1000 mm to 2000 mm. *Shorea robusta* constitutes an important species.

IFoS 2017 : Regulation of *solar radiation* gives a powerful tool to the forester, Justify [Paper – 1 | 10 m]

Solar radiation is one of the important site factors which affects the growth and vigour of any trees. Also, better light conditions can be used as a tool to obtain a maximum volume of quality timber

- The crop till the pole stage can be allowed to grow under congestion so that lower branches of trees do not get sufficient light due to shade created by the upper branches or canopy resulting in the death of lower branches. This natural pruning of lower branches helps in obtaining long clean bole.
- When tree crowns are restricted to the upper part of trees, it results in the development of a more cylindrical stem form.
- Light stimulus provided by creating heavy openings in crops towards the end of their life, after having been raised in closed crops results in rapid volume increment, called light increment.

IFoS 2017 : A soil can be wet, yet physiologically dry. How? What steps are suggested to correct the problem? [Paper – 1 | 10 m]

Physiologically dry soil means water is present in the soil but is not available to plants either because of high salt concentration, unavailability of water in liquid form or due to poor aeration. These conditions happen in saline marshes, cold deserts and water-logged soils respectively.

- Physiological dryness of soil due to high salt concentration can be corrected by improving the drainage or by the method of leaching. If we add enough water to the soil, salt present in the soil gets dissolved and

will move them below the root zone. Improved drainage will also give the same result. Another possible way to tackle the issue is by the use of suitable chemicals to neutralize the effect of salt.

- Cold deserts experience physiological dryness of soil due to lack of water in liquid state. Measures like adding suitable chemicals which can increase the freezing point of water help in overcoming the issue. However considering the cost-benefit ratio, this is not a practical solution for the problem. Important soil work carried out in such soils are trench-cum-pit type and irrigation-cum-drainage type. Improving drainage conditions in turn improves soil characteristics. Proper soil working and the addition of organic matter helps in enhancing good drainage.
- Physiologically dry soil in water-logged regions happens due to poor aeration and this condition can be rectified by improving the drainage. In India, planting in such areas is done either on ridges or on raised mounds.

IFoS 2017 : Enlist the advantages and disadvantages of vegetative propagation. What future do you foresee for it in forestry? [Paper – 1 | 10 m].

Vegetative propagation or asexual method of propagation is one in which the multiplication or reproduction of plants happens from any vegetative parts (*i.e.*, Cutting, Budding, Grafting, coppicing, suckers, etc), other than the seeds.

ADVANTAGES OF VEGETATIVE PROPAGATION ARE

- This is the only method of propagating plants which produce non-viable seeds or recalcitrant seeds, *i.e.*, Eucalyptus.
- Offspring (Ramets) have the same genotypes as the mother plant (Ortet), hence large-scale production of market-linked uniform produces is possible.
- Vegetatively propagated trees are usually of low height = facilitating easy pruning, spraying and harvesting operations.
- In some special cases, the rootstocks have tolerance to salinity, pest and disease resistance and these characteristics can be suitably exploited for beneficial uses.
- Vegetatively propagated plants take less time to reach maturity and hence have a shorter rotation period.
- Difficulties in obtaining seeds, their processing and storage can be avoided by adopting vegetative propagation.

DISADVANTAGES OF VEGETATIVE PROPAGATION ARE

- Vegetative propagation is feasible only for certain plant species.
- It requires more aftercare to maintain the survival rate.
- Special platforms and provisions have to be created, which is difficult and is costly.
- Vegetative parts can't be stored for a long time once taken/ separated from the mother plant.
- Transportation to distant places is difficult.
- Plants propagated through vegetative means are more susceptible to pests and diseases.

As most of trees *do not produce good quality seeds every year*; some *facing difficulties during seed germination and establishment* due to global warming and high biotic pressure; *Genetic makeup of offspring also not similar with mother* tree (in the case of seeds), and sometimes its *hard to collect them from remote terrains*. Whereas, vegetative methods like root cuttings, stem cuttings, branch cuttings, suckers etc., can be obtained at any season, this problem can be overruled. The easy establishment and faster growth rate enable the production of the required size timber in the shortest time.

IFoS 2017 : Discuss in detail, the kinds of *Soil Mycorrhizae* and the benefits derived by plants from them [Paper – 1 | 8 m].

Mycorrhiza refers to the symbiotic association of fungi with the roots of vascular plants. The roots of almost all vascular plants are associated with mycorrhiza and the infected feeder roots are termed mycorrhizae.

There are mainly three types of mycorrhizal association.

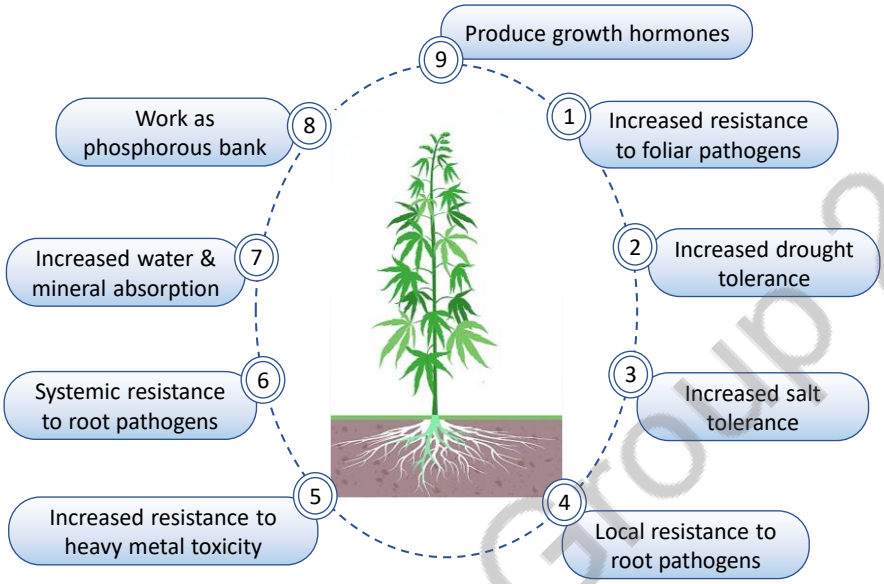
- **Ecto-mycorrhizae :** In this type of fungal association, the fungus covers the outer portion of the roots completely. It penetrates between the cells and separates them in the primary cortex.
- **Endo mycorrhizae :** In endo-mycorrhizal type infection, the fungus mycelium forms coils and various swellings within a certain group of cells of the primary root cortex.
- **Ecto-endo mycorrhizae :** Both the *ectomycorrhizae* and *endomycorrhizae* are found in this type of fungal association with vascular plants.

BENEFIT TO THE PLANTS

- *Better absorption of soil moisture and minerals* by increasing net water absorption surface area as fungal filaments work as root hairs that also

help plants increase *drought tolerance*.

- *Increase availability of unavailable minerals* to the plant : Some minerals become unavailable or unabsorbable, called fixation (*i.e.*, phosphate fixation) to the plant because of soil pH. Fungal hyphae release organic acids that make it in available form, so the plant can sustain even under harsh/unfavourable soil conditions, especially when the soils are deficient in phosphorus.



- *Nitrogen Fixation* : Some fungi also fix atmospheric nitrogen and make them available to the plant = plant can grow in nitrogen deficit soil where other plants cannot.
- *Produce some growth hormones*, *i.e.*, Auxin, gibberellin that further boost up the plant's root & shoot growth.
- *Phosphate reservoir* : Nearly 80–90 per cent of the absorbed phosphate remains in the fungal sheath. Thus, the fungal sheath may act as a reservoir of nutrients (especially phosphate) and release them as the occasion demands under adverse conditions.
- *Mycorrhiza-induced resistance (MIR)* – Mycorrhiza provides systemic protection against a wide range of attackers by inducing systemic resistance (ISR) after pathogen infection through Inter-plant signalling.

IFoS 2017 : Define *succession*. Explain different types of succession in detail, citing suitable examples. Discuss various theories of succession [**Paper – 2** | 15 m].

Succession is the process of replacing one set of biotic communities by the another set of more advanced and different nature biotic communities.

TYPES OF SUCCESSION

- **BASED ON AVAILABLE ORGANIC MATTER**

  (a) ***Primary succession*** : When the process of succession starts on freshly opened soil (there was no previously available organic matter), The rate of succession is slower. Example : Succession in alpine areas after nudation of land by a heavy landslide

  (b) ***Secondary succession*** : When the succession process starts on the old sites which had been destroyed due to fire, erosion, burning, grazing etc., is called secondary succession.

- **BASED ON CAUSE OF SUCCESSION**

  (a) *Autogenic Succession* : after the succession has begun, the community modified itself and its own environment and replaced its own with a new community. It means there was no external interference, *i.e.,* the Amazon rainforest.

  (b) *Allogenic Succession* : when the replacement of one community by another due to external forces.

- **BASED ON THE NATURE OF SUBSTRATUM**

  (a) *Xerarch Succession* : when succession (especially primary) starts on dry rock material, windblown send and mineral matter under extremely dry conditions.

  (b) *Mesarch Succession* : When succession begins on moist and well-aerated soil material.

  (c) *Hydrarch Succession* : when the succession process starts in water or very wetlands, *i.e.,* ponds, lakes, marshes etc.

MAJOR THEORIES

- ***Mono Climax Theory*** or ***Climatic Climax Theory*** **:** Given by *FE clement*. According to this theory, the only climatic condition involved in controlling succession so there is only one type of climax community formed.
- ***Poly Climax Theory*** : Proposed by *Tansley* to counter Clement's theory, Tensely suggests the climax community is never actually controlled by single factors. This theory considers that the region's climax vegetation consists of not just one type but a mosaic of vegetational climaxes controlled by soil moisture, nutrients, topography, slope, aspect, fire, grazing, etc. So, when the development of communities is controlled by climate, they described them as a *climatic climax*, when it due to -

  * Edaphic conditions then called → edaphic climax
  * If because of Biotic disturbances, then called → biotic climax

* or due to topography where dominant factor → topographic climax.

- ***Information Theory*** : Proposed by Fosberg (1967) and Odum (1969). According to this theory, succession is a function of energy balance and nutrient cycling. The climax stage is reached when the amount of energy and nutrients received from the environment by the vegetation is equal to it given to the environment it returns through leaf litter and other metabolic activities.
- ***Climax Pattern Hypothesis*** : According to *Whittaker* (1953), climax communities are patterns of populations varying according to the total environment. Thus, there is no discrete number of climax communities, and no one factor determines the structure and stability of a climax community. Whereas the mono-climax theory allows for only one climatic climax in a region and the poly-climax theory allows several climaxes, the climax-pattern hypothesis allows continuity of climax types varying gradually along environmental gradients and not separable into discrete climax types.

IFoS 2017 : Name the *method of thinning* that best promotes genetic improvement of the regular stand besides controlling density. Give reasons in support of your answer [Paper – 1 | 8 m].

Thinning operations are the tending operations where we remove inferior, diseased trees from the stand in order to facilitate light penetration, reduce competition between species and improve site quality.

Free thinning or Single-Tree Selection is a type of thinning where plants who fulfil these criteria are selected based on the criteria in terms of their age, bole diameter and other suitable parameters and the remaining trees are felled. As a result of this felling, only the superior trees are left in the stand having high growth potential.

This method has several advantages that make it particularly effective for promoting genetic improvement and maintaining stand diversity

- *Conservation of Genetic Diversity* : Trees with desirable genetic traits, such as rapid growth, resistance to pests or diseases, and adaptability to local conditions, can be identified and preserved. This helps maintain a diverse gene pool that supports the long-term resilience and adaptability of the stand.
- *Natural Selection Process* : Over time, the fittest and most suitable individuals will contribute more to the next generation, leading to an overall improvement in the genetic quality of the stand.

- *Improvement in the stand condition* : introduce superior genetic material into the stand through successive thinning.
- Reduced competition among trees, which can lead to improved growth rates and overall health.

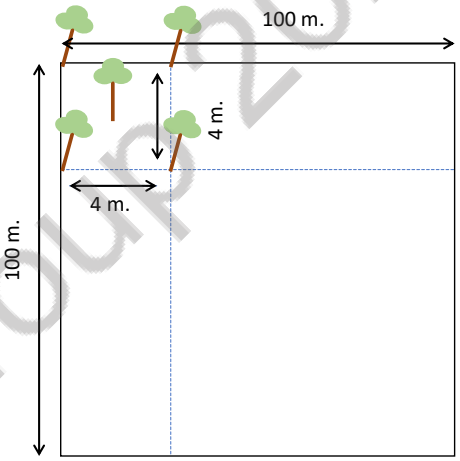
IFoS 2017 : Calculate the number of *seeds required* to raise a 20-hectare plantation with 4 m x 4 m spacing and an extra plant in the centre of each square. Plant percentage of the species is 75% [Paper – 1 | 8 m]

Suppose one seed produces one plant, therefore the number of seeds (plants) required per hectare are

= 625 + 576 = 1201

Total area = 20 hectares

Total seed requirements = 20 × 1201 = 24,020



Here, we found that our seed lots have 25 % impurities, which means, we get only 75 seeds of a selected species out of 100 seeds.

Therefore, we required = *32,026 Seeds* to get 24,020 Seeds (Plants) of a selected species.

IFoS 2017 : Some rural communities are opposed to *chir-pine* and advocate of removal of chir-pine and its replacement with broadleaved multipurpose trees. What is your reaction in this matter [Paper – 1 | 10 m].

Chir pine (*Pinus roxburghii*) is an evergreen tree species belonging to the family Pinaceae and grows in altitude ranges between 1000-2,500 m. It can be grown in quartzite-rich soil.

Since the local is advocating broadleaved multipurpose trees in place of Chir pine, the problems which may occur with multipurpose species are-

- Broadleaved multipurpose tree species are less likely to survive in extreme snowfall in the region as due to the weight of snow the species may break down.
- Multipurpose tree species are more vulnerable to grazing, browsing etc., which may result in site degradation
- Part of the plantation is also carried out in slopes, where the soil is devoid of nutrients, thus multipurpose tree species may not survive in such site

- Government planning of the region- The government adopted Chir pine because it fulfils their industrial demand for lightweight timber, resin etc. which cannot be fulfilled through multipurpose.

Based on such conditions I will try to convince villagers to promote the cultivation of Chir pine and not broadleaved multipurpose trees because, in the long run, it will fulfil their requirements much better than multipurpose trees. In order to gain their support, JFM can be started in which the participation of villagers can be sought.

IFoS 2017 : What is *sub-climax*? Explain its importance in the context of Indian forestry [Paper – 1 | 10 m].

Sub-climax refers to the stage in ecological succession preceding the climax stage. Such a stage is achieved due to natural or manmade factors like forest fires.

Figure

Importance of Sub-climax in Indian Forestry

- It helps in the regeneration of some of the forest species.
- It helps in inducing new flush shoots in species which are instrumental in collecting minor forest produce like Tendu leaves.
- It helps in inducing certain properties in plants like fire resistance.
- This serene stage is vital for the survival of wild animals like Rhino.
- It helps in preventing the expansion of invasive species in Indian forests and plantations.
- It also improves soil quality by clearing litter and removing soil pathogens.

IFoS 2017 : Explain the classification of forest types of India by Champion and Seth. Enlist major forest types and their group [**Paper – 2** | 10 m].

Champion and Seth classified the forest based on the ecosystem approach and considered vegetation, temperature, climate, soil etc. Thus, it classified the forest into five major groups and 16 types

- Major Group 1 –Tropical forest- it is further classified into seven groups like

    1. Tropical wet evergreen forest
    2. Tropical Semi-evergreen forest
    3. Tropical moist deciduous forest
    4. Tropical littoral and swamp forest
    5. Tropical dry deciduous forest
    6. Tropical thorn forest
    7. Tropical dry evergreen forest

- Major Group 2- Mountain Subtropical forest- they are further classified into

    8. Mountain subtropical broad leaves hill forest
    9. Mountain subtropical Pine Forest
    10. Mountain Subtropical dry evergreen forest

- Major Group 3 - Mountain temperate forest

    11. Mountain wet temperate forest
    12. Himalayan moist temperate forest
    13. Himalayan dry temperate forest

- Major Group 4 - Sub Alpine Forest

    14. Subalpine forest

- Major Group 5 - Alpine Forest

    15. Moist alpine forest
    16. Dry alpine forest

2

Chapter

AGROFORESTRY

IFoS 2022 : What are the constraints in the value chain under industrial agroforestry? (10m).

Approach : (1) Introduction – few lines about history of industrial agroforestry

(2) Body – write down their constraints in their value chain

In Forest policy 1988, the industries were required to generate their own wood resources and not depend on forest for wood production. Industrial agroforestry is the plantation raised by farmers or under the supervision of industry, exclusively to fulfil the requirement of industries. Despite such system there are several constraints in the value chain. Some of them are as follows.

- Regulation- despite these system are run by industry himself, yet there are transit rules which vary from states to states, along with the replantation clause that has to be achieved in a prescribed time. For e.g. in Gujarat, as per the replantation clause it is twice the number of felled tree in one year.
- Non availability of raw materials- due to heavy regulation of some specific types of trees, their availability is restricted and thus are substituted by their alternatives. E.g. after the introduction of composite wood, solid wood products are on decline.
- Production- the plantation usually has trees with the annual increment of 6-8 m^3/ha/yr which is considered as low production as modern progenies are capable of producing 30-50 m^3/ha/yr.
- Lack of mechanization- silvicultural operation are carried out by either hand or with minimal machines result in wastage of wood, energy and time.
- Post-harvest management and value addition- after the harvest of wood 20-30 percent of wood is suspect to infection by various pest, and in case of NTFPs, due to adoption of older method of extraction, the produce is low along with wastage of other byproducts.
- Middlemen issue- the supply chain is heavily infested with intermediaries result in distorted supply chain and higher cost of raw materials.

IFoS 2022 : What are the differences between traditional agroforestry and ethno-agroforestry?

Traditional agroforestry	Ethno-agroforestry
These are been used by village people near their	They are usually practiced by tribals since older

fields, waterbodies. They are generally modern in comparison to ethno-agroforestry	times. E.g. Zabo practice in Nagaland is more than 2000 year old.
Purpose- is to protect the crops and fields from geomorphic agents impacts and also increasing food production.	Purpose- to fulfil their nutritional requirement
Regeneration- they used the natural as well as some artificial measures to regenerate the forest	Regeneration- they completely rely on natural regeneration
Area- they are usually carried out in limited area i-e near the field and in the fields	Area- they are usually carried out in very large area.
They may be carried out by using modern method or on the basis of past experience	They are usually carried out on the basis of past experience only.
Exotic species may be used in this region in order to increase the efficiency of the plantation	Since they are the naturally regenerated forest, no use of exotic species can be seen here
Plants used here have higher increment than ethno-agroforestry system	They have lower increment $1m^3$/ha/yr
Majority of these system are of two layer (i.e., one is tree canopy while other is crops)	Here the region may be of two layer or multilayer (home garden).
e.g. alley cropping, windbreaks, taungya, protein bank	e.g. shifting cultivation, home garden, zabo

IFoS 2022 : How does agroforestry help to achieve the United Nations SDG? (8m).

Approach : (1) Introduction – few lines about sustainable development
(2) Body – write about how agroforestry influence SDG

Sustainable development refers to development that meets the needs of the present generation without compromising the need for future generation. Under UN SDG this type of development is promoted in which agroforestry can play an important role.

- Agroforestry and UN sustainable development goals
  - Goal 1- zero poverty- agroforestry help in providing employment it terms of silvicultural operations, thus help in preventing the underemployment problem of agriculture.
  - Goal 2- zero hunger- it prevent the problem of hidden hunger along with supply of food crops to an extent. E.g. trees like *Magnifera indica*, *Tamarindus indica* fulfil nutritional requirement of humans through their fruits.
  - Goal 3- health cost- they help in mitigate the pollution by diluting the concentration of pollutants in air, water etc, help in reducing waterlogging condition of the site by increasing the percolation thus help in minimising the incidence of water borne and vector borne disease.
  - Goal 6- Clear Water and Sanitation- agroforestry help in preventing site runoff by altering soil structure, thus minimising runoff. Also it help in increasing the soil water holding ability by

humification process. further it increase filtration of water through increasing percolation and infiltration, along with absorption of toxic compounds by root exudates.

- Goal 15 –life on land- agroforestry help wild animals by providing them shelter, fodder (via plantation of leguminous family) and protection against any extreme events like high temperature and rainfall.

➢ Goal 13- Climate action- agroforestry can be the answer to the climate change as it help in increasing site resilience against heat waves, agricultural drought. Also it helps in increasing soil productivity by increase nutrient composition through mineralization and

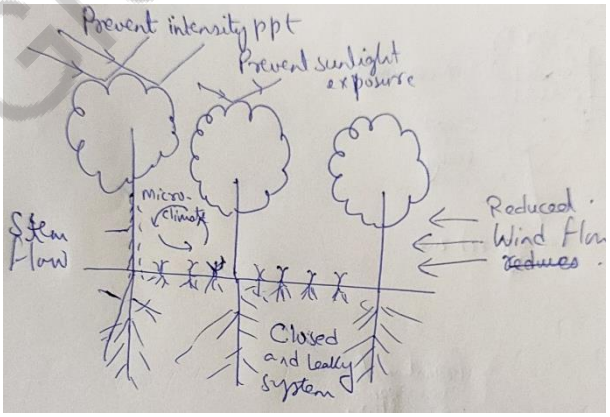
IFoS 2021: How do agroforestry wood perennials protect the understory crops (10 m).

Approach : (1) Introduction – few lines about what is wood perennials.
(2) Write their role in agroforestry, along with type of protection given by them.

Agroforestry refers to combining food crops with tree crops and/or livestock on the same unit of land at the same time or alternatively.

➢ Wood perennials protect understory crops through

- Climatic factors-
  1. Prevent direct sunlight exposure and precipitation on the crops by acting as barrier between them, thus protecting them from harsh climatic conditions like higher temperature and higher intensity rainfall.
  2. Improve and create microclimate in soil by maintaining and regulating temperature, moisture etc.



  3. Prevent strong wind to damage crops by reducing their speed
- Edaphic factors-
  1. Deep Roots of perennials crops minimize leakage of nutrients from soil, thus help in nutrient cycling.
  2. Roots of perennial facilitate the growth of endomycorrhiza, which is a reservoir of phosphorous.
  3. Woody perennials of leguminous family help in Nitrogen fixation of soil.
- Topographic factors-
  1. For young seedlings they act as nurse crop.
  2. They act as barrier for geomorphic agents, thus helps in reducing their intensity and thus minimize surface erosion
- Biotic factors- facilitate the growth of free-living bacteria, which helps in better production of humus.

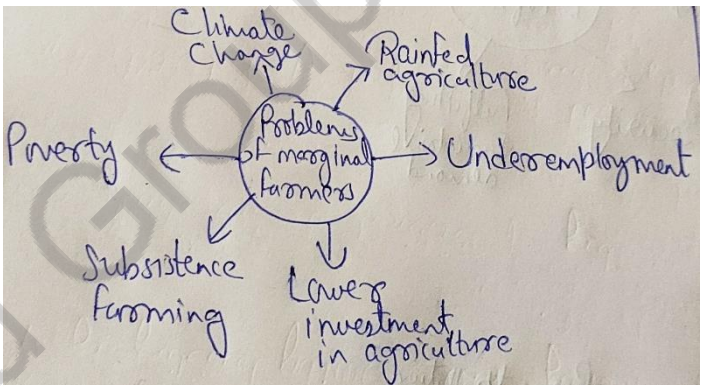
- Improve aesthetics of the region- tree with different length and width helps in improving the landscape of the region
- Differential tree architecture helps in increasing biodiversity of the region

IFoS 2021 : How does agroforestry promote sustainable livelihood of marginal farmers? (10m).

Approach : (1) Introduction – few lines marginal farmers
(2) write a flowchart about their problems
(3) how agroforestry help in getting them sustainable livelihood

Small and Marginal farmers are those farmers that own less than 2 hectares of land. in India they comprise of 86 % of total farmers in the country. They face multiple problems like-

- Agroforestry helps in establishing livelihood of marginal farmers through
  - It minimize the problem of underemployment that is prevalent in Indian agriculture.
  - It helps in providing an additional source of income through selling of timber and non-timber produce as well as promoting animal husbandry which is instrumental in doubling of farmers income.



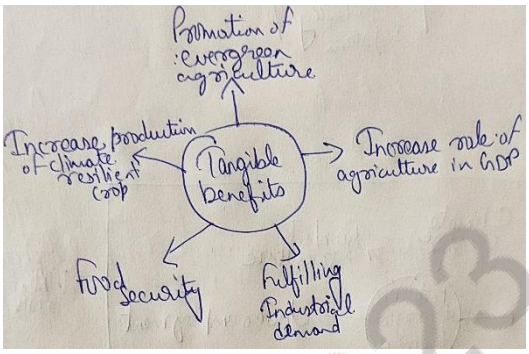
  - It acts as insurance in case of crop failure, thus help in reducing poverty in the region.
  - It helps in minimize the production cost by replenishing soil nutrients through minimizing leakage of nutrients, promoting the growth of beneficial fungi and bacteria to increase mineralization and humification and also minimize erosion through reducing the speed of geomorphic agents etc.
  - It helps in fulfilling nutritional requirement of farmers and their families to an extent, thus reducing the associated health cost. Also Through crops, it helps in ensuring food security to the farmer
  - It helps in watershed restoration by increasing infiltration of water, thus reducing runoff in the region.
  - Agroforestry facilitate the creation of microclimate, as well as prevent young crops from harsh climate thus facilitating climate smart agriculture.

IFoS 2020 : Write the tangible and intangible benefits of agroforestry? (8 m).

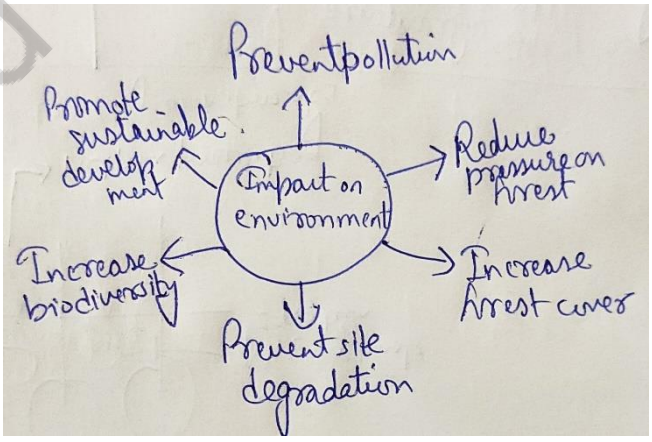
Approach : (1) Introduction – few lines about agroforestry.
(2) Write about tangible and intangible benefits of Agroforestry.

Agroforestry refers to the practice of growing crops along with trees on the same land at the same or alternate time. It provides multiple benefits like

- **Tangible benefits-**



  - It helps in attracting alternative private investment.
  - It increases farm income through selling of timber, NTFP, fuelwood. thus supports allied activities like livestock (via protein bank), fisheries (via aquaculture) through supply of nutritious forage, shade for animals.
  - It helps in reducing cost of production by replenishing important soil nutrients (macronutrients and micronutrients), thus reducing fertilizer requirement.
  - It helps in employment generation thus helps in solving the problem of underemployment in agriculture, thus help in reducing poverty in the region.
  - It help in modifying site conditions by manipulating sunlight, precipitation on crops thus help in growing high value crops.
  - It also acts as insurance against crop failure
  - It increases site resilience against natural calamity, thus help in preventing crop from lodging.
  - It helps in improving aesthetics of the region thus acting as a potential tourist site.
  - It help in ensuring food security through cultivation of crops.
- **Intangible benefits**



  - Act as buffer thus Helps in reducing noise pollution, air pollution, water pollution as well as protect site from natural calamity.
  - Increasing biodiversity in the region by allowing protection to smaller animal species, bees, aves etc by providing them shelter, food.
  - Improving water quality by filtration, increased its infiltration through stem flow thus help in watershed restoration.
  - Through plantation of vegetative material of elite trees, agroforestry protects natural forest by fulfilling industrial demand and thus prevent natural forest from deforestation.
  - Help in climate change mitigation by acting as natural carbon sink as well as increasing soil organic carbon and its adaptation by improving and modifying regional climate, thus increasing site resilience.
  - It helps in improving regional gaseous cycle and sedimentary cycle thus help in balancing Earth carbon budget.

- It increases forest cover outside the forest which help in maintaining 33 percent forest cover as stipulated by forest policy.

IFoS 2020 : How does shifting cultivation support community livelihood and biodiversity conservation? (8 m).

Approach : (1) Introduction – few lines about shifting cultivation
(2) Body – Write about how it support community livelihood and biodiversity conservation

➢ Shifting cultivation refers to clearing land by cutting forest for food crop cultivation and after few years cultivators shifts again to new land. It helps in community livelihood by

- Fulfill dietary and nutritional requirement of people through the crops grow in the land. E.g. the bewar cultivation in Madhya Pradesh usually grow coarse cereal which fulfil their dietary requirement.
- The highly intensified mixed cropping in the land result in higher production than any other agriculture system.
- The land is highly fertile during initial years, hence it has high productivity, thus require little or no investment for higher food production.
- This is usually practiced in forest area where open land was not available for agriculture, hence this type of cultivation ensures the quicker method for cultivation.
- After the land is fallow, it supports multiple shrubs and grasses, which helps in providing forage to domestic animals, thus supporting allied activities.

➢ **Biodiversity conservation**

- It is a rotational practice of agriculture and forest management where the fallow land is allow to rejuvenation for natural forest regeneration.
- It increases species richness by introducing new species in the region.
- Due to burning, invasive weeds are cleared from the forest for some time which reduces competition between plants species and helps in biodiversity conservation.

IFoS 2020 : Write the scientific names of any five multipurpose tree species suitable for agroforestry system in
1. Arid and semi-arid
2. Sub-tropical hills of India (10m)

➢ Arid and semi-arid multipurpose tree species

- *Acacia nilotica*- wood, N-fixation
- *Azadirachta indica*- fruits, leaves used as an antiseptic,
- *Magnifera indica*- fruits, wood, leaves
- *Albizzia lebbeck*- fodder for animals, wood, nitrogen fixation
- *Syzygiumcuminii*- fruits, wood

- Subtropical hills species
  - *Eugenia jambolana*- food (fruit), timber.
  - *Trema orientalis*- antiseptic, wood.
  - *Salmalia malabaarica*- medicinal industry, wood.
  - *Kydia calycina*- flowers, wood.
  - *Litsea glutinosa*- incense stick industry, wood

IFoS 2020 : "Taungya cultivation is a type of traditional agroforestry system." Justify the statement. (15m).

Approach : (1) Introduction – few lines about taungya cultivation
(2) Body – write about how taungya cultivation is a traditional agroforestry system

- Taungya is a Burmese word which means 'hill cultivation'. It is a type of agroforestry system where crops are grown in between tree space in an plantation.
- This type of system is a common practice in Burma, Malaysia, Thailand, North East of India etc. there are three types of Taungya system.
  - Departmental Taungya- where both agricultural crop and Plantation raised by Forest department.
  - Leased Taungya- when the department permits local villagers to grow the crop in space between plantation after paying rent.
  - Village Taungya- here the local resident of village inside the forest are permitted to cultivate food crops in between the tree plantation space.
- Taungya system is a traditional agroforestry system because
  - It is a modified form of shifting cultivation where crops are planted along side of trees rather than clearing forest as a whole and crops are planted before dense canopy of tree takes place.
  - This practice is adopted by the local people of Burma, Malaysia, Thailand and some parts of Northeast India. Thus it became an integral part of their culture.
  - The objective of taungya is to fulfil dietary requirement which is the basis of many traditional agroforestry system.
  - This system adopted intercropping thus simultaneously cultivates trees, crops, livestock etc.
  - Since taungya is practiced in evergreen forest, where soil is acidic in nature. Thus here crops should be planted along with trees that have positive tree crop interaction as well as adaptable to local site
  - This system uses natural methods to grow plants by using traditional farming methods.

Based on above thing we can say that agroforestry is a traditional method.

2019 : Agro-forestry is a better land use system for climate change mitigation and adaptation. justify (8m).

Solution :

The intensive farming system-based land use pattern led by our present wheat and rice has suffered a major setback of – (1) rapidly decreasing productive capacity of soil, (2) Increasing production cost and (3) Climate change, raising sea level and its effect on local monsoon. Moreover, we have some international obligations like INDC, REDD^{+} and SDGs too. And the only probable solution to all these issues is agro-forestry.

- **Because of -**
  - It helps in carbon capturing and soil carbon storage (as we have INDC obligation of 2.5 to 3 billion tonnes extra carbon sink).
  - In one side it didn't hampered the production of food crops on other side it prevent deterioration of soil by reduction of *surface run-off*, *nutrient leaching* and *soil erosion* through roots and stems.
  - Improvement *soil nutrients* and *soil structure* through the constant addition of organic matter from decomposed litter, loosening of soil by roots, recycling of leached minerals and freeing new minerals from parent rocks.
  - *Better protection* of Farm ecosystem, our crop against How winds and frost. Improvement of *microclimate*, such as lowering of soil surface temperature and reduction of evaporation of soil moisture through a combination of mulching and shading.

IFoS 2019 : Briefly Discuss the aim, Objectives and scope of Urban forestry in India (8m).

Solution :

Urban forestry a kind of social forestry wherein trees are planted in urban areas for the purpose of improvement of environment and landscape. Usually flowering and ornamental trees /shrubs are planted. Simply, it is the application of forestry principles and technology for the welfare of urban people.

- **AIM :**
  - Scenic beauty in urban parks and recreational purpose.
  - Reduction in Air and noise pollution
  - Provide shelters to the urban wildlife.
- **Objectives :**
  - Improve protection role of the trees to control and mitigate rising unban pollution challenges like Air pollution in Delhi.
  - Treatment of waste-land and dumping ground.
  - Creation of Noise buffer around industrial parks and Hospitals.
  - Creation of micro-carbon sinks along the roads.

- Managing urban watershed, reducing run-off and increasing water percolation.

➢ **Scope :**

- Supply of Fuel wood, fodder, timber and other forest products to the urban population.
- Creation of Noise fee zone or quit zones and Industrial buffer.
- Micro-carbon sink and carbon capturing near the source.
- in managing cities temperature.

IFoS 2019 : What are multipurpose tree species (MPTs) ? Explain their role in Social forestry (10 m)

Solution : Multipurpose trees or multifunctional trees are trees that are deliberately grown and managed for more than one output. They may supply food in the form of fruit, nuts, or leaves that can be used as a fodder, vegetable; while at the same time supplying firewood, add nitrogen to the soil, or supply some other combination of multiple outputs.

➢ **Its Role in Social forestry :-**

- Being part of a living fence, windbreak or a shelterbelt to protect our main constructions.
- Also supplying a staple food, fodder and timber for the owners.
- Increase soil fertility and productivity i.e. N-Fixation, helps *ground water recharge*, prevents *runoff* and *soil erosion*.
- It also supports *rural & Urban wildlife*.
- It role in reduces the *green house effects* in the environment + Reduces various pollutants such as $PM_{2.5}$ and PM_{10}.
- Trees also work as an *investment opportunity* to the rural poor.

IFoS 2018 : Write about the design survey and diagnostics of agroforestry. Can it help the farmers in the integration of trees and crops to enhance the crop productivity? (10m).

Approach : (1) Introduction – few lines about design and diagnostics
(2) Body – how it increase site productivity.

Design and diagnostics as a methodology used for diagnosing problems of land based management and the design of agroforestry solutions according to the problems. It is developed by ICRAF to assist agroforestry researchers and field workers in planning and implementing effective research and development projects. It purpose is to

- Describe and analyze existing land use system.
- To design appropriate agroforestry technology
- To design appropriate research works

➢ Design and diagnostics help farmer by

- Providing information regarding the best possible tree and crop that can be planted together by analyzing tree crop interaction.
- It helps in assessing site by checking soil type, local topography, watershed, climate which help in understanding the type of crop which can be grown here.
- It helps in assessing type of the agroforestry method will provide maximum return on investment.
- It help in increasing land use efficiency.
- Tree and crop management- it helps in management of tree by checking its silvicultural properties which helps in performing silvicultural operation from time to time. Similarly, through crop cycle it can assess optimal time for sowing and harvesting of crops.

IFoS 2018 : Write about the ***diagnostic and design*** survey of agro-forestry. Can it help the farmers in the integration of tree with crops to enhance the crop productivity in agro-forestry system? Justify (10 m).

Solution :- D & D is a methodology for the diagnosis of land management problems and design of agro-forestry solutions. It was developed to assist agro-forestry researchers and development fieldworkers to plan and implement effective research and development projects.
It can helps the farmers –

- To understand the easiness and flexibility of adoption of any agroforestry system as per their requirement.
- Calculation of productivity, Sustainability and skill requirement for the system for more effective management.
- it helps in Pre-diagnosis of the tree-crop –ve/+ve interactions, identification of proper methodology and pattern designed to minimizing –ve effects and inhance +ve effects to increase productivity and sustainability of the system.

IFoS 2018 : What is ***farm forestry***? Write about the objectives, difficulties and financial return from the farm forestry (10 m).

Solution : Farm forestry is the practice of growing commercial forest tree by the farmers on their own land like on the farm boundaries or in the form of block plantation.

➢ **OBJECTIVES** :-

- Increase net farm productivity and doubling the farmer's income by 2022.
- Increasing the sustainability of farm ecosystem and makes it climatically more resilient.
- Provide simple and alternative investment opportunity to the farmers.
- Supply of Fuel wood, fodder, timber and other forest products to the farmers
- Protection of agriculture land against harsh weather *i.e.* Frost, warm heat waves.

- Reduce pressure on forest
- Generate rural employment with rehabilitation of waste land
- Promote village and cottage industry

➢ **Difficulties face by farmers during adoption of farm forestry and after it :-**

1) 80 % farmers in India are small and Marginal farmers and they cannot afford to separate a small part of the farm for tree plantation that give return after 10 or 20 years.
2) High initial investment like buying of nursery, plantation and maintenance cost, chances of insect-pest attacks and failure of plantation.
3) Unavailability of proper high quality seedlings of locally required plants
4) Absence of market or small market that can not support/absorb large scale production.
5) Inappropriate govt support, lack of transparency in implementation of agroforestry/social forestry schemes and almost absence of Social audit/3rd party audit to check corrupt practices.
6) Vague forest policies – if someone raises Teak in 1-hectare area as a commercial plantation, they cannot harvest and market it easily. Because, it requires permission and NOC from Panchayat level to PCCF sitting in the state capital and nobody wants this extra headache.

➢ **Financial return from the farm forestry** : in a 10 year Poplar-wheat-Soybean cropping system – the financial returns are usually 160 to 170 % depends upon location of farm, Paper and timber based industries and availability of labour.

No needs to write this section, but to understand how this system work :-

- **1st, 2nd and 3rd year** : our total production decreases by 20 to 30 %, this reduction is not due to effect of tree crops on the food crops but because of reduction in total crop area for food crops.
- **4th, 5th and 6th year** : now poplar get enough growth and cover the entire area resulting further reduction in food crop production by next 20 to 30 %. And usually in 6th year the production of food crop come to 45 to 50 %. However it also reduce input cost too due to reduction in crop area
- **After 7th year** : food production is not possible for and we left the farm for next 3 years.

IFoS 2017 : Differentiate between windbreaks and shelterbelts. Discuss in brief, their impact on the environment (10m).

Approach : (1) write differences between Windbreak and Shelterbelts
(2) write their impact on environment

Windbreak	Shelterbelts
Purpose- to prevent wind erosion	Purpose- to prevent wind erosion, help in soil reclamation, fodder for plants, additional income for farmers
Here a uniform row of trees is planted	Here a uniform row of trees, shrubs, grasses

	are planted.
Shape- linear	Shape- triangular
Trees are usually of same size	Trees growing here has differential heights in different rows
Area of influence is small	Area of influence is large
Spacing between trees is very less	Spacing between trees is more than windbreak
Their efficiency decreases drastically if any of the trees is damaged or fell	Their efficiency is still affected but in comparison to windbreak it is still high
Less effective against surface winds as the trees does not have low branches	More effective against surface wind or any type of wind
Trees grow here are fast growing trees with great height are required	Trees grows here are of medium to fast growth, with medium height are also perform better
Tree species- *Casuarina equisetifolia*, *Eucalyptus spp*.	Here species are Grasses-*saccharum munja, Saccharum spontaneum*. Shrubs- *Cassia auriculata, Caloptopisprocera* Trees- *Acacia arabica, Dalbergia sisoo, Prosopis juliflora*

- Their impact on environment is as follows
  - Reduce wind erosion by forcing the surface air upwards. A single wind break can prevent surface erosion upto 20-25 times of their height.
  - Creating additional carbon sink.
  - Shelterbelts also help in soil reclamation by altering aggregate composition, binding soil particle through root exudates, altering porosity of soil, adsorbing and absorbing toxic compounds etc.
  - Act as buffer against natural calamities

- However, these trees consume additional resources from soil, affects the process of wind based pollination, and if the tree species causes allelopathic effect it is detrimental to entire plantation.

IFoS 2016: Discuss the role of agroforestry in nutrient cycling and soil conservation. (link Q).

Approach : (1) Introduction – few lines about Agroforestry and nutrient Cycling
(2) Body – write about its role in nutrient cycling and soil conservation

Agroforestry refers to combining food crops with tree crops or livestock on the same unit of land at the same time or alternatively on the same area.

Nutrient cycling refers to a cyclic process that encompasses the movement of nutrients from the physical environment to living organisms and back to the environment.

- Positive role of agroforestry in nutrient cycling
  - Through the process of mineralization, it recycles macronutrients and micronutrients back into the soil.
  - It facilitates the growth of VAM which acts as a storehouse of valuable macronutrients like phosphorous present in soil.
  - Roots help in minimising leakage of nutrients and accelerate weathering process thus releasing new nutrients.
  - Soil microclimate help in growing population of various free-living bacteria thus increases nitrogen fixation.
  - Due to presence of trees, it reduces direct intensity of sunlight on soil, thus reducing evaporation loss, reduces erosion by geomorphic agents.
  - Source of organic matter (leaf litter, broken branches, fruits) which help in increasing formation of humus through humification, which increases soil water holding capacity.
- Negative role of agroforestry in nutrient cycling
  - Increase competition of nutrients between species in their initial stages.
  - Some trees are nutrient exhaustive. As a result, in due course of time they left the site degraded and devoid of essential nutrients.
- Soil conservation refers to a combination of practices used to protect the soil from degradation. Agroforestry helps in soil conservation through
  - It facilitates the growth of evergreen agriculture, which helps in providing manure in the form of animal dung, their movements on the field altering physical soil composition by compacting top layer structure.
  - Improve soil structure by altering flocculation, and its texture through roots exudates, thus increasing their resistance against wind and water erosion.
  - They help in improvement of regional watershed management thus reducing the runoff speed of water and increase its percolation ability.
  - They help in soil reclamation by removing toxic minerals from soil through adsorption and absorption.
  - Improving soil aeration which helps in better decomposition of soil organic carbon, thus help in managing soil pH, as well as release nutrients from breakdown of complex compounds.
- Negative role of agroforestry in soil conservation
  - It reduces the intermixing of soil by reducing wind speed, thus some soils remained devoid of some nutrients.
  - Reduce light intensity of soil which also retard the rate of decomposition

IFoS 2016: The adoption of agroforestry practices by the farming community is the result of increasing human and cattle populations. Discuss. (10m).

Approach : (1) Introduction – few lines about cold desert or plant adaptation habit

(2) Body – Adaptive characteristics

- As per estimates, the world population is already cross 8 billion, alongside with rising population of domesticated cattle like cow, buffalo etc. in order to cater the rising demand new methods of agriculture is adopted in which agroforestry is the prominent one,
  - Rising adoption of allied services as an additional source of income. Agroforestry fulfills the demand by providing nutritious forage and provide shelter to these cattles.
  - Due to increase population per capita land availability is less, thus it necessitates the need to increase land use intensity by altering land use system.
  - In India around 50 % of the population depends directly or indirectly on agriculture, thus makes it necessary to be profitable which can be done by reducing production cost. Agroforestry helps in reduction in production cost by supplying vital nutrients in soil. E.g. mycorrhizae help in supplying phosphorous in the soil.
  - Due to increasing population, the demand of wood-based industry is set to rise and due to environmental concern the supply is interrupted and reduced. Agroforestry has the potential to fulfil that demand supply gap.
  - The rise in population creates the risk of food security, agroforestry facilitates climate smart agriculture which helps in attaining food security.
  - Water is an essential element for sustaining life on earth, and due to rise in population per capita availability is low, agroforestry through watershed restoration helps in ensuring proper water availability to the masses.
  - High cattle population increase the risk of raiding in agriculture fields, thus put pressure on agriculture field, boundary plantation of trees like Jatropha help in keeping animals away from agriculture fields.

2

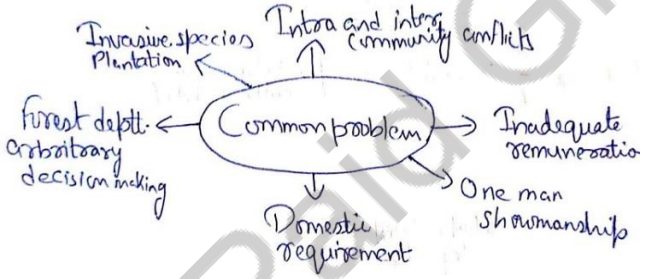
Chapter

Social Forestry And JFM

IFoS 2021 : Discuss the problem of commons in social forestry. Suggest some effective strategies to overcome these problems. (15 m).

Approach : (1) Introduction – Few lines about what is social forestry and common.
(2) Write detailed problem that are faced by common [About ½ part of Answers].
(3) How can such problem be mitigated and avoided.

Social forestry is the practice of forestry on land outside the conventional forest area for the benefit of rural and urban communities.



Commons refers to locals people living near the forest region, this includes locals workers work near the site etc. Their problems in social forestry is as follows.

IFoS 2008 : list constraints in obtaining people participation in social forestry.

- Role of locals in social forestry are not clearly defined in terms of forest management, silviculture operations.
- People uses these forests to fulfil Domestic cattle food requirement as well as fuelwood requirement, results in quick degradation of site.
- Lack of statutory backing to social forestry- because of it, everything depends on the whims and fancies of forest department and their officials.
- Agreement clause – under it, the benefits will be shared with locals however it is unclear on what parameter it shall be evaluated. Also tree having long gestation period results in delay in getting monetary benefits.
- Types of trees used in social forestry- sometimes due to unscientific planning invasive species were used in plantation, which results in site degradation and also it affects nearby area adversely.
- Inter and intra community conflicts harm the good works done by these communities in social forestry.

- Encroachment- since the land is outside of forest limit, encroachment by locals is a problem due to poor cooperation between the respective departments resulted in diversion of land for other purposes.

Solution to these problems

- Giving statutory status to social forestry by bringing an act which helps in specifying roles and responsibility of common and forest department.
- Taking strict action against encroachment and diversion of land for other use.
- The plantation shall have proper surveillance to prevent grazing and browsing by animals.

IFoS 2019: briefly describe the aim, objectives, and scope of urban forestry in India (8m).

Approach : (1) Introduction – few lines about urban forestry
(2) Aim of urban forestry
(3) Objective of urban forestry
(4) Scope of urban forestry

Urban forestry is a sub branch of social forestry which usually focus on planting trees in urban lands like parks.

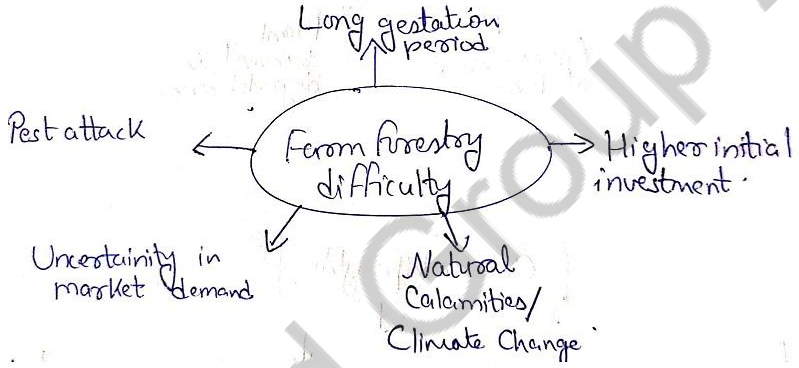
- **Aim**-
  - To increase forest cover outside forest.
  - Reduce pollution in the region
  - Improve aesthetics of the region
- **Objective**
  - To prevent soil degradation and restore it by altering soil structure to allow aeration to decompose organic matter and convert it into simpler compounds.
  - To moderate the effect of urban heat island
  - To improve aesthetics of urban landscape.
  - Improve water table of the region by help in percolation of water and prevent run-off of water.
- **Scope**
  - To prevent and mitigate the impact of flood and other natural calamities
  - To provide employment to locals.
  - To improve land use system.
  - Help in maintaining ecological balance.
  - To mitigate and adapt climate change impact by fulfilling the commitments made in Paris climate deals.
  - To act as a place for recreational activity.

IFoS 2018 : what is farm forestry? write about the objectives, difficulties and financial return from the farm forestry. (10 m)

Approach : (1) Introduction – few lines about farm forestry.
(2) Write down objectives, problems in farm forestry and financial return from farm forestry.

Farm forestry is a sub-branch of social forestry which focuses on planting trees in their farmland. Gujarat is the first state to introduce farm forestry.

- **Objectives-**
  - To increase farmer income and reduce problem of underemployment which is prevalent in agriculture.
  - To prevent desertification expansion by preventing soil erosion through geomorphic agents.
  - To increase forest cover outside forest land.
  - To improve aesthetics of farmland.
  - Reduce pressure on natural forest to meet industrial demand.
- **Difficulties of farm forestry-**



  - Land ownership- if the ownership is private then the forestry focussed on increased production and not about environment and vice versa if the land has public ownership.
  - The productivity of farmland reduces with due course of time as the farm forestry usually has monocropping.
  - Remuneration to farmers is uncertain due to long gestation period of trees and uncertainity in industrial demand during final felling of trees.
  - Pest problem may result in defected and stunted production which reduces monetary value.
  - Problem of Invasive species persists in the region if unscientific planning (usually on government land) is carried out in farmland.
  - Improper silvicultural operations and untimely felling (particularly in private plantation) results in site degradation.
  - Natural calamities causes a significant damage to the forest.

Financial returns from farm forestry- in the form of timber, non-timber forest produce, fodder for livestock, tourist activity due to improved aesthetic etc.

IFoS 2017 : explain the scope and aims of urban forestry. Discuss the need of urban forestry in the improvement of city environment (20 m).

Approach : (1) Introduction – few lines about urban forestry and its aims and scope
(2) Body – need of urban forestry in various climates

Urban forestry is a type of social forestry where trees are planted in urban areas for improvement of environment and landscape.

- **Aims**-
  - To reduce air pollution
  - To increase forest cover outside forest area
  - To improve local area landscape
- **Scope** –
  - To mitigate the impact of urban heat island- urban areas due to their low albedo absorb more sunlight than they actually reflect it, result in increasing the temperature of the region.
  - To minimize degradation of urban sites- due to urban household waste, C&D waste, sewage and concretization of land, along with commodification of land forces the land to become a scarce commodity, thus plantation site are usually near the landfill site.
  - Help in reducing cooling demand- Cooling demand is increased to cope with the rise in temperature, which requires large amount of energy.
  - To prevent site runoff and soil erosion and help in watershed restoration - rising construction activity forces land use change soil structure to become compact in order to stabilise large structure. As a result of this runoff increases.
  - As a potential tourist site due to improved landscape of the region.
  - Play a crucial role in achieving targets of Paris climate summit
- **Need of urban forestry in different region**
- **Coastal region**-
  - Prevent and minimise coastal erosion- due to tidal waves, human activities like port and harbour construction, higher river velocity in deltaic region due to high precipitation results in acceleration of erosion of coastal region.
  - Act as a buffer against natural calamities- almost every year India east coast faces cyclones which causes havoc near coasts through high velocity winds, high intensity rainfall.
  - Help in soil improvement and nutrient addition. E.g. land near coastal region has red and laterite soil which is devoid of basic essential nutrients. Also due to sea water intrusion in the land causes increased salinity in the region which left the land unproductive
  - To help fulfil requirement of local people, in the form of clean and improve air, employment generation, improved aesthetics of the region.
- **Hilly region**-
  - Maintain and improve aesthetics of the region. E.g. Nainital

- Prevent natural calamities like landslide in the region
- Creation of Forests on rocky and degraded sites in the hills.

➢ **Metro cities**-

- Increasing employment opportunities for the locals
- It can help prevent leaching of harmful material from landfill site by adsorbing and absorbing them.
- Absorption of harmful gaseous pollutants and diluting concentration of such pollutants.
- It helps in preventing soil degradation and its erosion- urban soil is made compact in order to support heavy structures, highly impermeable due to heavy concretization of top layer.
- Help in restoring watershed thus preventing floods- the root cause of urban flood is altering the use of lakes and other waterbody for residential purpose.

  Arid regions-
- Prevent shifting of sand dunes- frequent shifting of sand dunes alter the landscape by covering vital infrastructure like roads, covering oasis etc.
- Helpful in improving soil texture and its structure as arid soil usually has high salinity, thus it did not support much vegetation.
- Helpful in water conservation as these areas usually has high evaporation rate and due to larger soil aggregates water is quickly leached to lower horizons.

➢ **Temperate regions**-

- Help in meeting fuelwood demand- during winter the temperature goes down below zero degree centigrade, thus it necessitates the demand of external energy source to keep house warm.
- Improve aesthetics of the region
- Reduce acidification of soil as due to low temperature the organic matter didn't decompose. E.g. walnut trees, oaks
- Helpful in preventing soil erosion which causes due to snow and due to water runoff when snow melts.

IFoS 2016 : briefly discuss the aims, objectives and scope of social forestry. Why is people's participation must in social forestry (10 m).

Approach : (1) Introduction – few lines about social forestry, its aims

(2) Body – objectives and scope along with importance of public participation

Social forestry is the practice of forestry on land outside the conventional forest area for the benefit of rural and urban communities.

Aims-

- To increase forest cover outside forest
- To fulfil local demand

Objectives-

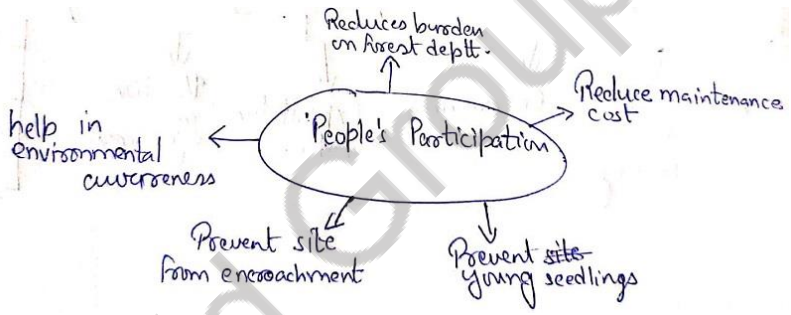
- To prevent further site degradation and its restoration.
- To provide employment to the locals

- Fulfil industrial demand to an extent.

Scope-

- It can help in achieving climate change and its targets- with the dense forest cover is continuously declining, social forestry can be the answer to increased forest cover as well as fulfilling commitments made in Paris and Glasgow summit.
- It can help in mitigating heat island and its effect- urban areas are reeling under the rising temperature inside cities due to heavy concretization which causes increased demand of energy.
- It can help in improving land use system- present land use in mainly focused on converting agricultural or forest land into urban structure for commercial or residential purpose.
- It can prevent desertification expansion- it slow down the degraded soil and prevent it from mixing it with good soil.
- It can help in watershed restoration- social forestry help in reducing runoff speed, increasing infiltration and percolation, disperse the harmful pollutants etc.

People's participation is important in social forestry because



- It helps in reducing burden from understaffed forest department by sharing their workload of manging forest.
- Plantation is usually carried out outside the jurisdiction of forest department, hence lack of local support causes encroachment, site degradation due to grazing and browsing activities, deforestation etc. E.g. plantation near highways, urban forest.
- It help in bringing transparency in forest department working, thus reducing the scope of corruption in the system.
- The sites in social forestry are usually very scattered, thus causes high maintenance cost. People's participation decreases this cost.
- The plantation is usually carried out for environment conservation purposes and not for timber harvest (except farm forestry), thus with local's help we can also spread the awareness regarding environment conservation. E.g. people protesting against felling of Aarey forest is the outcome of people's awareness regarding environment conservation.

IFoS 2022 : How do sacred groves help in conservation of biodiversity? (8m).

Approach : (1) Introduction – few lines about sacred groves and its example
(2) Body – write about sacred groves and biodiversity conservation

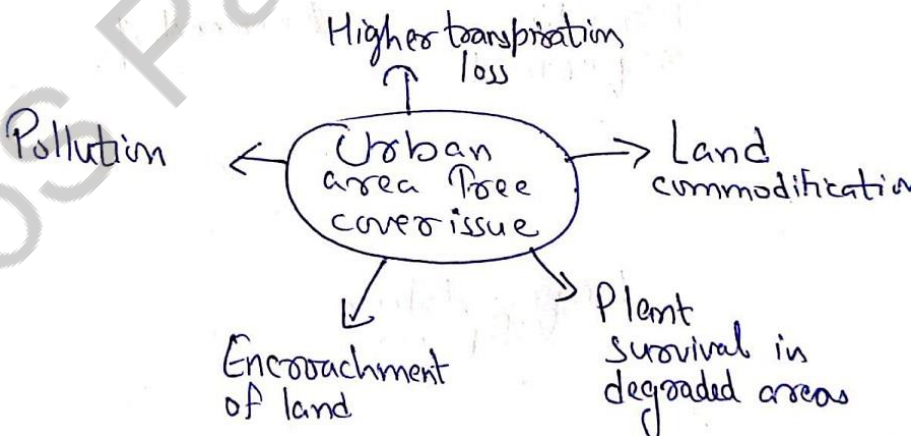
Sacred groves are the sites of cultural, religious importance for the locals. E.g. Pavithravana in Andhra Pradesh

- These sites are usually having minimum interference, thus help in conserve the local biodiversity.
- Such site usually has religious beliefs, thus cutting trees here is considered as inauspicious, which help in preserving the site.
- These sites has historical significance, thus it is an integral part of local culture, thus in order to maintain this culture they took care of the site.
- People took tree cuttings or seeds of the plant species and plant them in their home, thus it helps in expansion of forest outside of the forest.

IFoS 2022 : Discuss the key problems to expand tree cover in urban areas.
Explain the role of urban trees in abating soil pollutants. (15m).

Approach : (1) Introduction – few lines about urban areas
(2) Body –discuss key problems regarding expansion of tree cover in urban areas
(3) Role of urban trees in abating soil pollutants

Urban areas are those areas that are lying in the urban area boundary. They facing multitude of problems like urban heat island, pollution, soil degradation etc, the solution of these problem lies in increase vegetation cover in these urban areas. However there are multiple problems associated with expansion of tree cover like



➢ Problems of tree cover in urban areas
  - Land commodification in urban areas
  - Diversion of agriculture and forest land for commercial purposes.
  - Encroachment of land used for tree cover expansion.
  - Degraded urban sites, thus growing trees in this region is a challenge.

- Air Pollution causes problem like acid rain which is detrimental to young shoots, higher concentration of soot particles blocks stomata.
- Due to urban heat, the temperature in urban areas is higher, which retards the rate of photosynthesis and increases the rate of respiration thus increases transpiration loss.

➢ Role of urban trees in abating soil pollutants.

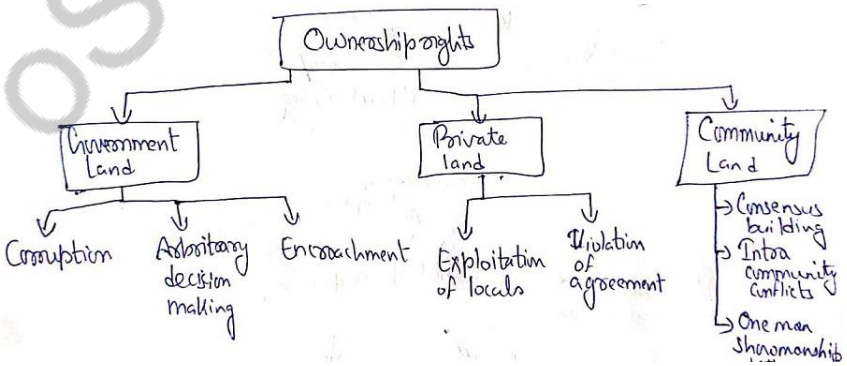
- They help in phytoremediation of pollutants by adsorbing and absorbing them in their roots.
- They help in improving aeration of soil which help in decomposition of organic matter.
- They help in increasing water percolation in the soil, thus help in leaching of toxic metals and salts in the lower horizon.
- It facilitates the growth of beneficial bacteria that help in fixing nitrogen, thus abating nitrogenous pollutants in soil.
- Root exudates help in fixing of certain soil-based pollutants by reacting with them and converting them into non-pollutant form.

IFoS 2021 : How do the ownership rights of forests influence the success of joint forest management (8m).

Approach : (1) Introduction – few lines about JFM
(2) Body – types of ownership and how it influence JFM

Joint forest management is an integrated approach of forest management where the forest department encourage locals to protect and support forest by sharing the cost and benefits from the forest with them. Ownership are of three types.

- Government land
- Private land
- Community land



- **Forest on Government land**- it is usually managed by forest official thus they has to follow proper guidelines and work according to them, here the aim is environment protection along with monetization of forest produce. JFM helps by improving functioning of forest department by reducing burden on them increase transparency in their functioning, protect forest from illegal felling of trees, However they face

the problem of encroaching the forest site under the garb of forest rights act, corruption prevalent in the system, inter and intra community conflicts which jeopardized joint forest management.

- **Forest on private land**- here the forest is managed to maximise timber production (or non timber forest produce). Thus through JFM, they can protect crops from various biotic forces, increase site production efficiency through proper silvicultural operations, also help in ensuring availability of cheap labour etc. However due to private ownership, often it leads to exploitation of poor in terms of denial of sharing of benefits, violation of agreement (as JFM lacks statutory support)
- **Forest on community land**- JFM helps the forest community by ensuring sharing of benefits associated with the forest in the community by recognising their hard work, help in gender empowerment in the community. However getting consensus within the community is a daunting task which is further crippled by the intra community conflicts, rise of strongman within the community.

IFoS 2020 : How does collaborative forest management ensure community and household resilience (8m).

Approach : (1) Introduction – few lines about collaborative forest management

(2) Body – role in resilience of community and household

Collaborative forest management refers to a type of forest management where forest department and locals resided near to the forest come together to manage the forest together.

It ensures community and household resilience through

- By providing a kind of employment to people for managing forest, and sharing of revenue help in recognising of their hard work
- It allows locals to utilise vacant space to grow food crops thus helps local to attain food security. E.g. taungya cultivation
- It helps in preventing further site degradation, thus reducing incidence of land based pollution and help in maintaining productivity in the region.
- It helps in increasing women's participation, thus help in gender empowerment.
- It helps in reducing criminal activity (like illicit felling, encroachment) in the region
- It helps in providing other intangible benefits like royalty free nistar, allowing local to collect and dispose NTFPs.
- It helps in increasing public participation thus help in increasing accountability and transparency of the forest department, thus help in minimise corruption.

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

Approach : (1) Introduction – few lines about PRA, its advantages

(2) Body – briefly explain tools and techniques of PRA

Participatory rural appraisal is a method to facilitate collecting and analysing data from locals in various parameters, thus help in inventorying, monitoring and planning of local forest management.

Importance of PRA

- It help in identification of target group priorities
- Help in understanding the bottleneck that is prevalent between engagement of institutions and public at large
- It act as a social audit to identify the penetration of government based services in the life of locals and upto what extent they benefitted from that.
- Such appraisal provide information regarding the needs of locals to administration and made them aware about the gap between requirements of service and delivery of services.
- Such appraisal help in effective utilization of indigenous knowledge of locals
- It helps in increasing efficiency in effective delivery of services by utilising available resources and prevent concentration of benefits in the hand of few.

Tools for PRA

- Stakeholder analysis- it is usually carried out with the help of venn diagram, where the constraints in people's participation is usually find out by finding out intensity of engagement between locals and various organisations and institutions. Thus it helps in clear understanding about the role, influence of various department over locals.
- Gender analysis- it helps in assessing the role of women in extracting natural resources, owning of property by women, level of decision making in the hands of women, socio economic condition of the region. Thus it helps in understanding the local demography division of labour.
- The community needs assessment- it helps in assessing the needs of local community by identifying their problems and providing them solutions or options regarding these problems.
- History/timeline- it helps in understanding the village history and help in making a timeline of all important activities that are carried out in the area.
- Participatory mapping- here land use map and demographic map are prepared which help us understand the level of government infrastructure as well as the social distribution of people.
- Wealth and well-being ranking- it help us understand the wealth holding group among the population and level of well-being among the population in terms of various parameters.
- Transect walk- it involves visual inspection of the area, the land use pattern, level of development in terms of government infrastructure penetration, level of degradation in the region, availability of natural resources in the region etc.
- Cropping patterns- it highlights types of crops growing in the region, sowing season and their patterns, cost benefit analysis of different crops etc.
- Seasonal calendar- it help us to understand weather patterns, holidays, festivals and local cultural events in the region, outmigration of labour, income and expenditure patterns.
- Matrix scoring- it help us in identifying the importance of forest product in local household of the region.
- Mobility mapping- it help us in understanding the type of mobility used by household, its frequency etc.

- Livelihood analysis- it help us in finding the source of income of household, their expenditure patterns, level of unemployment in the region.

IFoS 2018 : What are the objectives of joint forest management (JFM)? Give methods used for preserving forest resources through JFM? (15m).

Approach : (1) Introduction – few lines about JFM
(2) Body – its objectives, and preserving forest resources through JFM

Joint forest management is an approach of forest management where the forest official encourage locals to participate in collaboration with forest department to protect and manage forest by sharing the benefits associated with managing the forest with them.

- **Objectives of JFM**
  - Sustainable use of forest by reducing and eliminating shifting cultivation
  - Increase public awareness and their participation in forest management activities
  - Allow gender empowerment by increasing women participation.
  - Increase transparency and accountability in forest department and its working and Reduce burden on forest department by providing them local support in managing forest.
  - To rejuvenate and regenerate degraded areas by preventing illegal activities like theft, felling, encroachment etc
  - It plays an important role in government action against climate change adaptation and its mitigation and also help them in fulfilling INDC targets.
  - It help in providing employment to locals thus help them in sustaining themselves and also increase their income and help them in their upliftment.
- Methods of preserving forest resources through JFM
  - **Royalty free nistar**- it provides them a right to utilise forest produce without paying any royalty for it. Thus it help in formalize the utilization of resources thus preventing theft and illegal felling
  - **Revenue sharing model**- it helps in providing a kind of employment to people, which helps them by recognising their hard work in managing the forest, and at the same time it helps in preventing illegal encroachment and clearing forest through fire.
  - **Right over silvicultural operation**- it helps them by paying them in kind for their services, thus it helps in accelerating in cleaning up forest debris, while help them in fulfilling their fuelwood, timber and forage requirement.
  - **NFTP collection rights**- trees having either less valuable NFTP or having scattered NFTP producing trees, their collection and disposal rights have been given to tribals or people resided near forest, it helps in preventing grazing and browsing in forest
  - **Sacred groves**- such plantation are better protected as some communities main deity are resided in that forest and damaging these forest means angering the deity for them, thus they do anything to preserve these forest. These forests are majorly used for environment conservation related purposes.

IFoS 2017: Write the details as to why the joint forest management was initiated and what are the constraints in its implementation? (15m).

Approach : (1) Introduction – few lines about JFM its reason to implement
(2) Body – constraints in implementation of JFM

JFM is an integrated approach of forest management where forest department encourage locals to preserve and protect the forest by sharing the benefits associated with forest with them. The reasons for which JFM policy was initiated is as follows.

- Upliftment of communities residing near forest areas by providing them employment in forest.
- To check illegal felling, theft, encroachment and biotic pressure (i.e., grazing, browsing) on forest land by local mafia and their cattle.
- Bringing transparency and accountability in forest department functioning and reduce burden on them.
- Increase public awareness and their participation in managing forest, thus help in effective management of forest resources.
- To regenerate and rehabilitate degraded forest areas.
- To correct policy lapse i.e., in 1952 forest policy, agriculture was prioritise over forest which result in change in land use system to accommodate agriculture. As a result forest area decreases rapidly. Thus JFM is a step to conserve forest and prevent their diversion into agriculture.
- Fulfilling international commitments like INDC,

Constraints in implementation of JFM

- Lack of statutory backing as at present only JFM related guidelines are given.
- Excessive rules and regulation
- Arbitrary power vested in forest official
- Long gestation period for remuneration
- No additional funding granted for projects under JFM
- Does not cover any sudden calamities like forest fire, locust attack etc.
- Inter and intra community conflicts over benefits associated with JFM
- JFM v/s FRA 2006- after forest right act was passed utility of JFM in question, as FRA grants more right over JFM and has legal backing.
- No sync between micro plan and working plan result in asymmetry between operations performed under different plan result in confusion.

IFoS 2016 : Trace the history of JFM in India, narrate any one success story with details? (15m).

Approach : (1) Introduction – few lines about JFM and its timeline
(2) Body – Arbari experience of west bengal

- JFM is an integrated approach of forest management where forest department encourage locals to preserve and protect the forest by sharing the benefits associated with forest with them.
- It was started by British under the pen name VAN PANCHAYAT in Uttarakhand in 1931 to manage forest in order to minimise burden on forest official. After independence, the focus of government is to increase food production, thus it allow diversion of forest toward agriculture expansion, which led to problems. Thus in order to rectify the mistake, JFM was brought back and found in 1976 National Commission on Agriculture report which emphasis on protecting forest and finally it mention in National forest policy 1988, which provide detailed guidelines to utilize forest wealth to improve local livelihoods.
- The first successful story of JFM lies in Arbari village in East-Midnapur Forest division in West Bengal, which suffered degradation of Sal Forest due to biotic pressure. Then DFO of the region A.K. Banerjee, necessitates the need of local participation in managing forest. Through the involvement of local community, he rejuvenate and restored 1271 hectare of degraded forest. Because of this restoration, the forest department with a investment of mere 10 lakh rupees earns 1crore 20 lakhs rupees in 14 years.
- They also recognise the locals support in this successful endeavour and as a token of respect they agree to share 25 % of their sale proceeds with the locals.

07223970423 Hornbillclasses@gmail.com

2 Chapter

Pollution and Environment conservation

IFoS 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 pollution) Act, 1981 in relation to pollution management. Suggest name of suitable plant species. (15 m).

Approach :

1) Introduction – few lines about pollutants and climate change and its relationship.
2) Role of forest vegetation in abating pollutants [About ½ part of Answers].
3) Write down about salient features about air act 1981.
4) Write down name of suitable plant species.

- Relationship between air pollutants and climate change
  - Pollutants like nitrous oxide help in inducing climate change due to their higher global warming potential.
  - Climate change helps in inducing forest fire, thus helps in releasing air pollutants. E.g. Australian bushfire in 2019 is the result of excessive drought caused by climate change
  - Land Degradation caused by pollutants accelerates release of carbon from the soil, thus aid in climate change.
  - Climate change accelerates the intensity of natural calamity which become the source of degraded site that help in releasing of harmful pollutants. E.g. water polluted site become the source of releasing pollutants like methane, nitrous oxide.
  - Pollutants like sulphur dioxide reflects sunlight thus help in cooling earth and mitigating climate change
  - Climate change induces unseasonal rain, higher wind speed which help in reducing pollution level in the region by diluting their concentration in the environment.
- Role of forest in abating pollution
  - Absorb harmful pollutants- trees like neem, mango absorb harmful pollutants.
  - They help in improving gaseous cycle like N cycle (through their roots action), and C- cycle (through photosynthesis) as well as sedimentation cycle like sulphur cycle(through sulphonate desulphurization, sulphonate ester cleavage), thus help in checking pollutants level.
  - Through their wind flow action they help in diluting the concentration of pollutants, as well as adsorbing pollutants on their hairs (particularly PM)
  - For carbon cased pollutants (i-e carbon dioxide) they act as natural carbon sink

- They help in maintaining sufficient moisture level, thus preventing haze formation.
- They help in managing watershed of the region by help in infiltration of rainwater, as well as reducing pollution in soil by leaching of harmful pollutants.

➢ Sometimes forest trees also act as pollutants. E.g. Russian poplar trees in Kashmir were act as pollutant and allergic to human

➢ Air pollution act 1981 was passed with the intent to regulate factors that caused air pollution, its salient features are as follows

- This act made mandatory for state government to constitute state pollution control board, which is been introduced in water act 1974
- It provides additional powers to CPCB and SPCB to monitor air quality in the region
- It helps in laying down standard of air quality
- It helps in creation of air quality and control laboratory
- Introduction of emission norms for automobile vehicles
- It helps in prevention of Industrial pollution by restricting certain high polluting industries, including laying down norms for industries.
- It gives power to CPCB and SPCB to inspect and take sample of polluted site.
- It bars civil court from granting jurisdiction in this matter.
- It also prescribing penalties in violation of this act.

➢ Name of plant species to abate pollution

Azadirachta indica, Moringa oleifera, Ficus religiosa

IFoS 2021 : Explain the role of trees and forests in environmental conservation (15m).

Approach : (1) Introduction – few lines about environmental conservation.

(2) Role of trees and forest in abating water, soil, air and noise pollution

Environmental conservation refers to those activities that tend to mitigate the degradation or prevent degradation.

Role of trees and forest in environmental degradation

➢ **Prevention and reduction of concentration of pollutants**

- Water degradation- they help in preventing degradation through
  1. Reduced runoff speed by help in percolation and infiltration of water downwards, thus help in watershed restoration.
  2. Adsorbing and absorbing harmful pollutants from the degraded water site (through their roots action) thus help in improving the water quality
- Soil degradation
  1. Reduced the speed of wind by acting as barrier and their roots help in binding the soil thus preventing wind erosion and minimise evaporation loss from the region

2. Their canopy act as a barrier against the falling droplets, and allowing stem flow thus minimising splash erosion. And by increasing infiltration they leach out harmful pollutants from the top layer to lower horizon.
3. Accelerate biological weathering beneath the soil surface thus help in soil formation as well as release of nutrients like sulphur, phosphate were made available to soil.
4. Enriching soil by through humification, mineralization and nitrogen fixation, thus help in improving texture, as well as its nutrient composition.
5. Help in creating a microclimate through moderating the climate near soil, which facilitate the growth of bacteria like Azobacter, Azospirilium etc.

> **IFoS 2019** : explain the role of trees and forest in combating in environment degradation (link Q).
>
> **IFoS 2009** : describe the role of forest in environment conservation. (12m)

- Air quality
  1. They help in dispersing the pollutants, thus reducing the concentration of harmful air pollutants in the air.
  2. They help in absorbing pollutants like particulate matter through their hairs on stem and leaves.
  3. Act as source of carbon sink, thereby absorbing carbon dioxide
  4. Some trees like neem, khejari etc absorb harmful pollutants.
  5. Through their transpiration activity they maintain moisture in the air thus prevent formation of haze.
- Noise pollution
  1. Forest help in absorbing high pitch sound, thus reducing their intensity
  2. Plantation of oakleaf holly croabilitp near highway, rail line help in reducing sound pollution.

- **Biodiversity conservation**- trees and forest provide shelter to animals, prevent them from their predators, provide food to animals, thus helps in increasing biodiversity conservation.
- **Carbon balance**- forest act as a source of carbon sequestration which can counter the carbon dioxide concentration in the atmosphere.
- **Forest based industry**- Through plantation of improved species, such forest help in fulfilling the demands of industries and helps in minimising the pressure on existing forest.

  However, now a days with rising creation of artificial forest, the forest loses its biodiversity and become plantation forest with emphasis on single species crop. As a result of this forest may be vulnerable to pest attacks, weed problem and invasive species infestation in the region. Further in case of forest fire, (though it has certain benefits), however it is also the source of release huge carbon from the sink thus disrupting carbon budget of the earth.

IFoS 2021 : What are the impacts of COVID-19 pandemic on environment and biodiversity. (8 m).

Approach : (1) Introduction – few lines about what is COVID-19 pandemic.

(2) Positive and Negative impacts of COVID-19 on environment and biodiversity

COVID 19 pandemic is caused by SARS CoV- 2 virus which mainly affects lungs. Because of this pandemic we witnessed a halt in the everyday life of humans in terms of their mobility, change in lifestyle etc.

- Impacts of COVID-19 on environment and biodiversity
  - Due to closure of factories, pollution witnessed a sharp decline, thus help in improving environment and also increasing biodiversity due to non-disturbing of forest area.
  - Halt of anthropogenic activities allowed natural healing of forest and marine region.
  - There has been evidence of species returning to their original site, result in increasing local biodiversity.
  - This pandemic focuses back on the importance of understanding nature and its role in sustainable development
- However this forced halt also bring many future problems like
  - These benefits were proved to be short term, as economies cut their funding towards environment conservation programs.
  - The consumption of oil will increase in the near future as heavy discount were given to the oil importing countries.
  - Increased waste generation- due to COVID a large amount of toxic waste is generated without having proper disposal methods, which is now polluting environment.
  - Increased wildlife crimes- due to diversion of large workforce towards managing COVID situation, this allows illegal wildlife trade, poaching of animals and deforestation
  - The world is heading towards recession which might again start prioritise growth over environment concern.

IFoS 2021 : What is REDD+? how does clean development mechanism help in sustainable development of forests? (8 m).

Approach : (1) Introduction – definition of REDD+

(2) Body – brief introduction about CDM and sustainable management of forest

- REDD is an abbreviation for reducing deforestation and forest degradation and plus refers to the role of conservation, sustainable management of forests and enhancement of forest stocks in developing countries.
- Clean development mechanism is implemented under Kyoto protocol under which the developed countries has the obligation to undertake clean energy projects in the developing countries. This reduction in carbon production due to such projects were converted into a tradable entity called carbon credits where one carbon credit is equivalent to 1 ton of carbon dioxide. This carbon can be traded between countries who were unable to achieve these targets. It helps in sustainable development of forest through

- By switching towards more efficient mode of energy production, the use of fuelwood as an energy source reduced thus preventing deforestation of forest and help in increasing biodiversity in the region.
- It opens the door for interconnection between developing countries and developed countries, thus increased adoption of modern methods which optimise utilization of forest resource and increased productivity of forest resources.
- It brings in the limelight of importance of forest in preventing and mitigate the impact of climate change.
- It also put more emphasis on alternatives of forest based industry as forest intangible wealth far outweighs its tangible worth.
- It helps countries to implement and enforce strict environmental laws, which help in increased forest cover, which also helps in conservation of soil and water resources.

IFoS 2021 : What is the role of forest plantation in carbon sequestration? (10 m).

Approach: (1) Introduction – few lines about carbon sequestration
(2) Body – how forest plantation help in carbon sequestration

➢ Carbon sequestration is the capture and permanent storage of carbon (i-e carbon dioxide). Forest plantation play an important role in it because.

- The biomass of the forest plantation is a permanent storehouse of carbon.
- The litter produced due to falling of leaves, twigs and broken branches is converted into smaller compounds and thus absorb into the soil.
- Forest plantation usually contains fast growing species which absorb carbon faster than the natural forest.
- These forests are properly managed under silvicultural operations, thus it helps in supporting sustainable forest.
- The roots of the plants helps in increasing the surface area of the soil by altering soil structure thus increasing the capacity of soil to absorb carbon as well as preventing soil erosion thus preventing leaking of carbon into the atmosphere.

However, these plantation are harvested after their rotation period is completed, thus this plantation become the source of carbon release into the atmosphere, further the harvesting site is prone to soil erosion, thus releases the soil carbon into the atmosphere.

IFoS 2020 : Describe the in-situ biodiversity conservation with reference to biosphere reserve. (8m).

Approach : (1) Introduction – write about in-situ conservation of biodiversity.

(2) Body- how biosphere reserve method help in biodiversity conservation

- In-situ biodiversity conservation refers to conservation of biodiversity directly on site without creating any artificial measure. E.g. national park, biosphere reserve, wildlife sanctuary etc.
- Biosphere reserve is a protected area recognised by UNESCO under Man and biosphere programme. It comprises of three area namely
  - Core zone- this region is undisturbed region of the biosphere reserve, which is highly protected.
  - Buffer zone-this region surrounds the core zone and are used for research activities, tourism activities etc.
  - Transition zone- this is the outermost zone of biosphere reserve, here we witnessed tribals or locals residing near the reserve and engaging in their household activities.

IFoS 2020 : Discuss the role of national parks in conservation of biodiversity.

- It helps in biodiversity conservation through
  - They are the natural habitat of animals, and also they have large areas in comparison to ex-situ conservation reserve, thus animals conserve here already adapt to this environment and therefore does not require and special measure for their survival.
  - The gene pool of animal in in-situ site like biosphere reserve are much wider, thus the problem of gene recess does not arise.
  - The animals conserved in in-situ sites are much stronger, and acquired natural immunity against diseases.
  - Biosphere reserves are the natural made forest highlights very wide biodiversity, thus food availability is much wider helps in ensuring food security.
  - Biosphere sphere has ability to cater multiple keystone species at the same time by providing them necessary prerequisite condition. E.g. Manas biosphere reserve has cater tiger, rhino, hoolock gibbon etc

IFoS 2020 : What do you mean by population diversity? What are the different method to measure biodiversity? (15m).

Approach : (1) Introduction – few lines about population diversity

(2) Body- methods to measure biodiversity.

Population diversity refers to variation in terms of genetic and morphological features that define different population.

Genetic diversity – it is the variation of genes and genotypes within a species. The higher the diversity the higher will be the survival of the species and its adaptability to different types of climate. E.g. different types of rice like pokkali rice (which grows on salt water), basmati rice etc.

IFoS 2017 : what are the different measures employed to measure biological diversity. (link Que)

Measuring genetic biodiversity-

Gene frequency- it is the proportion of different alleles of a gene in a population. It is usually calculated by Hardy Weinberg law

Species diversity- it refers to different species present in an ecosystem and relative abundance of each of those species. For e.g. population of animals in tropical rain forest.

- Species diversity is measured through
  - Species richness- it represents the number of species represented in an ecological community. It does not highlight abundance of any particular species.
  - Shannon index- it is used to measure diversity of a species in a community. It is denoted as H and is calculated by

$$H = -\Sigma p_i * ln(p_i)$$

Σ: A Greek symbol that means "sum"

***ln*:** Natural log

p_i**:** The proportion of the entire community made up of species *i*

the higher the value of H the higher will be the value of the diversity of an species. If H=0 then the community represent only one species.

- Simpson diversity index is a measure of species diversity which takes into account the number of species present, as well as the relative abundance of each species. As species richness and evenness increase, so diversity increase.

$$D = 1 - \left(\frac{\Sigma\, n(n-1)}{N(N-1)} \right)$$

n = the total number of organisms of a particular species.

N = the total number of organisms of all species.

- The value of ***D*** ranges between 0 and 1. With this index, 1 represents infinite diversity and 0, no diversity.
- Ecosystem diversity- it is the diversity present between ecosystem within an geographical location and their overall effect on human life. It can be measured into 3 types
- Alpha diversity- it is the diversity prevalent in a particular geographical area or ecosystem. It can be measured by counting the number of taxa within the ecosystem.
- Beta diversity- it is the species diversity within ecosystem, it involves comparing the distinct animal species of the taxa.
- Gamma diversity- it is the overall diversity of an different ecosystem in a region.

IFoS 2020 : Explain the methods of environmental impact assessment. (15m).

Approach : (1) Introduction – few lines about EIA.

(2) Write down different methods of EIA

- Environmental impact assessment is the process to check the impact of certain developmental projects on the geographical area in general and local ecosystem in particular. there are certain methods of EIA. Some of them are-
  - Ad-hoc method- this type of assessment indicates broad areas where possible impacts of such projects can be seen. Here each parameters can be considered separately and the nature of impacts is considered
  - Checklist method- here environmental factors are listed in a format by giving weight to important factors and through scaling is applied to the impacts of each alternative to check impact identification.
  - Matrix method- in this the framework for the interaction of different activities is listed where project actions are listed on one axis while their environmental impacts are listed on the other axis.
  - Network method- it uses the matrix approach and extends it to include both the primary as well as secondary impacts.
  - Overlay methods- it depends on a set of maps of a project area's environmental characteristics covering physical, social, ecological and aesthetics aspects.
  - Stimulation methods- it is used for a very specific situation and the scope of the method is limited to a single activity.
  - Cost benefit analysis- it is used on a single comparative analysis of the positive and negative of any particular activity or project.
  - Environment index method- here assessment is based on the 32 indicators and 11 parameters and based on the result an environment performance index is prepared. This ranking is variable in nature.

IFoS 2020 : Write the chemistry of ozonosphere and list the adverse effect of ozone layer depletion? (10m).

Approach : (1) Introduction – few lines about ozonosphere
(2) Write down chemistry of ozonosphere and the effect of ozone layer depletion.

- Ozonosphere is a specific region of the stratosphere where due to higher concentration of ozone it is called as ozonosphere. It is generally found at around 40-80 km from earth.
- Chemistry of ozonosphere- due to higher distance from earth, here the gases are in scattered form and at the same time vulnerable to higher energy sun rays that breaks the bond between the atom. When UV-C rays from sun interact with oxygen molecules it breaks the compound into nascent oxygen. This nascent oxygen is highly reactive and is ready to make bonds with anyone who is free. This nascent oxygen reacts with oxygen to form ozone. However this molecule of ozone is unstable and it disintegrated quickly to form oxygen and dioxygen. Apart from ozone and oxygen, this sphere contains nitric acids clouds, polar stratospheric clouds and nacreous clouds.

- ozone layer depletion- when the concentration of ozone falls below 100 dobson units, the condition is called as ozone layer depletion. Due to this high intensity rays like UV-C and UV-B falls on earth which causes
  - Change in biogeochemical cycle of plants, animals, and aquatic species
  - Death of phytoplankton and other stenothermal species
  - In marine organism, it causes decreased reproductive Capacity and impaired larval growth.
  - Exposed material degradation may accelerate
  - Direct exposure to human causes diseased like melanoma (skin cancer), cataract and other disease.
  - These high intensity rays accelerate the rate of evaporation which cause change in water cycle.

IFoS 2020 : What is arsenic pollution? Discuss the strategies to mitigate it (10m).

Approach : (1) Introduction – few lines about arsenic its source and it can be spread
(2) Write down strategies to mitigate the arsenic pollution.

Arsenic is a heavy metal in the atomic table and came through weathering of rocks and minerals and burning of coal in power plant, vulcanism etc. Arsenic pollution refers to intake of arsenic via air or water by human.

- Strategy to mitigate Arsenic pollution
  - Use standard quality bituminous coal
  - After any volcanic activity, water from any open source i.e., lakes, pond, rivers should not be used for drinking related purpose.
  - Use adsorbents like activated alumina, iron oxide coated sand,
  - Coagulation by using potassium permanganate as oxidising agent and ferric chloride as coagulant.
  - Co-precipitation – here steel waste slag is used which while absorbing arsenic precipitates iron water which is further adsorbed by iron-oxyhydroxides and the remaining mixture is passed through treated sand which retain arsenic.
  - Microbial oxidation - through the use of *Mycobacterium lacticum*, Arsenic III can be oxidised into Arsenic V And this oxidised arsenic can be adsorbed into activated alumina
  - Zero valent iron technology - it is used to oxidised arsenic III into arsenic V which can be adsorbed by anhydrous ferric oxide.

IFoS 2017 : what are the possible impact of green house gases on the global environment (8m)

IFoS 2020 : Write the salient features of the solid waste management act, 2000 and 2016. What new initiatives have been taken in the solid waste management rules, 2016. (8m).

Approach : (1) Introduction – few lines about intention of SWM act and its salient features
(2) Write down new initiatives that are taken under SWM rules 2016.

- Solid waste management act was passed with the intention to regulate the solid waste and formalize the waste management and its disposal. Salient features of solid waste management act 2000 is as follows.
  - It is the first act that focuses on collecting the waste, its segregation into wet and dry, its transportation, processing and its disposal.
  - It also focus on landfill site, its construction and necessary precautions that must be taken into account.
  - It also focus on monitoring of air and water quality around the polluted site like incineration, landfill site etc.
- New initiatives under SWM 2016
  - Duties of waste generators- for the first time it specified duties of waste generators like segregation of waste at source site, payment of fee to collect waste, shall not burn any waste.
  - Construction of waste to energy plants
  - Recognition of informal waste collector organisation.
  - Construction of waste management system by waste manufacturer.
  - Construction of waste deposition centre
  - Obligation to waste manufacturer to buy back waste that was manufactured by them

IFoS 2020 : What is the ecological and economical importance of biodiversity? Mention the salient measures for conservation of biodiversity. (8m).

Approach : (1) Introduction – few lines about biodiversity
(2) Write down ecological and economical importance of biodiversity along with measures to conserve biodiversity.

Biodiversity refers to the variety and variability of organisms, of genetic material and of community or ecosystem.

- Ecological importance of biodiversity
  - Help in nutrient cycling- biodiversity help in improving gaseous and sedimentation cycle by acting as sink to store excess of these gases.
  - Help in ensuring food security- it helps in creation of food webs which helps in ensuring sustainable supply of food materials.
  - Balancing pest predator relationship thereby preventing any outbreak of any pest attack.
  - Prevent gene recess- monoculture species are suffering from this syndrome which result in weak produce which is vulnerable to disease.
  - Erosion control- it helps decreasing the intensity of geomorphic agents along with restoring their valuable characteristics, thereby reducing erosion.
- Economical importance of biodiversity
  - IPR- by using biodiversity scientist develops novel drugs from the medicinal plant species and monetise it making it a billion dollar industry.

07223970423 Hornbillclasses@gmail.com

- Due to improved soil productivity, agricultural production may increase which in turn increasing farmer income.
- it helps in creating the new branch of science i-e biotechnology, which now has widespread use in almost every field
- Wider gene pool help in preventing gene based diseases in living organisms, thus reducing health cost that may be associated with such disease.

➢ Conservation of biodiversity

- Effective policymaking by passing of important acts, policies, international convention for biodiversity conservation.
- Restoration of degraded areas by afforestation and reforestation.
- Increased focus on environment awareness and its conservation, thus help in sustainable use of resources.
- In-situ mode of conservation like protected area, community reserve, conservation reserve etc and ex-situ methods like botanical garden, conservation breeding, zoo etc.

IFoS 2019 : List out the greenhouse gases that contribute to global warming. What are the effects of global warming. (8m).

Approach : (1) Introduction – few lines about GHGs and write some of their examples.
(2) Write down effect of global warming.

Greenhouse gases are those gases that absorb long range radiation thus help in imitating the greenhouse effect on earth. The gases are as follows- carbon dioxide, water vapour, ozone, nitrous oxide, sulphur hexafluoride, methane etc.

➢ Effects of global warming-

- Rise in population of invasive species- because of their ability to survive in harsh climate and their quick regeneration ability helps them to dominate the area.
- Forest degradation become irreversible- forest has their ability to regenerate themselves in due course of time however due to climate change there is a rising threat that this degradation become irreversible.
- Extinction of species- due to rise in temperature, species like polar bear, panda become extinct.
- Food security- due to loss of moisture in top soil, along with presence of salts in top soil, and reduction in agriculture area due to rise in sea level, food security may arise.
- Shifting of vegetation in higher altitudes.
- Energy demand for cooling requirement increases, which further consumes fossil fuel (as more than 60 % power generation in India is based on fossil fuel) and thus creates a vicious cycle.
- Degradation of natural resources like water, soil, air happen, which cause rift between countries result in rising conflicts between them. E.g. by 2030 perennial river will become seasonal in Indian subcontinent which may increase tension between countries

- Intensity and frequency of forest fires will increase result in loss of biodiversity, wildlife and accelerates global warming by releasing more carbon in the atmosphere
- Intensity, frequency and duration of natural calamities will increase loss of infrastructure, human lives and accelerates degradation.
- Forced change in land use system in order to accommodate human and wildlife population due to submerging lowland area in sea.
- Melting of glaciers causes release of harmful bacteria as well as carbon, which causes healthcare concerns for human.

IFoS 2019 : Explain the concept of sustainable development. Discuss in brief the agenda of sustainable development. (10m)

Approach : (1) Introduction – few lines about history of sustainable development

(2) Write down agenda of sustainable development along with 17 goals.

The concept of sustainable development was first mention in Brundtland report where it stated that it is the idea under which human societies must live and meet their needs without compromising the ability of the future generation.

The agenda for sustainable development is divided in 17 goals and 169 sub goals known as sustainable development goals which is a 15 year period and is supposed to be achieved by 2030 these are as follows.

IFoS 2018 : What is sustainable development? Write about the criteria and indicator of sustainability fulfilling the needs and demands of growing populations of India?. (10m).

Approach : (1) Introduction – few lines about cold desert or plant's adaptive behaviour.
(2) Write down adaptation at various morphological, Physiological, and molecular levels.

Sustainable development is development that meets the needs of the present, without compromising the ability of future generations to meet their own needs.

- Criteria of sustainable development
  - Social inclusion- it is the basis of sustainable development and its focuses on including women, poor and marginalised community into the development process.
  - Environmental protection- in the quest of growth we forgot environment result in looming threats like climate change, food security etc.
  - Economical growth- it helps in equitable distribution of wealth as well as help in increasing purchasing power of the people.
- Indicator of sustainability
  - Poverty- according to UN reports around 21.2% people still lives under poverty line.
  - Gender bias- due to patriarchy, women often face dependence regarding financial, education, travelling, marriage etc.
  - Health- Rural India faces lack of basic health infrastructure, while due to poverty a section of the population lacks affordability of healthcare.
  - Income bias/ Inequality- as per Oxfam report, around 1 percent of the rich population holds wealth that is equivalent to 80 percent of the wealth hold by population at the bottom.
  - Pollution- India is the third largest carbon emitter in the world, however its per capita emission is less than world average.
  - Hunger- India ranks 101 rank in global hunger index and has the highest percentage of stunted children in the world.

IFoS 2017 : Discuss the term biodiversity. Explain the levels in which it can be studied. (link Q).

Approach : (1) Introduction – few lines about biodiversity and its importance
(2) Write down the three levels in which it can be studied.

Biodiversity is the variety of animals, plants, fungi and even microorganism that make up our natural world. It support everything in nature that we need to survive i-e food, clean water, medicine and shelter. India has 2 percent of word land but it holds 7.52 percent of biodiversity including four biodiversity hotspots.

- Importance of biodiversity-
  - Biodiversity and food security- it helps in shifting of food chain towards food web which provide multitude of food options to species.
  - Biodiversity and forest productivity- higher biodiversity help in understanding interaction between species like symbiotic, competition, amenalism etc, thus help in increasing forest productivity.
  - Biodiversity and medical science- biotechnology is a modern science technique which is the modern day saviour of allopathic rely on biophysical properties of various species.
  - Biodiversity and marine life- coral is the rainforest of marine animals as this region has the highest biodiversity. Further 90 percent of marine productivity is restricted to coastal and the region around coast.
  - Biodiversity and tourism- sites with higher biodiversity potential has garner much more attraction than single species site owing to different canopies and lush green vegetation, multiple animal species.
  - Biodiversity and environment conservation- it helps in preventing erosion of soil, maintaining population of flora and fauna by maintaining pest predator relationship, check and control the level of pollution.

Levels of biodiversity- it can be studied at three levels

Genetic diversity – it is the variation of genes and genotypes within a species. The higher the diversity the higher will be the survival of the species and its adaptability to different types of climate. E.g. different types of rice like pokkali rice (which grows on salt water), basmati rice etc.

Measuring genetic biodiversity-

Gene frequency- it is the proportion of different alleles of a gene in a population. It is usually calculated by Hardy Weinberg law

Ecosystem diversity- it is the diversity present between ecosystem within an geographical location and their overall effect on human life.

It can be measured into 3 types

- Alpha diversity- it is the diversity prevalent in a particular geographical area or ecosystem. It can be measured by counting the number of taxa within the ecosystem.
- Beta diversity- it is the species diversity within ecosystem, it involves comparing the distinct animal species of the taxa.
- Gamma diversity- it is the overall diversity of an different ecosystem in a region.

Species diversity- it refers to different species present in an ecosystem and relative abundance of each of those species.

IFoS 2016 : Define global warming. Explain in brief the principle behind greenhouse effect. Write the consequences of global warming on forest, wildlife and the human health. (20m).

Approach : (1) Introduction – few lines about global warming and Green house effect

(2) Write down its consequences on forest human and wildlife.

Global warming is the long-term average rise in temperature of the earth. Since Industrial revolution earth temperature is already rise about 1 degree Celsius, and is expected to rise about 4-5 degree Celsius if no precautionary steps is being taken in this regard.

Green house effect- this principle was based on green house that were present in colder region to allow growing of plants in an artificial environment. This green house is made up of glass that allows short waves radiation (that came from sun) to pass through it and block long wave radiation (that radiated back from plants), thus helps in keeping the closed compartment warm.

On earth the sun rays are short wave radiation, when these rays strike the surface of earth, they get absorbed by surface, and due to this the surface radiates back long wave radiation in order to dissipate this extra energy. However gases like carbon dioxide, water vapours, ozone etc, absorb these long wave radiation thus increase the temperature of earth (though they allowed short wave radiation to pass through them).

- Consequences of global warming on forest
  - Tropical rainforest- due to global warming
    1. Herbs become rare- due to higher temperature excessive moisture loss will happen which demand more nutrient supply to dominant, dominated trees. As a result nutrient requirement of herbs will not be fulfilled and they will die.
    2. Shade demander species are difficult to grow- shade demander species require low light and moderate to low temperature to grow, however due to global warming photosynthesis rate may decrease, which causes reduction in growth of dominated tree canopy thus allowing direct sunlight to fall on these shade loving plants.
    3. Degradation become irreversible- forest has the capability to regenerate himself after degradation. However, due to erratic rainfall and decrease in rate of photosynthesis, the rainforest may convert into permanent shrubland.
  - Desert forest
    1. Invasive species- due to increase in temperature, infestation of invasive species is evident because they have the capability to sustain such high temperature and has ability to quickly regenerate when conditions are favourable
    2. Shifting of sand dunes- due to higher temperature, stronger wind may generate due to stronger high pressure convectional current. Which increases the chances of shifting of sand dunes result in expansion of desertification to nearby forest.
    3. Retarding the growth of shrubs, herbs- due to higher temperature, photosynthesis activity is declined and as a result smaller plant species growth become stopped.
  - Temperate forest-
    1. Shifting of tree- temperate forest are mostly stenothermal, so in order to adapt such condition they tend to move northward or on higher altitude where temperature is favourable to them.
    2. Forest fire- due to high resin content in their leaves, these forest are prone to fire, and global warming help in increase the temperature which might be sufficient to induce fire in them.

3. Increase risk of landslide in the region- due to warming, the snow melted which then induced solifluction, landslide.
4. Reduced regeneration period- seeds of coniferous trees become dormant during snowfall period and become regenerate only in spring period, however with earlier snowmelt period they dormant period reduces thus accelerate their regeneration.

- Grassland-
  1. Growth of weeds- due to their ability to bear such extreme climates and quickly regenerate after degradation they are likely to dominated the region
  2. Grasses with tap root system are dominant as they are able to draw nutrient from deeper levels.
  3. High surface moisture loss result in site degradation due to soil erosion.
  4. The region become prone to forest fire due to high temperature.
  5. The region become prone to prolonged drought as well as locust attack
- Mangroves
  1. Due to rise of extreme events like cyclones, their regeneration ability affected
  2. Due to rise in evaporation of water, the concentration of salinity increases and hence only high salt tolerant shrubs and herbs may survive in the forest.
  3. Coastal erosion may accelerate which causes the problem in holding structure of mangroves tree.

➢ Consequences of global warming on wildlife

- Terrestrial wildlife
  1. Change in metabolism activity of animals- higher temperature increased the temperature of skin of animals which in turn increases production of sweat to combat such heat. If this continues for prolonged period the metabolism activity of animals changed.
  2. Rise in disease among animals- due to higher temperature animals become vulnerable to disease.
  3. Small animals may go extinct- due to higher surface area of animals the rate of water loss become higher than the ability to replenish water, because of this, the toxic content in their cell increase and they die.
  4. Food crisis- due to lower productivity of forest, forage availability for herbivorous animals decrease which may cause food crisis.
  5. Change in behaviours of animals- the animals tend to become more aggressive.
  6. Forest fire- due to forest fire the animals population may decline. E.g. due to Australia bush fire around 3 billion animals species died in it and some animals are now in endangered category
- Marine wildlife-
  1. Coral bleaching become permanent- coral is very sensitive to temperature and salinity. Because of this any rise in temperature coral bleaching occurs which reverses when condition become favourable. However, due to global warming there is a threat that this bleaching become permanent.

2. Ocean acidification- due to rise in temperature concentration of carbonate ion increases which eventually reduce pH value of ocean. As a result of this animals with soft calcium body get dissolved more in shallow water.
3. Most marine species are Stenothermal species, they may move northwards or towards colder water where conditions are favourable to them
4. Due to higher temperature dissolved oxygen content decreases, and phytoplankton and zooplankton population are under stressed and they consumed more oxygen result in deficiency of oxygen in upper region may take place.

- Consequences of global warming on humans
  - Issue of food security may take place.
  - Rise in man animal conflict
  - Rise in desertification expansion which reduces agriculture productivity
  - Due to increasing intensity of natural calamity like cyclones, heat waves, landslide, drought etc, loss of infrastructure may take place.
  - Rise in zoonotic and vector borne diseases and their spread.
  - Energy consumption may increase in order the mitigate the heat effect on our body.
  - Natural resources like potable water become scarce result in conflict between countries

IFoS 2016 : What are the objectives of carrying out EIA. Discuss sequentially, the different phases of an EIA study. (10m).

Approach : (1) Introduction – few lines about EIA and its objectives.
(2) Write down different phases of EIA.

Environment impact assessment is an exercise to evaluate progressive and harmful environmental impacts of a proposed plan, strategy or program.

- Objectives-
  - to assess the damage done to the environment by a proposed project
  - Consult local and stakeholder about a proposed project and its impact on the region and try to alleviate their concern
  - Proposed action to minimise the impact of the project
  - Proposed alternative of the project if the damage caused by the project is way beyond recovery
  - As s tool for sustainable forest development
  - Help in mitigating undesirable impact that suits the local environment
  - To maintain transparency and accountability in project
- Phases of EIA-
  - Screening phase- it is the first phase of the assessment in which is mandatory for all categories of projects. however, in case of B category project, the projects requires detailed scrutiny of SEAC

report, based on which it is decided whether the project requires EIA studies or not. Based on this scrutiny the project is categorised as B_1 or B_2.

- Scoping- in this process, the expert appraisal committee (for A category project) or State level expert appraisal committee (for B category project) determine terms of reference which help in addressing relevant environmental concern for the preparation of an EIA report. Some of the terms of reference are
  1. Description of the project
  2. The environmental baseline data collection
  3. The impact identification
  4. The impact prediction
- Public consultation- in this stage, all relevant stakeholders and affected persons and their concerns regarding the project are taking into account. Except B_2 category project, all projects went through public consultation (except defence and national security) and the hearing process shall be conducted by the state pollution control board.
- Appraisal -here the detailed scrutiny of the submitted documents takes place which even include final EIA report, outcome of public consultation process etc. these documents are then scrutinised by EAC or SEAC concerned. After the proceeding these committee shall make their recommendation to the regulatory concerned either to grant or reject of prior environmental clearance on stipulated terms and conditions.

IFoS 2015 : What is penalty prescribed in section 15 of the environmental (Protection) act, 1986 for contravention of the provisions of the environmental act, rules and order?. (8m).

Approach : (1) Introduction – few lines about Environment protection act 1986
(2) Write down section 15 provisions of Environment protection act 1986.

➢ Environment act 1986 was passed on may 1986 with the intention to regulate industries and other activities that may cause pollution section 15 of the EPA 1986 prescribed penalties in contravention of the act. According to section 15

- Imprisonment for a term which may extend to 5 years in contravention of the provision of the act.
- Or a fine upto rupees 1 lakh shall be imposed on the person violating the provision of the act.
- In some cases both imprisonment of 5 years as well as fine of 1 lakh shall be imposed on the convict.
- In cases of repeated violation, the additional fine which may extend upto rupees 5000 per day shall be imposed during the period in which this violation continues
- In case this violation continues for more than one year then the term of imprisonment shall be extended to 7 years.

2

Chapter

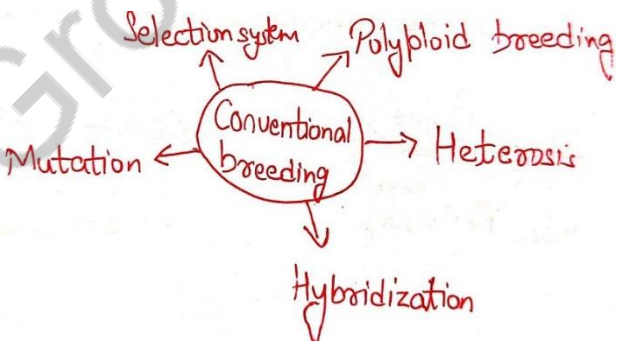
TREE IMPROVEMENT

IFoS 2022 : Why is conventional breeding that has a much better role to play in genetic improvement of trees not given much importance in research.(8m)

Approach : (1) Introduction – few lines about conventional breeding methods and draw a flowchart depicting their types

(2) Write down their disadvantages over modern method.

- Conventional breeding refers to seed-based breeding methods some of the example of conventional breeding methods are as follows
- However in present scenario they are considered redundant and not used in research because



  - Success rate- in seed-based reproduction there is only 25% chance of success that the seed will attain the required characteristics.
  - Gestation period of conventional breeding method is very high as compared to modern method to see actual result
  - Addition of particular gene in a species is more complex than the modern method like tissue culture.
  - Funding- biotechnology get a higher chance to access funding due to their ability to quickly deliver sure shot result compare to conventional method
  - Regulation- emerging technologies are usually encouraged by countries thus has lesser regulation than conventional methods.
  - Area- conventional area require large area and that too in a conducive site which is usually remote compared to lab grown species which can be grown in a petri dish.
  - Even after we develop tree, we have to wait for the tree to produce seeds as per their phenology, this problem does not arise in modern method as they have the capability to supply 24*7 seeds.

IFoS 2022 : What are the objectives of progeny testing? Discuss the advantages and disadvantages of different methods of progeny testing. (15m)

Approach : (1) Introduction – few lines about progeny testing and the objectives associated with it.
(2) Write down advantages and disadvantages of different methods of progeny.

Progeny is a method which is being used to identify the genotype of the plus tree. In progeny testing, we tend the assess the genetic potential of parent material by looking at the performance of their offspring.

Objectives of progeny testing-

- Selecting the species having the best genotype
- To identify and verify the genetic traits and their characteristics of the offspring and determine their expression in next generation.
- To improve the quality of the offspring by removing the undesirable traits that may be introduce in the offspring.
- Research- it helps in understanding breeding and plant genetics which help in performing scientific research.
- Progeny testing is highly cost-effective method over other conventional breeding methods, where multiple breeding cycles are required.

➢ Method of progeny testing
- Half sib progeny testing- this method is prescribed when only one parent is known and conducted when quick result are required.
- Full sib progeny testing- this method is prescribed when both seeds and pollen parents are known.

➢ Types of progeny testing
- Half-sib- where only one parent is known
- Full-sib- where both the parents are known

➢ Advantages of progeny testing
- This process is of immense help when the both the parent species is unknown.
- For exotic species whose provenance trial cannot be carried out, Progeny trial is the only method.

➢ Disadvantages of progeny testing
- Time consuming process- compared to modern methods, progeny is a long process
- Limited to single generation and not provide insights regarding traits of future generation.
- The testing of progeny is limited to certain specific traits.
- It is a costly process
- It required technical expertise to perform such experiments.

IFoS 2022 : Discuss the important considerations that are made before choosing a tree improvement approach.(10m)

Approach : (1) Introduction – few lines about tree improvement process
(2) Write down important points that need to be considered for tree improvement.

- Tree improvement is a practice of tree breeding in which we can enhance the performance of the species by adding desirable traits. It can be done through genetic engineering, use of biotechnology or traditional tree breeding methods. Some important points needs to be consider are as follows-
  - Objectives of programme i.e., whether we are trying to revive degraded forest or improving specific quality of tree.
  - Market demand- any tree improvement program must find resonance with market demand
  - Species- it is important to understand the basic property of trees like its phenology, its special characters, etc.
  - Type of breeding system to be adopted by trees.
  - Climate- all the species shows his highest efficiency in a particular temperature, light, rainfall etc.
  - Tree genetics- it help us to understand some special properties of certain trees that help them to survive in competition which can be incorporated into the target species.
  - Cost of the program- it help in assessing whether the requirement meets the cost incurred or not.
  - Regulation – modern method like biotechnology, genetic engineering are heavily regulated due to their far reaching consequences.

IFoS 2021 : What are the advantages and disadvantages of tree breeding methods over biotechnological methods.(10m)

Approach : (1) Introduction – few lines about tree breeding
(2) Write down their advantages and their disadvantages over biotechnology.

- Tree breeding is the application of biological, genetic principles for the genetic improvement and management of forest trees. It has certain advantages over biotechnological method like-
  - It is comparatively a cheaper process, than biotechnological methods.
  - The trees produced are strong, resilient and long lived.
  - It can be operated on wide variety of trees, and are easy to manage
  - In traditional tree breeding methods, much work is already done which can be exploited and has proven result. Thus it is predictive, while biotechnology requires considerable time in research.
- However there are certain disadvantages associated with traditional tree breeding methods
  - The gestation period is long, and the result in uncertain
  - It is not applicable if some unique property is added in tree. E.g. through biotechnology, tree can be made pest resistant.
  - Market demand is fluctuating and traditional tree breeding might be irrelevant if the present demand and future demand changes.

IFoS 2021 : Give an overview of forest genetic resources and gene conservation programmes in India. Suggest effective practices for sustainable management for quality improvement in Indian forest. (15m)

Approach : (1) Introduction – few lines about forest genetic resources and mention gene conservation programmes

(2) Write down some practices for sustainable management for quality improvement.

- Forest genetic resources refers to diverse plant population present in an ecosystem. India is rich in these resources as India has 4 biodiversity hotspots several keystone species, indicator species etc. in India, it was covered under forest policy of 1988, which calls for managing genetic diversity. Some of the gene conservation programmes are run under organisation like
  - In-situ conservation-

    various states government like Maharashtra (in Chanderpur), where such programme are carried out.

    Central government through National afforestation and eco-development board, National mission on bamboo applications help in gene conservation programme.

    Apart from these, organisation like ICFRE also undertaking various programmes through arid forest research institute, Himalayan Forest research institute etc.
  - Ex- situ conservation- here gene conservation is carried out through botanical garden (like Acharya Jagdish Bose Botanical Garden), seed banks (in Ladakh), tissue culture (at Institute of forest genetics and tree breeding), cryopreservation centres (National bureau of plant genetic resources) etc.
- Some of the effective practices for quality improvement are as follows
  - Inclusion of modern technology like genetic engineering which help in producing plantation of superior tree species, thus improving quality and minimize deforestation of natural forest.
  - Share advanced research with other countries to facilitate production of superior tree species.
  - Effective rules and regulation to facilitate people's participation in forest management.
  - Forest certification shall be given to forest produce to promote adoption of sustainable methods in felling of trees.
  - Promotion of agroforestry and social forestry as it helps in improved production and reduce reliance on natural forest.
  - Proper protection against natural and anthropogenic measures and proper fire management.
  - Availability of funds for facilitating research and development in improving the quality of trees.

07223970423 Hornbillclasses@gmail.com

IFoS 2020 : Describe the advantages, peculiar problems and various steps in tree improvement.(15m)

Approach : (1) Introduction – few lines about tree improvement process.

(2) Write down advantages, some of the common problems and outline various steps in tree improvement.

Tree improvement refers to improvement of overall yield and quality of forest produce by combining silviculture, forest management and tree breeding.

- Advantages of tree improvement
  - The tree produced by tree programme are best in quality in the region.
  - It help in improving certain qualities of species like pest resistance, disease resistant, clear bole, improved wood quality etc.
  - By Vegetative propagation, pure clone can be produced which has superior genotype.
  - Through seed orchard conservation of endangered and rare species can be carried out.
  - Help in fulfilling industrial requirement without exploiting natural forest.
  - The research work conducted on tree improvement can be used in different region of the world, thus pave the way for introduction of exotic trees
- Peculiar problems-
  - Gestation period is very long and future demand is uncertain.
  - The condition used for tree improvement are close to ideal, thus their imitation on the field is challenging
  - This process requires large area as well as require skilled manpower for the site management.
  - Measurement of trees with large sizes poses problem for officials.
  - No past data evidence is available in multiple trees, thus sometimes these exercises end up as a dead end, wasting up resources, time and money.
  - Growth trajectory of tree is different and unpredictable, thus prediction shall not be taken in their juvenile phase.
- Essential steps of tree breeding

  Phase 1 – it includes certain activities like
  - Selection phase- here we select phenotypically superior trees from a group of trees. From these trees we select candidate trees, then we select plus tree.
  - Testing phase- in this phase, we performed test like provenance test, clonal test, progeny test to check the genetic material and its potential to produce, thus help in finding the elite trees

  Phase 2- it includes activities like
  - After we find elite trees, we create seed orchard altogether.
  - From seed orchard, we carried out breeding activities like intergenic, intragenic, transgenic breeding.
  - After breeding activity we multiply and monitor the produce in order to check the performance of progenies. Then this produce is disseminated to the industry.

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

Approach : (1) Introduction – few lines about exotic trees
(2) Write down factors influence the introduction of exotic trees.

Exotic trees are those trees that are grown outside the natural boundary of the country. E.g. Eucalyptus spp.

- Factors governing introduction of exotic trees.
  - Tree adaptability – it should be wide enough to tolerate changes like temperature, rainfall, sunlight etc, when it is introduced in a new location. However, it should not turn out to be an invasive species.
  - The genotype of the exotic species should be superior, so that the purpose with which the introduction is carried out should be served.
  - Before introduction, its germplasm should be evaluated in order to ensure that its introduction should not be harmful to the local environment
  - The seedling that is introduced into the area should be free from pest and disease
  - Before introduction of species proper treatment should be carried out in their quarantine area, in order to acclimatise the new area.
  - The trees should not be allelopathic, in order to avoid its conflict with the other local species.
  - The introduction site should not be degraded and shall be free from any outbreak.

IFoS 2020 : What is meant by accompanied and unaccompanied clonal seed orchards? Why are the gains from the two types so different? (8m)

Approach : (1) Introduction – few lines about accompanied and unaccompanied clonal seed orchard
(2) Write down the difference in their gains.

Accompanied clonal seed orchards are those-orchard which is progeny tested, and the propagation material is obtained from plus tree.

Unaccompanied clonal seed orchard is created from phenotype superior plants, thus it is not progeny tested.

- The gains are different because
  - While unaccompanied orchard focus on gene conservation, accompanied clonal seed orchard focus on increasing production.
  - Unaccompanied orchard is made up form tree planting in degraded site, while accompanied orchard tree is chosen after proper assessment.
  - There is generally no genotype checked in unaccompanied orchard, while proper progeny test is carried out in accompanied orchard.
  - Results of unaccompanied are very uncertain than accompanied one.

IFoS 2019 : Define

1. Variation
2. Selection differentiation
3. Selection intensity
4. Heritability

How do you increase the genetic gain for a given trait in tree breeding. (15m)

- **Variation**- it refers to the differences in traits or characteristics within a population or species. It can due to genetic differences, environment differences etc. it is an important aspect of evolution as it help in increasing diversity in population, help in increasing adaptation ability of an individual.
- **Selection differentiation**- it is the process by which species evolve different traits overtime due to natural selection. It usually takes place in those individuals who are isolated from others result in developing specific traits due to factors like interactions with different species, availability of resources, climatic and environmental factors etc. result in greater diversity among species.
- **Selection intensity**- it is the magnitude of natural selection process acting on a particular trait on a population. If the intensity is strong, the result is strong natural forces and are likely to influence rapid changes in the particular traits of the population. It is highly variable and can be varied due to environmental changes and changes within a population.
- **Heritability**- it is the degree of change in phenotype of an individual due to genetic factors. It is more of a statistical concept and represented in 0 and 1 where 0 means no genetic variation in a phenotype of a species and vice versa.
- Genetic gain can be increased in tree breeding by factors like
  - Hybridization- here the selected species is cross-breed with genetic divergent individual of the same species.
  - Mutation- it is a complex process where we witnessed alteration in genetic makeup or formation of new gene altogether.
  - Heterosis- it is a process where the offspring holds higher potential than their parents altogether.
  - Genetic engineering- here through gene editing, the genetic makeup of the tree can be altered.

IFoS 2019 : As a tree breeder, how do you use these two phases simultaneously to meet the short-term demand of wood-based industry and the long-term demand of establishing seed orchard for a given tree species (link Q).

Approach : (1) Introduction – few lines about tree improvement.

(2) Write down about short term demand and long term demand and how tree improvement help in this

- Tree improvement refers to improving yield as well as quality of by combining silviculture, tree breeding and forest management.
- As a tree breeder- To fulfil the short-term demand of wood
  - Felling of trees which are not qualified for candidate tree, plus tree and elite trees.
  - Periodic tending operations that are carried out to manage the site properly.
  - In case of seed production area, site clearing to creation isolation zone and pollen dilution zone require felling of trees.
  - Trees which fail to hold specific properties.
  - To fulfil the demand of creating seed orchard
- To fulfil demand of long-term demand of seed orchard.
  - By carry out gregarious testing of trees and find out the best tree from the sample
  - Use tree vegetative material or seeds to create seed orchard.
  - Manage these orchard by creating pollen dilution zone, supply proper nutrition to the plants.

IFoS 2019 : What are the objectives of tree improvement (link Q)

Approach : (1) write about tree improvement and its objectives

Tree improvement is a method to increase yield and quality of the produce by combining silvicultural operations, tree breeding and forest management.

- Objectives of tree improvement
  - Creation of new species with desired traits like clear bole, no forking.
  - Through its high yielding variety, they Help in creation of plantation to fulfil industrial demand
  - Improving wood quality like reducing lignin content, density of wood.
  - Help in creation of tree species that can withstand prolonged drought, locust attack etc.
  - Help in preservation of endangered species and rare species.

IFoS 2019 : Explain in detail five essential steps of tree improvement.(link Q)
IFoS 2019 : write two phases of tree improvement. (link Q)
IFoS 2018 : how would you develop tree improvement programme for raising productivity in forestry.

Their detailed study helps in introduction of any exotic species in a region.

IFoS 2018 : Describe incomplete mating design used in tree improvement.(10m)

Approach : (1) Introduction – few lines about incomplete mating design
(2) Write down its types along with some advantages and disadvantages.

Incomplete mating design refers to a practice of mating where only one parent is known for any progeny. This type of design is used when there is a paucity of time or one species is exotic. Some of the types of incomplete mating design is as follows.

Open-pollinated mating- in this method, the seed are collected form a natural stand and progeny obtained from these seeds are used in establishing seed orchard.

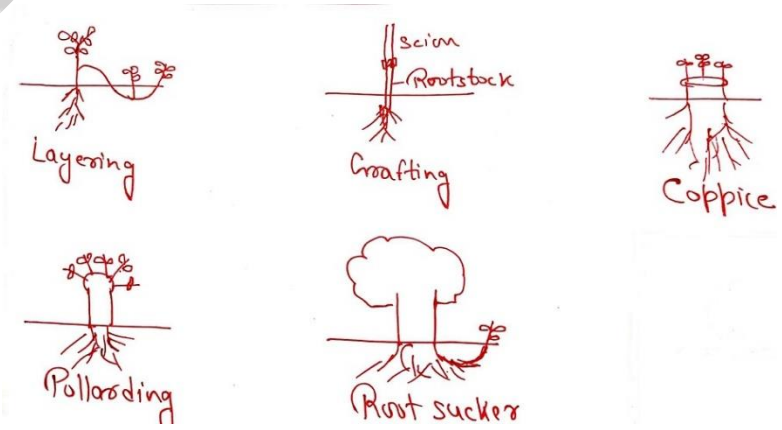
Poly-cross design- this type of design usually deployed crossing of female parent from a bouquet of several selected male parents.

- Advantages of incomplete mating design
  - Faster method and most effective when one parent is exotic species.
  - Help in estimation of general combining ability and breeding value.
- Disadvantages of incomplete mating design
  - Does not estimates specific combining ability
  - Estimation of breeding value can be biased due to inclusion of non-random pollination included in the mix.
  - Open pollinated test are of limited utility for future generation.

IFoS 2018 : What is a mother tree? How is a plant prepared through vegetative propagation different from a plant raised through seeds? (15m).

Approach : (1) Introduction – few lines about mother tree
(2) Write down flowchart of types of vegetative propagation
(3) Advantages and disadvantages of vegetative propagation over sexual reproduction methods.

Mother tree refers to a superior tree (usually plus or elite tree) whose plant material is used in vegetative propagation and tree breeding program. The plant grown out of this vegetation has the desirable traits similar to the mother tree. Thus it helps in fulfilling industrial requirements.



Vegetative propagation is a method to regenerate trees without having process of fertilization being followed. Some of the example of this method is as follows

- Cutting- in this method a part of plant usually leaf, stem is being used to regrow trees.
- Layering- here a part of tree usually stem is being rooted while it still attached to the main plant. Some of the type of layering are as follows- air layering, mound layering, trench layering etc.

- Grafting- in this type of propagation two close identical tree species are connected in such a way that, the root part belong to one species while the leafy part is from different species. The prerequisite condition for grafting to be successful is that the scion and rootstock shall be of similar size. E.g. cleft grafting, whip and tongue grafting etc
- Budding- here the bud of plant is taken and is attached to other plant. E.g. t-budding, chip budding etc.
- Root sucker- it is a special property of some plants like *Dalbergia sisoo* which can be regrow from the severed roots of plants.
- Coppice and Pollarding- in some plant due to excess presence of epicormic buds, the plant produces coppice from it leftover stem. If this coppice is produced from 5-10 feet above the ground, this type of coppice is termed as pollarding.

➢ Difference between vegetative propagation and seed base regeneration

- The tree produced through propagation contains the original genetic material of the plant, while on seed it is restricted to half.
- The desired traits can be added during propagation (like pest and disease resistance) simply by using the material of superior species.
- The rotation time is greatly reduced if vegetative propagation is used as it help in inducing early flowering and fruiting.
- Tree which does not produce viable seeds or having long time in two successive good seed year, vegetative method is the only viable method to regenerate the plant species.
- It maintains clonal fidelity and eliminates variability.
- It helps in preserving the genotype of the species by using clonal bank.
- It is more economically feasible to produce large scale plantation than with seed-based production.

➢ However there are some constraints associated with the vegetative propagation like-

- They lack proper roots-based system, thus are liable to be uprooted during heavy wind, rainfall etc.
- Their initial cost is higher than seed-based propagation. Also requires high skill during propagation.
- In successive propagation they are prone to gene recess, making them vulnerable towards epidemic.
- Their shelf life is smaller than seed-based propagation.

IFoS 2018 : What are the different selection methods used by the tree breeders? (10m).

Approach : (1) Introduction – few lines about what is selection methods
(2) Write down different types of selection methods.

➢ Selection methods refer to the selection of Plus tree species from the bunch of candidate trees for improvement based on certain parameters. The different selection methods are as follows.

- **Comparison tree selection method**- it is applicable in even aged stand of single species. here some candidate trees are selected from same class and same stand (usually 3-4 trees per hectare) and compare them based on certain phenotype measure. Those who qualify these parameters are considered as plus trees and others are rejected.
- **Baseline index method**- this method is prescribed for uneven aged and mixed stands. In this method average of selected traits are taken and a baseline is formed. Those who perform above this baseline are qualified and others are discarded.
- **Regression equation method**- this method is almost same as baseline method, but here instead of baseline a graph is plotted based on regression value of single parameter. Hence multiple graphs are plotted based on single parameters, the trees whose value is higher than regression graph is selected. It is also applicable to mixed and uneven aged forest.
- **Mother tree selection method**- this method is applicable to degraded areas where the purpose is not to select superior trees but to preserve trees that are left in that areas. Thus here tree is usually selected on ocular method. It is applicable to short rotation hardwood species.
- **Subjective grading system**- this method is based on the experience of people working on such areas, hence either a experience scientist or farmer's experience is usually exploit to select plus tree from the group of candidate trees. It is usually adopted along with mother tree system.

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

Approach : (1) Introduction – few lines about heritability and its types

(2) Write down importance of heritability and mathematics estimation method of genetic gain.

Heritability is the estimation of the degree of variation in a phenotypic trait in a population due to genetic variation between individuals in that population. It is of two types.

- Broad sense heritability
- Narrow sense heritability

Importance of heritability

- It helps in estimation of forest produce, thus help in formation of working plan in accordance with the plantation.
- It helps in understanding phenotype and its variation in this regard.
- Adaptation under varying condition and its ability to resist pest and disease can be estimated by heritability
- Its reproductive potential, good seed year can be estimated by heritability

Genetic gain can be estimated by comparing the performance of the progeny with the parent trees based on wood quality, growth rate, pest resistance etc. mathematically it can be defined from the formula

$$R = h^2 S$$

Where h is the narrow sense heritability coefficient and can be calculated by

$$h = \frac{\sigma_a}{\sigma_g}$$

where σ_a = phenotype variability

σ_g= genetic variability

And S is the selection differential

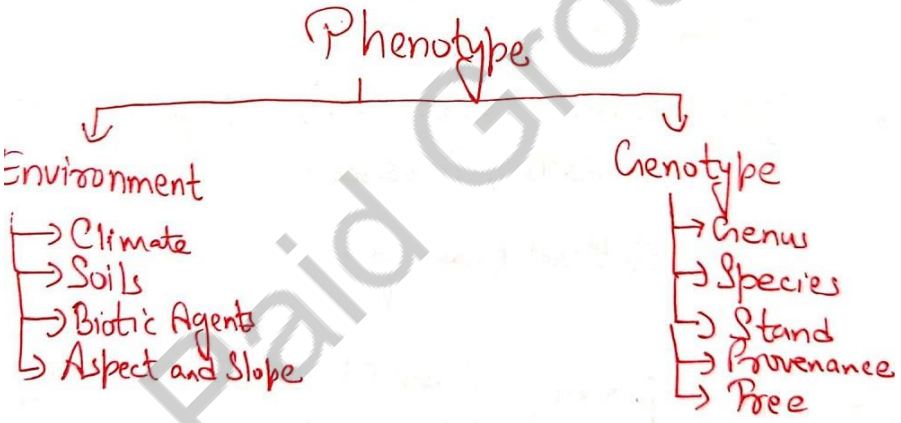
IFoS 2017 : List the different components of phenotypic variation. How are they important for tree breeders? (10 m).

Approach : (1) Introduction – few lines about phenotype variation

(2) write a flowchart of different components of phenotype variation

(3) importance of phenotype variation for tree

Phenotypic variation refers to changes in the physical structure of the plants in order to survive in that particular environment conditions. However, these adaptations may not pass to the next generation. E.g. flowering and fruiting of teak growing in north India and south India varies for few days.



- Different components of tree variation
- Importance of these variations for tree breeders
  - They help in maintaining genetic diversity of the species.
  - It helps in assessing wider adaptability of trees in various sites.
  - It helps in assessing the type of climate in which the tree has higher production.
  - It helps in assessing special requirements of trees in terms of light requirement, nutrition requirement etc.
  - It helps in finding special qualities of some of the species within the population. E.g. white tiger in tiger population.

IFoS 2017 : What is seed production area (SPA)? Explain the purpose of establishing them. Briefly highlight the advantages and disadvantages of SPA. List the step involved in establishing SPA. (20m).

Approach : (1) Introduction – few lines about seed production area
(2) write down some of its purposes
(3) highlights advantages and disadvantages of SPA
(4) steps of formation of SPA

Seed production area is the phenotypically superior tree species stand upgraded by thinning of poor trees and manage them to produce abundant seed.

- Purpose of seed production area-
  - Ensure continuous supply of seeds
  - Reduce harvesting pressure from wild population
  - The seed produced here are superior trees seeds, their progeny holds potential for superior trees.
  - Reduce collecting cost of seeds.
- Advantages of SPA
  - In SPA since the seeds produced from the fertilization of two superior trees (candidate trees), the tree producing from these seeds hold good potential to be phenotypically superior.
  - It helps in stock piling of seeds and help in formation of reliable seed supply.
  - The seed produced here has high genetic diversity than those found in inside forest.
  - Help in formation of integrated direct seeding restoration programs.
- Disadvantages of SPA
  - Required large land area to establish SPA
  - Require skill workforce to collect and manage seeds.
  - Location of such SPA is quite remote and has difficult terrain
  - Modern technology like tissue culture holds potential to produce good quality trees in less time and has potential to add required characteristic in that tree.
  - High initial cost of setting up SPA.
- Important steps involved in formation of SPA
  - Identification of species- the species produced here should have characteristics like high commercial value, history of producing heavy flowering/fruiting in that area.
  - Surveying- it involves targeting forest of selected species which fulfil all phenotypic requirement, and has good health.
  - After selection of suitable area, the boundaries of the area is being marked.
  - Creation of pollen dilution zone- to prevent mixing of pollen, this zone is formed by felling of all trees of selected species around the site of around 200m width and if possible retaining tree of other species in this zone to prevent soil erosion.

- Now start removing trees of other species from the site followed by removing defected, deformed, weak trees of the targeted species.
- Perform necessary silvicultural operation in order to facilitate required condition for the tree to grow.
- Develop necessary plan to ensure continuous production of seeds.

IFoS 2017 : Explain general combining ability (GCA), specific combining ability (SCA) and their utility? (8m).

Approach : (1) Introduction – few lines about GCA and SCA
(2) Write down utility of GCA and SCA.

General combining ability is the ability of an individual to produce progeny that has desirable characteristics across different environment, when breeds with another species. It is usually of half-sib progeny testing.
Specific combining ability- it is the average performance by an individual when combining specific cross between the two parent species. It is of full-sib progeny testing.

➢ Utility of GCA and SCA
- It helps in assessing the performance of specific gene in the progeny.
- It helps in finding the best combination of parent tree which produced high yield varieties.
- This combination can be used to fulfil industrial demand and minimise wastage of resources.
- It helps in production of improved wood quality, increased oil production in seeds, developing pest resistance etc.

IFoS 2017 : Write in brief advanced generation tree improvement. (8m).

Approach : (1) Introduction – few lines about modern tree improvement methods
(2) Write down their advantages and their disadvantages.

Advanced generation tree improvement refers to the use of modern propagation method for tree improvement.
Tissue culture- in this method the tissues of selected species is selected and then allow to grow under closed condition by providing them necessary nutrients.
Genetic engineering- this type of propagation methods usually alters the genetic composition of trees by adding and removing certain gene from the plant's gene composition and allowed them to grow inside laboratory. Thus the tree produced due to this method has certain properties.

➢ Benefits of advanced generation –
- Require less time than traditional methods in regeneration of these tree species.
- Additional qualities like pest resistance can be easily added in this method
- Easy transportation of propagation material and require less area to regenerate the species.
- Maintenance of genetic uniformity and genetic gain.

➢ However certain issues are also present in this advanced generation like

- It requires great degree of skill to achieve tree improvement through this process.
- It is costly than traditional method
- They are vulnerable to field-based complication as they grows in controlled environment.
- The tree lacks stronger roots made them vulnerable towards heavy winds.

IFoS 2016 : Discuss the reasons for widespread use of exotics for plantations and advantages of exotic over native species.(8m)

Approach : (1) Introduction – few lines about reason of preference of exotic over indigenous species
(2) Write down their advantages.

- Reasons for widespread use of exotics over indigenous trees for plantations are as follows-
  - Their ability to tolerate wide range of soil, climate etc.
  - In their initial period they are pest resistant.
  - Their properties improve due to research work is already conducted on them, thus has improved quality than local species.
  - These crops are usually not raided by local animals, thus plantation is secured from any biotic attack.
- Advantages of exotic over native species
  - They help in increasing diversity in the region and also improving aesthetics of the region.
  - They have wider adaptability than native species and some of them even grow on degraded areas, thus help in improving soil quality.
  - Their woods holds some of the unique properties which are not present in indigenous species, thus they can be used for some specific purposes.
  - Their industrial value is higher than indigenous species.
  - They have higher production ability than indigenous species.
  - They have relatively shorter rotation period than indigenous species.

IFoS 2016 : Define the seed orchard. Write types of seed orchard. List the various aspects considered prior and after establishment of seed orchard for its management. (20 m).

Approach : (1) Introduction – few lines about seed orchard
(2) write down types of seed orchard
(3) write down points to be considered before establishing seed orchard
(4) Write down points to be considered after establishing seed orchard

Seed orchard is a plantation of genetically and phenotypically superior trees which is managed intensively for seed production and tree breeding purposes.

- Types of seed orchard-
  - Clonal seed orchard- this type of seed orchard is usually prepared by using vegetative propagation material of superior trees. It is of two types
  - Seedling seed orchard- this type of orchard is usually generated by planting seed produced by these superior trees by maintaining sufficient isolation and other necessary condition for their growth.
  - Extensive seedling seed orchard- this type of orchard is usually prepared by seeds of superior tree species. The difference between seedling and extensive seedling is that in extensive seedling the seeds were prepared from special stock of minimum 50 superior trees
- Important points before establishing seed orchard-
  - Distance of seed orchard should be minimum from the plantation site
  - The seed orchard should be made accessible and not located in remote area.
  - A proper pollen dilution zone should be prepare around the orchard to prevent contamination of the site.
  - The site shall have flat topography and the soil and climate of the site is conducive to the species whose progeny are to be raised in seed orchard.
  - Proper soil treatment and levelling of site is carried out by removing unwanted materials.
  - A proper plan to be created for the site which contain the necessary layout, cultural practices to be adopted etc.
  - Arrangement of necessary resources like water at the site.
- Important points after establishing seed orchard
  - There should be proper supply of nutrients, water etc.
  - There should be proper pest control to prevent any epidemic in the site.
  - Adopt proper silviculture operations like selective harvesting to maintain genetic quality of trees.
  - A proper record needs to be made at the site where record of every operation like pest management, silvicultural operation etc needs to be recorded.

IFoS 2016 : Define provenance. Discuss the role of provenance trial in tree improvement and mention different phases of a provenance trial (10 m).

Approach :(1) Introduction – few lines about provenance and its role
(2) Mention different phases of provenance trial

Provenance literally mean place of origin of the reproductive material or the place from where the parent tree belong.

- Role of provenance in tree improvement
  - It help in confirming the selected race is best suited for local condition

- The selected tree has a superior genotype, thus has higher yield and higher resistance against pest.
- it helps tree breeder to find best genotype.

➢ However in case of exotic species, provenance test might have lesser relevance because we could not find the parent tree.

➢ Different phases of provenance trial-

- Range wise provenance trial- under this trial, we tend to identify the promising areas from where we get the potential parent of these plus trees. It helps in understanding the adaptability of a species under different climatic zone as well as its genetic variability.
- Restricted provenance trial- under this, we narrow down the area and now we tried to find sub region and ultimately provinces suited to site under this test. It try to detect minor differences between the races and help in finding location from where we get the best germplasm.
- Provenance proving phase- its objective to find the actual stand under normal conditions.

IFoS 2015 : As a community of interbreeding individuals, what parameters would need to be known to describe a population of forest trees.

Approach : (1) Introduction – few lines about interbreeding.
(2) Write down some important parameters about describing population of forest trees

➢ To understand a population of forest trees following parameters to be taken care of-

- Historical event in the area like any earthquake, forest fire, natural calamity which change the landform and thus alter composition.
- Local environmental condition- like climate, rainfall pattern
- Type of forest- if the forest is natural it has higher diversity compared to man-made forest.
- Reproduction traits includes type of dispersal of pollen, mating system etc.
- Spatial distribution- it help in understanding the distribution of species within the landscape and availability of resources like light, water etc.
- Phenotypic traits- it refers to the visible traits present in a species.

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

Approach : (1) Introduction – few lines about variation
(2) Type of variability
(3) Type of methods to manipulate variability

Variation refers to differences between individuals of a population based on genotype and phenotype variation. There are two types of variation

Phenotype variation

Genotype variation

- The variation can be manipulated into different types
  - Tree breeding- in this method the tree of same species growing in different stand were taken that has some unique properties and the progeny produced by this mating has the improved properties. However this method is risky as there is only 25 chance that the species produced has the required characteristics.
  - Artificial selection- this type of variation is usually carried out in two closely related trees of different species. Here, the breeding is carried out and the desired characteristic is added into the offspring.
  - Genetic engineering- this method is mainly genotype manipulation where the genetic composition of the species is altered in order to add certain properties in the species. Here the chances of success are very high as compared to other two methods.

 07223970423 Hornbillclasses@gmail.com

2

Chapter

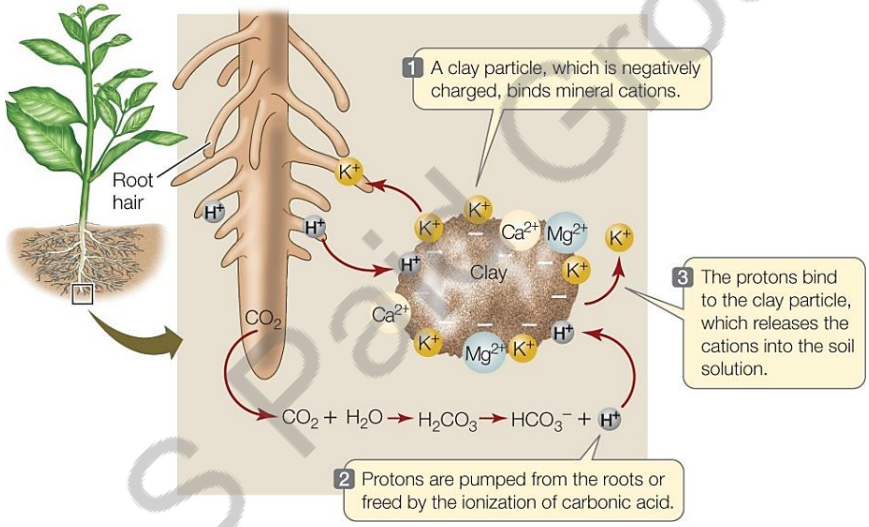
Soil conservation and Watershed management

IFoS 2021 : Explain the terms – (a) Cation exchange capacity, (b) Salinity and alkalinity (8m).

Approach : Define them with flowchart / Diagram

Answer

(a) **Cation Exchange Capacity** (CEC) - is a measure of the total negative charges within the soil that absorbs plant nutrients such as calcium (Ca^{2+}), magnesium (Mg^{2+}), and potassium (K^{+}). It is simply a capacity of soil to hold exchangeable cations (Nutrients).



- Soil with higher clay content has higher CEC.
- Organic matter has higher CEC.

It is an important indicator of soil pH, fertility and soil quality, as higher CEC soil retains more cation thus beneficial for plant growth and vice versa. It also provides a buffer against soil acidification.

Environmental protection: Soils with high CEC can act as a "sink" for positively charged pollutants like heavy metals. By binding these pollutants in the soil, CEC helps to prevent their leaching into groundwater and other water bodies.

(b) **Salinity and alkalinity** - it is the accumulation of dissolved salts present in the soil. In salinity, it consists of primarily sodium salts, while calcium and magnesium are found in alkalinity-based soil.

It is usually the result of overirrigation, arid and semi-arid condition of soil. Sandy soil are more prone to alkalinity while loamy soil to salinity.

IFoS 2021 : How does soil organic matter decomposed influence forest productivity (8m).

Approach : (1) write about soil organic carbon
(2) write about how it helped in improving soil quality

Soil organic matter refers to carbon present in total soil organic matter. It plays an important role in improving physical, chemical and biological properties of soil. It influences forest productivity by

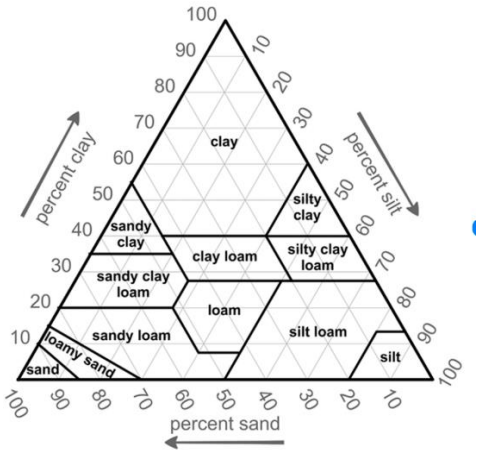
- Balance pH of soil- the humus contains various types of compound, which during humification help in releases in the soil and thus influence pH of soil.
- Improving soil texture- this improved texture increases gaseous diffusion, regulates roots carbon dioxide efflux thus limiting the amount of waste gases in the soil.
- Chelate formation in soil helps in improving water holding capacity of soil
- Maintain soil temperature which allow stability to soil compounds and increases the required condition for soil microbes to work efficiently
- Releasing important macro and micro nutrients of soil, thus help in replenishing the soil nutrients that was consumed by plants.

IFoS 2020 : Write short notes on the following

1. Soil texture and structure
2. Soil organic matter
3. Carbon nitrogen ratio (15m).

Approach : (1) Introduction – few lines about sloped soils and problems associated with it
(2) Body – methods adopted to conserve soil on sloping areas

Soil texture and structure- it refers to the relative composition of sand, silt and clay present in the soil. Based on this composition soil has been classified into various types. It influences water holding capacity of soil, help in providing mechanical strength to plants.



07223970423 Hornbillclasses@gmail.com

Soil structure on the other hand refers to the binding of different aggregates present in soil. It is usually are of following types i-e columnar, granular, crumb, platey, blocky etc. these soil structure play an important role in permeability of soil.

Soil organic carbon- it refers to the amount of carbon present in the soil, this carbon is usually received by soil via decomposition process. This carbon plays an important role in improving soil texture, improving water holding capacity of soil and improving soil fertility. It also help in the carbon sequestration. As per estimates, around 56 percent of the total absorbed carbon is present in the form of soil organic carbon.

Carbon nitrogen ratio- it is the relative amount of carbon and nitrogen present in the soil. It is an important indicator to assess the level of readily available nitrogen to plants. The ideal ratio is 18:1 to 25:1. It is an important measure to assess soil fertility. Further this C/N ratio is an important indicator to assess whether the sample is a source or sink of carbon. It ratio is low then it is a sink of carbon or vice-versa.

IFoS 2019 : Soil is an interface of air, minerals, water and life. Comment (8m).

Approach : (1) Introduction – few lines about soil
(2) Body – how air, minerals, water and life is important for soil.

Soil has also been defined as a natural body consisting of layers (soil horizons) that are composed of weathered mineral materials, organic material, air and water.

Water- it is the important constituent of soil. It helps in transportation of nutrients from top soil to lower soil horizon and vice versa, it accelerates weathering process, helps in diluting the concentration of salts. It also helps in undertaking of nutrients by plants.

Minerals- these came out due to the weathering of parent rock or been brought up by any geomorphic agent like wind, air etc. these mineral composition affects soil texture, its structure, its fertility and ph of soil. Also it play an important role in deciding what tree will be growing in the soil.

Air- it helps soil by diffusion of carbon dioxide from the soil which was present due to respiration of roots, microbes. Also to fulfil nitrogen requirement, atmospheric nitrogen is used in absorption form by plants.

Life- it refers to plants, animals and microbes present in soil. While plant and animal help in providing dead organic matter which is utilised by microbes to create humus. Further microbes paly an important role in nitrogen fixation.

IFoS 2019 : What is the different soil type found in India? Identify five trees species growing each in Alluvial soils, red soils, Black cotton soils and arid and desert soils (15m).

Approach : (1) Introduction – mention different types of soil found in India
(2) mention tree species growing in above mention region

- As per government, India soil is divided into 8 types.
  - Alluvial soil – it comprises around 40 percent of the total soil in India. It is predominantly found in Gangetic plains, delta of major rivers like Brahmaputra, Indus and its tributary, Mahanadi, Godavari, Cauvery, Krishna etc.

- Black soil- it is predominantly found in deccan plateau and its extensions. It is formed due to erosion of basalt rocks. It is known for their shrinking ability
- Red and yellow soil- this soil contains iron oxide which on hydration turns yellow and when dry turns into red. It is majorly found in peninsular region.
- Laterite soil- this soil is found in the region where we witness higher rainfall and higher temperature, thus result in leaching phenomenon which causes desilication of soil. The area under this soil is increasing due to use of artificial irrigation in drier areas.
- Saline and alkaline soil- it is the outcome of excess irrigation. As a result of which. Salt concentration in the top soil increases result in kankar formation. When pH increases to 8.5 and above, the soil is called as alkaline or sodic soil.
- Arid soil – this soil is majorly concentrated to Rajasthan and Gujarat region. Due to capillary action in these soil, the soil is basic in nature. This soil has low productivity, but with the availability of water, this soil has very high productivity.
- Peaty soil – this soil formed in terai region where due to partial decomposition of organic matter, this soil is formed. This soil is acidic in nature.
- Forest soil- this soil is dark in colour due to partial decomposition of humus. It is usually limited to forest region in the temperate region.

➢ Trees found in

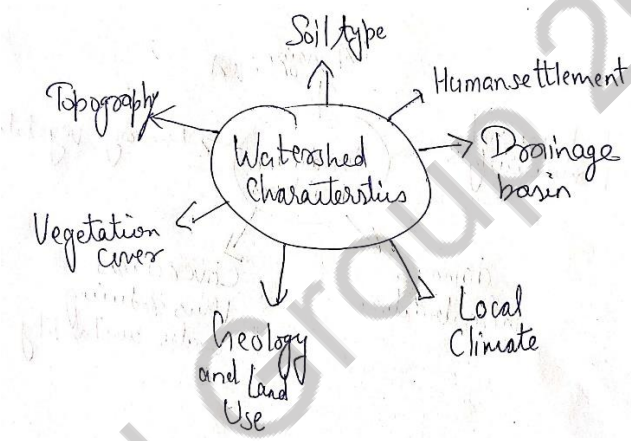
- Arid region
  1. *Acacia catechu*
  2. *Prosopis juliflora*
  3. *Eucalyptus camaldulenesis*
  4. *Prosopis cnineria*
  5. *Acacia Senegal*
- Red soil
  1. *Pterocarpus marsupium*
  2. *Syzygium alternifolium*
  3. *Terminalia pallida brandis*
  4. *Dalbergia latifolia*
  5. *Shorea robusta*
- Alluvial soil
  1. *Butea monosperma*
  2. *Albizia procera*
  3. *Terminalia tomentosa*
  4. *Bombax ceiba*
  5. *Dalbergia sisoo*
- Black soil
  1. *Cassia fistula*
  2. *Acacia nilotica*
  3. *Ziziphus mauritania*

4. *Tectona grandis*
5. *Ailanthus excela*

IFoS 2019 : Write the characteristics of watershed. Explain how the forest affecting watershed management (8m).

Approach : (1) Introduction – few lines about watershed and flowchart about its characteristics
(2) Body – role of forest in watershed management

Watershed is the land based area where all the flowing water meet and drain at a common point.



➢ Role of forest in watershed management

- Forest increasing the stem flow thus reducing the splash erosion that was caused due to precipitation.
- Forest roots disturbs the soil structure thus increase infiltration of water and reduced runoff by increasing humus content in the soil.
- Forest help in reducing the wind flow speed, thus help in reducing the intensity of evapotranspiration loss from the surface of soil and young plants.
- Forest help in improving water quality by help in leaching and absorption of toxic water pollutants.
- They help in preventing waterlogging and prevent invasion of weeds into the region, thus help in preventing degradation of the site.
- Forest act as barrier against the natural calamity like floods, landslides etc, thus preventing downstream areas from the harmful effects of these events.

IFoS 2019 : What are the characteristics of saline and alkaline soils. Explain the reclamation of saline and alkaline soils with suitable tree species (15m).

Approach : (1) Introduction – few lines about saline soil and alkaline soil
(2) Body – write their characteristics and reclamation methods .
(3) write name of suitable plant species

Saline soil are those soils which has high soil content due to either leaching(in case of excessive irrigation) or capillary action (in case of arid region) or places where sea water intruded into farm land. Gujarat has about 50 percent of the total saline soil land in the country.

- Physical properties-
  - Presence of kankars
  - Compact surface structure
  - Hardpan formation
  - Low moisture availability on top soil
  - High osmotic pressure
  - High water table
  - Leaching of nutrients
- Chemical properties
  - Ph – 7-8.5
  - High salt concentration in which sodium salts dominate
  - Low aeration due to compaction
  - Electrical conductivity- above 4 dsm^{-1}
- Biological properties
  - Low microbial activity
  - Low biodiversity in the soil
  - Lower carbon content in the soil
- Saline soil reclamation-
- Physical methods
  - Breaking of hardpan of soil so that the undersoil exposed
  - Scrapping the soil so that kankar and large salts aggregates can be removed
  - Flooding the region so that salt concentration can be diluted and by leaching the salt can be percolated down
  - Use salt free water for irrigation- the water used in irrigation shall be come from fresh water sources. Polluted lakes, ponds, nallah shall be avoided
  - Deep tillage- it helps in hardpan breaking and improve aeration of the soil
- Chemical methods
  - Adding sulfur through Gypsum, Iron pyrites which bring down the Ph value of soil
  - In order to increase the population of microbes, molasses should be adding in the soil.
- Natural plant species growing in saline soil
  - *Acacia leucophloea*
  - *Acacia nilotica*

07223970423 Hornbillclasses@gmail.com

IFoS 2018 : Write in detail about the influence of parent rock in the distribution of tree species (8m).

Approach : (1) Introduction – few lines about parent rocks
(2) Body – how it influence soil type and in turn vegetation supported by them

Parent rock refers to the main rock from which soil is formed. It is usually found in the lowest soil horizon and it continues to weather thus enriches soil.

- Influence of parent rock in tree distribution
  - The type of soil i-e acidic or basic is highly influenced by the parent rock, thus it help in tree distribution.
  - Supplying nutrients to soil. Weathering of parent rocks help in unlocking various plants nutrients which helps trees to survive.
  - Water permeability of soil depend on the types of aggregates formed by the parent rocks- for e.g. black soil due to presence of clay has low permeability, while sandy soil has very high permeability.
  - Minerals in soils are added by parent materials (although some enrichment are carried out by humus) which play a crucial role in supplying macro and micro nutrients to soil. E.g. *Pinus roxburghii* grow well in quartz based soil.

IFoS 2018 : What are the pedogenic process ? explain the important process of soil formation (15m).

Approach : (1) Introduction – few lines about what is pedogenic process
(2) Body – mention some of the pedogenic process and write the process of soil formation

- Pedogenic process refers to creating soil from the parent rocks by the action of geomorphic agents as well as other process. Some of the pedogenic process are as follows

1. **Humification-** it is the process of transforming organic matter to humus, this process is usually carried out by bacteria, earthworm and fungi. This process has two parts mineralization where the complex compounds is converted into simple compounds which are absorb by plants. Second is the humification process where the simpler organic compound is converted into humus. In this humus, the cations are retained and remained polysaccharides are used for soil aggregations.
2. **Eluviation-** it refers to mobilization and translocation of soil materials in between the different horizons result in textual differences. It helps in addition of new minerals in the soil.
3. **Illuviation-** it refers to leaching process in which the material are removed form the top soil and deposited in the lower soil horizon result in soil being devoid of some nutrients in top soil.
4. **Podzolization-** it refers to formation of podzols in soil by accumulating silica in top soil and addition of sequioxides.

5. **Laterization-** it literally means brick formation, this soil has higher proportion of sequioxides, but suffer desilication of soil, as a result when it is dried it become very hard like brick.
6. **Gleization-** it is usually found in waterlogged region where due to poor bacterial activity, glei is formed in lower horizon (also known as hydromorphic soils). Here peat is found in the top soil.
7. **Salinization-** it refers to process of accumulation of salts of calcium, magnesium, sodium and potassium. The ph of the soil lies between 7-8.5. it is usually occur due to excessive irrigation in the region.
8. **Salonization or Alkalization-** it refers to accumulation of sodium ions (also called as sodic soil) in the soil. The soil has a ph of more than 8.5. it is usually formed in arid and semi-arid region.

➢ Process of soil formation- this process takes place in following steps.

- Weathering – it is the basis of soil formation. In this process, the parent rock is deformed into smaller pieces by the physical, chemical and biological weathering.
- Geomorphic process- the geomorphic agents like wind, water, snow etc further disintegrates the chunks of rocks by the action like hydraulic action, attrition, chemical reaction (with water) results in further refinement of the soil. The size of the aggregates of soil depends on the intensity of geomorphic agents, types of rocks, chemical composition of rocks.
- Horizon formation- it is the horizontal bed formed based on the rock size.
- Pedogenic process- these process add and remove certain material from different soil horizon result in enrichment of soil. It also includes process of humus addition.

IFoS 2018 : What are the measures to be taken into consideration during preparation of earthen check dams in the forest areas? (8m).

Approach : (1) Introduction – few lines about earthen check dam
(2) Body – factors that were keep in mind while preparing check dam in forest areas.

Earthen check dams are temporary structures built on the temporary rivulets or semi-permanent rivers in order to collect the runoff water which can be later utilised for other purpose. Earthen check dams are those check dams which are usually made up of locally available soil and rocks. In case of forest areas following things needs to be kept in mind while preparing such check dams

- Local material availability- in forest, the availability of outside material is a challenge, thus one should rely on local material.
- Slope- it help in determining the velocity of the runoff water, which help in understanding thickness of the retaining wall.
- Soil type- it help us in assessing the physical, chemical properties of soil which help in finding the strength of the structure.
- Site selection- the selected site shall not cause any harm to the surrounding environment.
- Water flow- it help in finding the rate of water flow as well as the direction of the water flow which help in assessing the size of the check dam
- Maintenance- the dam should be built in such form that will require low maintenance and high durability

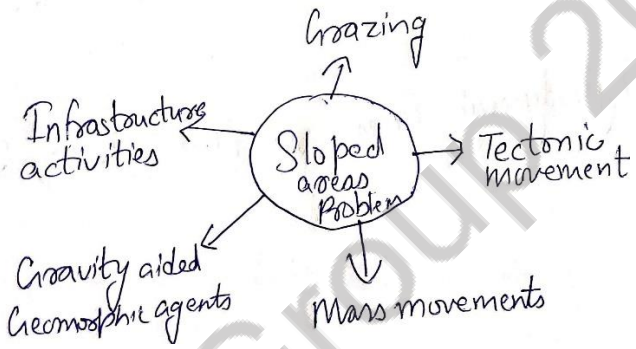
07223970423 Hornbillclasses@gmail.com

IFoS 2017 : What are the various methods adopted to conserve the soil on sloping areas? Explain in brief (10 m).

Approach : (1) Introduction – few lines about sloped soils and problems associated with it

(2) Body – methods adopted to conserve soil on sloping areas

- Sloped areas soil are shallow soils that are found on the leeward and windward side of slope. This soil is very prone to erosion due to



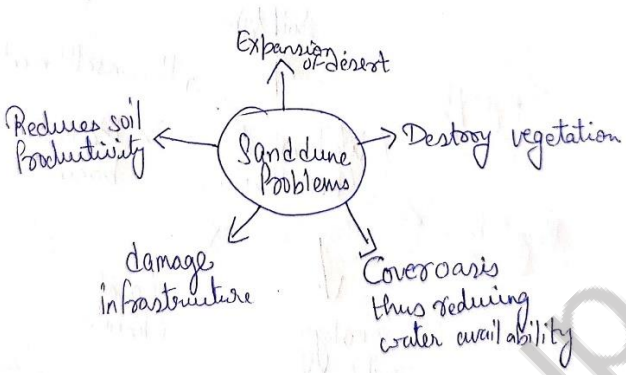
- As per reports around 12 percent of the area of India is prone to landslide, thus it is important to conserve soil on the slopes. The methods adopted for this process is as follows.
  - Physical barriers formation- under this either retaining wall or contours will be formation which acts as barrier in the free movement of the soil.
  - EQ prone zone – if the region is lying between EQ prone zone then infrastructural development in the area shall be restricted.
  - Drainage- the soil should be well drain in order to avoid soil-fluction like condition. Thus there shall be proper mechanism for surface, sub-surface drainage, which can be attained by trenches digging in the slope to facilitate water movement downwards.
  - Vegetation on slopes with surface roots, which help in binding soil particles together thus preventing them from runoff.
  - Gradation minimise- it help in reducing the kinetic energy of the particles as well as geomorphic agents, which increases the risk of landslide.
  - Thermal treatment- in this we tend to increase the temperature of the region, which causes decrease in moisture in the soil and also make the soil compact.
  - Chemical treatment- in this we tend to add certain chemical in the sloping soil which helps soil by increasing their resistance against kinetic energy.
  - Electroosmosis- in this the soil is passes through membrane which blocks material that are prone to erosion, which can be discarded and the soil is ready to used

IFoS 2017 : Describe the technique of sand dune fixation in the thar desert. Also mention the choice of species for plantation (10m).

Approach : (1) Introduction – few lines about soil

(2) Body – how air, minerals, water and life is important for soil.

Sand dunes are the deposition features of wind based erosion system, these dunes if left unattended can cause multiple issues like



- Techniques used in sand dune fixation
  - **Physical barrier**- it comprises of construction of walls or placing gravels on the top of sand dune in order to prevent its movement. However constant presence of fine particles around soil causes erosion of the boulder.
  - **Sandbags**- it is formed by accumulation of sand in the bag and placed it in a series perpendicular to wind direction which acted as a barrier to sand dune movement.
  - Application of binding material in the soil to stabilise the sand dune and thus help in freezing its movement.
  - **Sand fencing**- it is formed around the habitation as it helps in trapping sand.
  - **Mulching**- it involves using of smaller grasses, organic materials on the sand dunes as its roots help in binding the soil and thus help in sand dune fixation.
  - **Geotextiles**- it is made up of artificial materials which helps in covering the sand dunes, thus freeze their movements.
- Choice of species suitable for plantation-
  - *Prosopis cnineria*
  - *Prosopis juliflora*
  - *Acacia nilotica*

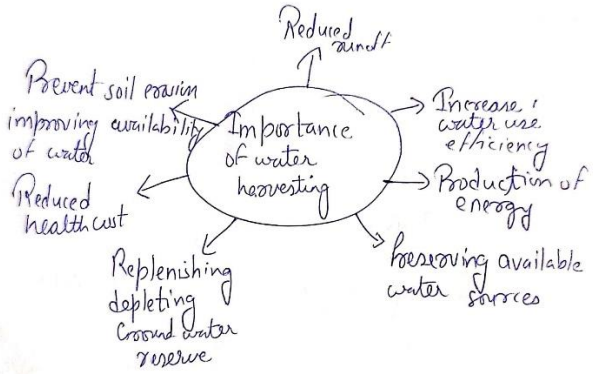
IFoS 2017 : What is water harvesting? list the different methods of water harvesting and suggest various practices for efficient use of conserved water. (20m).

Approach : (1) Introduction – few lines about water harvesting and its importance

(2) Body – different modes of water harvesting and regional water harvesting methods.

07223970423 Hornbillclasses@gmail.com

Water harvesting refers to collection and storage of water from various sources which can be put to further use.



- Methods of water harvesting
  - Rainwater harvesting- it refers to collection of rainwater and then use for generally household purposes.
  - Dams and reservoir- they are usually of bigger sizes and generally formed on the river. It collect water from rivers, rainfall and this water can be utilised in tapwater supply, hydel power project, irrigation etc,
  - Groundwater recharge- here runoff water are allowed to enter into the soil through creation of soakpits, thus through infiltration via these soakpits, the runoff can be reduced as well as ground water can be recharge to an extent.
  - Check dams- these dams are used to harvest surface water of rivulets which are usually activated during rainy seasons.
  - Terrace farming- in case of sloped areas where gravity aided water to flow downwards at a higher speeds, the contours are formed which help in reducing the velocity of these streams and also help in collecting this water which can be used for later use.
- Local practices for collection of groundwater
  - Zabo system- this system is adopted in Nagaland where the runoff water flowing from the slopes are collected in small ponds, when these ponds overflows the water is flowing towards the downwards ponds, which can be utilised later.
  - Bawaris- these are stepwells created in the Rajasthan region, which collects water from rain and from underground sources which can be utilised for drinking water.
  - Zing- this practice is usually adopted in Ladakh region where pits are being dug to collect melted snow water which can be further utilised for daily household chores.
  - Phad- this system is being utilised in Maharashtra region where check dams are being built to collect water from rivulets and canals.
  - Ahar pynes -ahar are traditional floodwater irrigation systems while pynes are artificial rivulets. This system is used in Bihar

IFoS 2016 : Explain types of rocks based on formation and minerals based on chemical composition (8 m).

Approach : (1) Introduction – few lines about rocks and its types
(2) Body – minerals found in rock based on chemical composition composition

- On the basis of formation rocks are classified into three types
  - Igneous rocks- these are considered to be formed by the lava, when it is cooled these rocks formed. e.g. granite, basalt etc.
  - Sedimentary rocks- it is formed due to weathering of igneous rocks and metamorphic rocks. These weathered material under influence of pressure transformed into sedimentary rocks. E.g. sandstone, limestone, coal
  - Metamorphic rocks- it is formed when the sedimentary or igneous rocks underwent high temperature and pressure, which causes refinement in their structure. E.g. marble, schist, graphite.

Minerals are those material which has well defined chemical structure and the crystal formation. On the chemical basis, minerals are categorised into various types

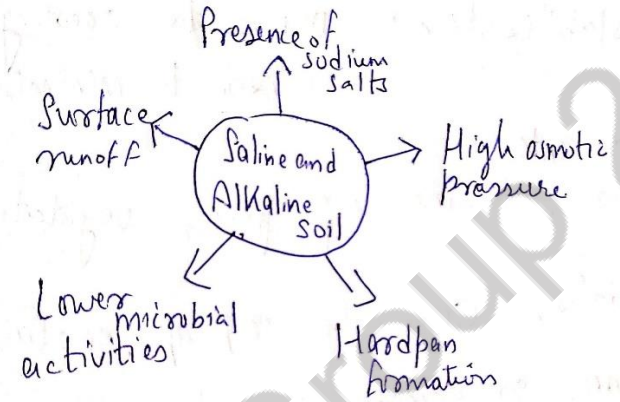
Chemical Class / Mineral Group	Anion or Anionic Complex	Description	Representative Minerals
Native elements	-	Naturally pure; only one kind of element is present	S-sulphur, Au-gold, Hg-silver, Cu-copper, C-diamond, C-graphite
Sulphides	S^{2-}	A metal bonds directly with sulphur as the nonmetal	FeS_2-pyrite, PbS-galena, ZnS-sphalerite, $CuFeS_2$ - chalcopyrite
Oxides	O^{2-}	A metal bonds directly with oxygen as the nonmetal	hematite, magnetite, chromite
Halides	Cl^-, F^-	A metal bonds with a halogen (Cl, F, Br or I) as a nonmetal	NaCL-halite, CaF_2-fluorite
Sulphates	$(SO_4)^{2-}$	A metal bonds with the SO_4 complex ion acting as a nonmetal	$CaSO_4$-anhydrite, $CaSO_4.2H_2O$-gypsum, $BaSO_4$-barite
Carbonates	$(CO_3)^{2-}$	A metal bonds with the CO_3 complex ion acting as a nonmetal	$CaCO_3$-calcite, $CaMg(CO_3)_2$-dolomite
Phosphates	$(PO_4)^{3-}$	A metal bonds with the PO_4 complex ion acting as a nonmetal	$Ca_5(PO_4)_3(F,OH,Cl)$-Apatite
Silicates	$(SiO_4)^{2-}$	A metal bonds with the SiO_4 complex ion acting as a nonmetal	SiO_2-quartz, $(Na,Al,C)Si_3O_8$-feldspar

07223970423 Hornbillclasses@gmail.com

IFoS 2015 : Why is saline alkaline soil considered problematic (link Q).

Approach : (1) Introduction – few lines about saline alkaline soil.
(2) write down problems associated with saline and alkaline soil [About ½ part of Answers].

Saline alkaline soil is a basic soil type where its pH varies from two parts like 7-8.5 (for saline soil) and more than 8.5 (for alkaline soil). It has certain properties like



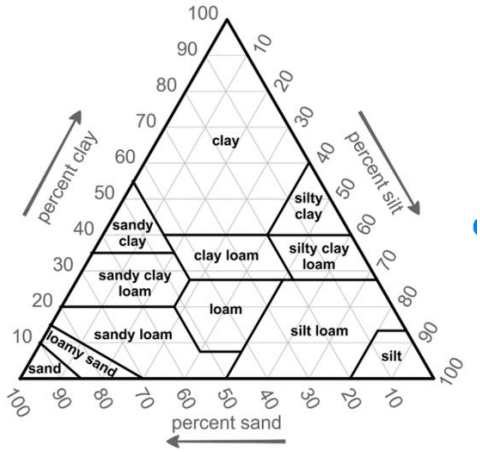
It is considered problematic because

- Formation of hardpan in the soil which prevent penetration of roots downwards, thus reduced plant strength against wind as well as concentration of salts in top soil.
- High concentration of alkaline salts increases osmotic pressure in soil which affects plant ability to absorb nutrients.
- The compact structure of the soil causes reduction in infiltration capacity, results in increased runoff as well as reduction in aeration capacity of soil.
- Such soil has lower microbial activity due to such hostile condition which causes reduction in recycling of nutrients of soil.

IFoS 2015 : Describe different textural classes of soil and the way they affect plant growth (10m).

Approach : (1) Introduction – few lines about soil texture
(2) flowchart of different textural soil class
(3) describe how they affect plant growth

Soil texture is the percentage of sand, silt and clay present in the soil. The different textural classes of soil are as follows



- Sand: Soil with a high proportion of sand particles, feels gritty and is well-drained.
- Silt: Soil with a high proportion of silt particles, feels smooth and has moderate water-holding capacity.
- Clay: Soil with a high proportion of clay particles, feels sticky when wet and has a high water-holding capacity.
- Loam: Soil with equal proportions of sand, silt, and clay, has a good balance of water-holding capacity and drainage.
- Sandy loam: Soil with more sand than silt and clay, but still has a good balance of water-holding capacity and drainage.
- Silty loam: Soil with more silt than sand and clay, has moderate water-holding capacity and moderate drainage.
- Clay loam: Soil with more clay than sand and silt, has high water-holding capacity and poor drainage.

Role of soil texture in affecting plant growth by

- Providing mechanical strength to plants. E.g. large height trees cannot be grown in sandy soil.
- Help in holding and increasing water capacity of soil.
- Prevent leaching of valuable nutrients from soil.
- Allowing favourable environment for bacterium and roots by allowing aeration.

IFoS 2015 : Why is a lot of emphasis laid on research relating to soil conservation (8 m).

Approach : (1) Introduction – few lines about soil conservation
(2) Write the need for research in soil conservation

Soil conservation refers to the practices and procedures adopted by the people in order to minimise topsoil degradation.

➢ The reasons are as follows

- Rise of desertification- around 28 percent of land are facing desertification problem due to natural and other activities which result in reduction in productivity.
- Climate change- rise of climate change causes the submergence of fertile lowland area thus reduction in area increases the pressure on available area.

- Increased shifting of lands towards agriculture induces leaky system which causes leaching of valuable nutrients towards lower soil horizon. And activities like using pesticides, fertilisers, flood irrigation etc causing soil erosion, soil salinization and reduced the population of biota i-e fungi, bacteria present in soil.
- Increasing intensity of natural calamities causes degradation of soil.
- Polluted soil affects groundwater and surrounding open water sources, which in turn become the cause of water borne diseases and increases the chances of eutrophication in water bodies.
- Soil played an important role in supporting giant structures, thus poor soil increase maintenance cost of such structures and also reduce the shelf life of such structure.

IFoS 2015 : Good watershed management must consider the social, economic and environmental sustainability and institutional factors. Comment (10m).

Approach : (1) Introduction – few lines about watershed management

(2) Body – how social, economic, environmental and institutional factors affect due to it .

Watershed management refers to an integrated and holistic approach to the planning, protection and development of land and water resources within a watershed. Good watershed management while on planning consider some of the important parameters like

- **Social factors**- watershed defines the region in terms of type of human settlement, gender roles, type of society formed in the region. good watershed improve access and benefits of resources, impact on local communities, women empowerment through improved role, help in formation of inclusive society.
- **Economic factors** – watershed influences business types, level of infrastructure creation, the type of employment etc. good watershed management help in increased income which help in reducing poverty, change in consumption pattern thus reducing health cost etc.
- **Environmental factors**- watershed influences regional soil, air, water, local flora and fauna etc. good watershed management help in improving soil productivity, improving air and water quality, preserving local flora and fauna population, thus help in sustainable development of the region.
- **Institutional factors** like prescribed norms and customs which help in connecting with people, statutory provisions created by multiple bodies namely states, centre, local body etc. good watershed management helps in increasing public participation, fulfilling government targets thus sharing the burden, make public responsible regarding its responsibilities etc.

1

Chapter

ETHNOBOTANY

IFoS 2021 : Discuss the role of tree domestication in biodiversity conservation? [**Paper – 2** | 10 m].

Biodiversity conservation means the protection, preservation, and sustainable management of the Earth's biological diversity. Tree domestication plays a significant role in biodiversity conservation by promoting the sustainable use and preservation of tree species and their genetic diversity.

- **Preservation of Genetic Diversity:** Tree domestication programs often involve the collection, propagation, and cultivation of a wide variety of tree species and genotypes.
- **Conservation of Endangered Species:** Tree domestication efforts focus on endangered or threatened tree species.
- **Promotion of Underutilized Species:** Tree domestication programs can promote the cultivation of these lesser-known species, reducing the pressure on more commonly exploited tree species and increasing overall biodiversity.
- **Habitat Restoration:** Restoring natural habitats with native trees helps recreate ecological niches and provides habitat for other species.
- **Promotion of Agroforestry:** combine the cultivation of trees with agricultural crops or livestock, can enhance biodiversity by creating diverse and productive landscapes.
- **Ecosystem Services**: Tree species provide essential ecosystem services such as carbon sequestration, soil stabilization, water regulation, and wildlife habitat.
- **Research and Knowledge Generation**: Tree domestication programs often involve research into the biology, genetics, and ecological roles of various tree species.
- **Community Engagement:** Tree domestication efforts involve local communities in the selection, cultivation, and management of tree species.

IFoS 2021 : Write the scientific name of 10 medicinal plants and their uses? [**Paper – 2** | 15 m].

Medicinal plants are those herbs, shrubs, trees, or other vegetation, that have been traditionally used for their properties employed for centuries in the treatment of various diseases. These plants contain chemical compounds with potential health benefits.

- Belladonna

  Scientific name – *Atropa belladonna*
  Growing area – Kashmir + Chakrata (UK)
  Useful part - leaves
  Chemical – Alkaloids, Atropine, Scopolamine
  USE –

  - Belladonna used as a painkiller, twilight sleep.
  - Treating Asthma
  - Motion Sickness and Nausea

- Quinine

  Scientific name – *cinchona officinalis*
  Family - *rubiaceae*
  Growing area – Nilgiris and Anamalai hills of Tamil Nadu
  Useful part – Stem Bark mainly (+ root bark)
  Chemical – *alkaloids*, *quinine* and *cinconine*
  Use

  - Treatment of Malaria
  - Digestive Aid
  - Cardiac problem

- Sarpagandha

  Scientific name – *rauvolfia serpentina*
  Family - *apocynaceae*
  Growing area – it is widely found in the sub-Himalayan region, lower hill of Gangetic plains, Andaman, eastern and western ghats.
  Useful part – Root bark
  Chemical – *Reserpine & Reserpinine, Serpentine & Serpentinine, Ajmaline*

  USE

  - Treatment of Snake Bite
  - Control high blood pressure.

- Use as a tranquillizing agent.

➢ Ashwagandha

Scientific name – *Withania somnifera*

Family - *solanaceae*

Growing area – it is widely found in Rajasthan, Punjab, Haryana, Uttar Pradesh, Gujarat, Maharashtra and Madhya Pradesh

Useful part – Dried Root powder

Chemical – *somniferin & somniferinine, withananine*

USE

- Treatment of Parkinson, memory loss, stress induced diseases,
- improves the ability to remember.
- helps in increasing strength.

➢ Adusha

Scientific name – *adhatoda vasica*

Family - *acanthaceae*

Growing area – Pan India

Useful part – Dried leaves

Chemical – *Vasicine, Adhatodic acid*

USE

- Cough Serapes.
- Helps Purify Blood and Maintain Heart Health.
- It also controls blood pressure

➢ NEEM

Scientific name – *Azardirachta indica*

Family - meliaceae

Growing area – Pan India

Useful part – leaves, bark seeds

USE

- treatment of inflammation, infections, fever, skin diseases.
- Use as a pesticide.
- dental disorders.

➢ AAMLA

Scientific name – *Emblica officinalis*

Family - Euphorbiaceae

Growing area –Madhya Pradesh, Uttar Pradesh

Useful part – fruits

USE

- Making Triphala
- Useful in stomach irregularity .
- to prevent hair fall

➢ TULSI

Scientific name – *Ocimum sanctum*

Family - Labiateae

Growing area – Pan India

Useful part – leaves mainly, bark, seeds, stem

USE

- Cough Serapes
- to treat insect bites
- useful in headaches and kidney stones.

➢ BHRINGRAJ

Scientific name – *Eclipta alba*

Family - Asteraceae

Growing area – moist places in warm temperate to tropical areas of India

Useful part – leaves mainly and seeds

USE

- Useful in treatment of col, cough asthma.
- Treatment of liver disoders.
- Hair care

➢ Harra

Scientific name – *Terminalia chebula*

Family – Combretaceae

Growing area – *Northern India*

Useful part – fruits

Use

- Laxative,
- Gargle
- Useful in stomach irregularity.

IFoS 2018 : Define ethnobotany. Write in detail about the role of ethnobotany in modern medicine and its approaches to the drug industry [**Paper – 2** | 15 m].

Ethnobotany is the study of how people of a particular culture or region utilized indigenous (native) plant knowledge through the age. They often work closely with

these communities to understand the ecological, cultural, and socioeconomic significance of plants in their lives.

Role of ethnobotany in modern medicine

- It helps in using plants as direct therapeutic agents. , E.g. Neem seeds and bark are used in cosmetics for acne treatment.
- It complements modern medicine during the COVID period, thus helping reduce mortality, e.g. kadha was promoted by the Indian govt. Contains dried parts of essential medicinal plants.
- It improves dietary composition by supplying essential micronutrients, thus helping in reducing the chances of having diseases due to deficiency of nutrients. E.g., amla is high in vitamin C, thus preventing scurvy as well as strengthening the immune system.

The approach of ethnobotany in the drug industry

- Ethnobotany provides the most productive plant screening method.
- It is more targeted-oriented and traditional knowledge-based.
- These databases facilitate collaboration between ethnobotanists, pharmacologists, and pharmaceutical companies in the search for new drugs.
- It helps in supplying raw materials for synthetic drug formulation.
- Researchers in ethnobotany aim to understand the mechanisms of action, dosage, and safety of traditional remedies.
- promoting integration between traditional and Western medicine.

IFoS 2018 : Enlist the common and scientific names of trees and shrubs seven each having medicinal properties in ethnobotany. [**Paper – 2** | 10 m].

Medicinal plants are those herbs, shrubs, trees, or other vegetation, that have been traditionally used for their properties employed for centuries in the treatment of various diseases.

1. Medicinal trees species

➢ Harra

Scientific name – *Terminalia chebula*

Medicinal Use

- Laxative,
- Gargle
- Useful in stomach irregularity.

➢ AAMLA

Scientific name – *Emblica officinalis*

Medicinal Use

- Making Triphala
- Useful in stomach irregularity.
- to prevent hair fall

➢ NEEM

Scientific name – *Azardirachta indica*

Medicinal USE

- treatment of inflammation, infections, fever, skin diseases.
- Use as a pesticide.
- dental disorders.

➢ Quinine

Scientific name – *cinchona officinalis*

Medicinal Use

- Treatment of Malaria
- Digestive Aid
- Cardiac problem

➢ GUGGAL

Scientific name – Commiphora wightii

Medicinal Uses

- Treatment of arthritis,
- Obesity, high blood cholesterol etc.
- Havan, worship material.

➢ INDIAN HEMP

Scientific name – Cannabis sativa

Medicinal Used

- Relieving pain, Sedative & Hypnotic,
- Treating nervous disorder

➢ BAEL :

Scientific name – Aegle marmelos

Medicinal Used

- improving liver function
- control cloistral
- control diabetes

2. Medicinal shrubs spicies

➢ TULSI

Scientific name – *Ocimum sanctum*

Medicinal USE

- Cough Serapes

- to treat insect bites
- useful in headaches and kidney stones.

➢ Belladonna

Scientific name – *Atropa belladonna*

Medicinal USE –

- Belladonna used as a painkiller, twilight sleep.
- Treating Asthma
- Motion Sickness and Nausea

➢ BHRINGRAJ

Scientific name – *Eclipta alba*

Medicinal USE

- Useful in treatment of col, cough asthma.
- Treatment of liver disoders.
- Hair care

➢ Sarpagandha

Scientific name – *rauvolfia serpentina*

Medicinal USE

- Treatment of Snake Bite
- Control high blood pressure.
- Use as a tranquillizing agent.

➢ Ashwagandha

Scientific name – *Withania somnifera*

Medicinal USE

- Tretment of Parkinson, memory loss, stress induced diseases,
- improves the ability to remember.
- helps in increasing strength.

➢ Adusha

Scientific name – *adhatoda vasica*

Medicinal USE

- Cough Serapes.
- Helps Purify Blood and Maintain Heart Health.
- It also controls blood pressure

➢ SATAWAR

Scientific name – Asparagus racemosus

Medicinal Uses –

- power improver
- Milk production
- Reduce symptoms of menopause

IFoS 2017 : What is ethnobotany, and describe the role of ethnobotany in the Indian system of medicine [**Paper – 2** | 8 m].

Ethnobotany is the study of how people of a particular culture or region utilized indigenous (native) plants knowledge through the age. They often work closely with these communities to understand the ecological, cultural, and socioeconomic significance of plants in their lives.

Role of ethnobotany in the Indian system of medicine

- It is the basis of the older system of medicine like Ayurveda and Siddha, as several plant extracts are used in Ayurveda, and Siddha is sourced from tribal knowledge.
- It also complements the Indian system of medicine by assisting the drugs and activities performed (in yoga and naturopathy) used in these systems. Thus, they help in quick recovery.
- Many indigenous communities have a rich heritage of using local plants to treat various health conditions. This knowledge can be passed down through generations and is invaluable for the development of herbal medicine.
- They study the taxonomy, distribution, and properties of these plants, helping to create comprehensive databases and resources for practitioners and researchers.
- Traditional healers and Ayurvedic practitioners rely on this knowledge to create herbal remedies and formulations that are effective for specific health issues.
- It can increase the efficacy of the Present medicine system against modern lifestyle diseases like diabetes, cancer, and hypertension.

IFoS 2016 : The ethnobotany knowledge helps identify viable medicinal plants for the pharmaceutical industry. Explain [**Paper – 2** | 10 m].

Ethnobotany is the study of how people of a particular culture or region utilized indigenous (native) plant knowledge through age. They often work closely with these communities to understand the ecological, cultural, and socioeconomic significance of plants in their lives.

- Traditional knowledge of the medicinal properties of plants helps in identifying potential plants which can be used for further research.
- Developing new medicine by using the therapeutic properties of medicinal plants. E.g., tulsi (*Ocimum sanctum*) extract is used in cough medicine

- They also help in providing raw materials for developing synthetic drugs. For E.g., digoxin is developed from *Digitalis lanata* leaves which are used for cardiovascular ailments.
- It helps make affordable medicines by reducing the cost of developing medicines.
- Researchers in ethnobotany aim to understand the mechanisms of action, dosage, and safety of traditional remedies.
- promoting integration between traditional and Western medicine.

IFoS 2015 : Give the scientific names of at least five drug-yielding plants with their use in pharmaceutical industry [**Paper – 2** | 8 m].

Drug-yielding plants, also known as medicinal plants, are plants that contain compounds or substances that have therapeutic properties and can be used for various medical purposes.

1. TULSI

   Scientific name – *Ocimum sanctum*
   Growing area – Pan India
   Useful part – leaves mainly, bark, seeds, stem

   USE
   1. Cough Serapes
   2. to treat insect bites
   3. useful in headaches and kidney stones.

2. Belladonna

   Scientific name – *Atropa belladonna*
   Growing area – Kashmir + chakrata (UK)
   Useful part - leaves
   Chemical – Alkaloids ,Atropine, Scopolamine
   USE –

   1. Belladonna used as a painkiller, twilight sleep.
   2. Treating Asthma
   3. Motion Sickness and Nausea

3. BHRINGRAJ

   Scientific name – *Eclipta alba*
   Growing area – moist places in warm temperate to tropical areas of India
   Useful part – leaves mainly and seeds

   USE
   1. Useful in treatment of col, cough asthma.

2. Treatment of liver disoders.
3. Hair care

4. Sarpagandha

Scientific name – *rauvolfia serpentina*

Growing area – it is widely found in the sub-Himalayan region, lower hill of Gangetic plains, Andaman, eastern and western ghats.

Useful part –Root bark

Chemical – *Reserpine & Reserpinine, Serpentine & Serpentinine, Ajmaline*

USE

- Treatment of Snake Bite
- Control high blood pressure.
- Use as a tranquillizing agent.

5. BAEL

Scientific name – Aegle marmelos

Growing area- middle India and deccan plateau

Useful Parts- fruits and leaves

Used

- improving liver function
- control cloistral
- control diabetes

IFoS 2013 : A Write short notes on the following medicinal plants [**Paper – 2** | 4 x 2.5 = 10 m].

(i) Aconitum heterophyllum
(ii) Orchis latifolia
(iii) Podophyllum emodii
(iv) Morchella esculanta

Medicinal plants are those herbs, shrubs, trees, or other vegetation, that have been traditionally used for their properties employed for centuries in the treatment of various diseases.

➢ Aconitum heterophyllum

Comman name - Atis or Ativisha,

Family - Ranunculaceae.

Growing area- sub-alpine and alpine region of the Himalayas.

Use

- They are used as expectorant, febrifuge, anthelmintic, anti-diarrhoeal, anti-emetic, and anti-inflammatory.
- poisoning due to scorpion or snake bite

- Cure fever and contagious diseases.

➢ Orchis latifolia

Comman name- Salep

Family - Orchidaceae

Growing area- Jammu and Kashmir, Sikkim, Arunachal Pradesh, Uttarakhand, and Himachal Pradesh

Use

- Help treat cancer.
- Improve eyesight.
- Increase the testosterone level and also help to increase sexual desire

➢ *Podophyllum emodii*

Comman name - Himalayan May Apple

Family - Berberidaceae

Growing area- Himalayan region (Uttarkashi)

Use-

- treatment of genital warts.
- treat fever, jaundice, liver disorders, syphilis.
- diseases of lymph glands.

➢ Morchella esculanta

Comman name - morel

Family - Morchellaceae

Growing area - Jammu and Kashmir (Doda)

Use-

- used purgative, laxative, body tonic, emollient
- used for stomach problems,
- for general weakness.

IFoS 2013 : Write critical notes on - Siddha system of medicines (2.5 m). [**Paper – 2** | 2.5 m].

Siddha is one of the oldest systems of Medicine discovered in South India. Its name is from the term 'Siddha', which means achievement. These principles and doctrines of this system have a close similarity to Ayurveda, with a specialization in Iatrochemistry. According to this system, the human body is the replica of the universe and believes that all objects in the universe, including the human body, are composed of five basic elements: earth, water, fire, air, and sky. Additionally, there are three humors or the DOSHAS called the Vata, Pitta, and Kapha. Siddha medicine believes that diseases occur when there is disequilibrium or imbalance in these humors or if their individual harmony is disturbed.

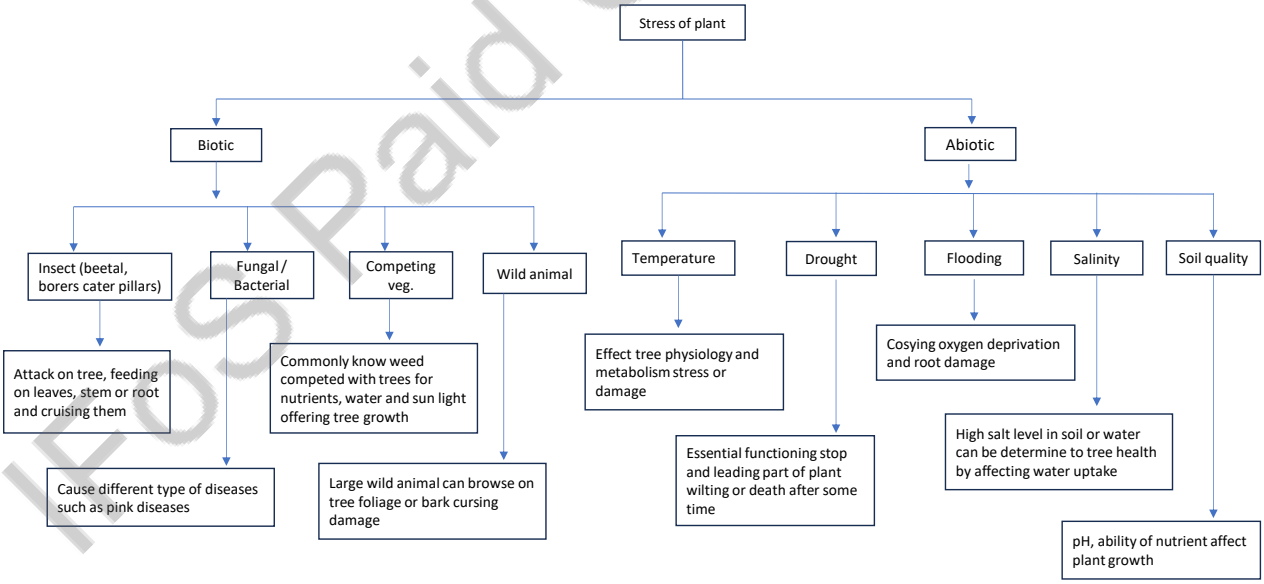
2

Chapter

FOREST PROTECTION

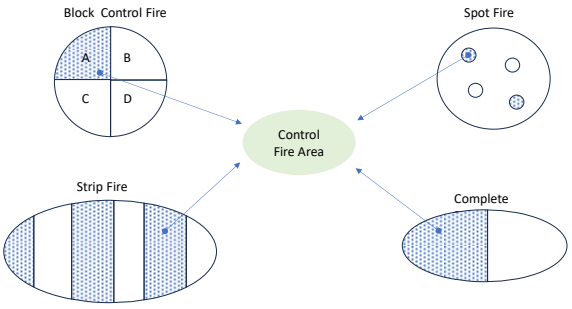
IFoS 2022 : What are the biotic and abiotic stresses on trees? Explain the responses of trees to these stresses? [**Paper – 2** | 8 m].

- Biotic tresses -living organisms such as pests, pathogens, and other organisms that directly affect tree health.
- Abiotic stresses - non-living environmental factors that can impact trees. These stresses are often related to unfavourable physical or chemical conditions.



IFoS 2021 : What is controlled burning? How does it help in improving forest regeneration? [**Paper – 2** | 10 m].

It is an intentional fire used by the forest department to achieve some objectives, usually before onset of summer season.



Control Fire

It helps in forest regeneration by

- It helps clean weeds and pests from the site, thus reducing competition between species.
- Fire is an essential tool to remove the dormancy of some seeds.
- It helps in the regeneration of Sal trees.
- It helps in inducing new leaf shoots by removing old leaves. (kaziranga national park)
- It helps in inducing better shoot flush used for tendu (*Diospyros melanxylon)*
- It improves soil conditions by removing pathogens from the soil.
- It provides valuable nutrients to the soil by burning down the grass, leaf litter, etc.
- After a forest fire, the forest land is open for regeneration, giving all species an equal chance.
- Decrease the chances of forest fire.
- Controlling Invasive Species

IFoS 2021 : Unscientific Harvesting of NTFP has led to the depletion of NTFP resources. discuss [**Paper – 2** | 8 m].

Nontimber forest produce refers to produce other than fuelwood, timber, and Smallwood.

Unscientific Harvesting of harvest results in-

- Habitat destruction- in case of honey collection, unscientific harvesting result in habitat destruction of bees, and forest fire result in disturbing local ecological balance.
- Vulnerability of trees against pest attack increases which in turn may damage the whole tree.
- Unscientific harvesting try to maximise profit, thus adopted unsustainable practices, as a result in the future tree productivity declines.
- Poor efficiency in extracting products results in lower yield and higher wastage of resources result in depletion of resources.
- The overexploitation of herbs may results in the local extinction of species.
- Unscientific harvesting results in the loss of other valuable by-products. E.g., poor Katha extraction results in loss of cutch.
- Unscientific Harvesting of leaves results in loss of branches, fruits, etc, which affects tree ability to fulfil its basic requirement.
- Over exploiting result in the depletion of certain species, making them less available for future harvests. e.g. Kani tribes jeevni medicine case.
- Disturb plant phenology and create problem in regeneration.

IFoS 2020 : What is the need to protect the forest? Enumerate the significant threats responsible for forest injuries. Suggest suitable preventive and protective measures to safeguard the forest's wealth. [**Paper – 2** | 15 m].

Forest protection is the branch of forestry deals with the activities directed toward the prevention and control of damages to the forest by man (including fire), Animals, insects, fungi, injurious plants, and adverse weather

➢ **Need to protect the forest**

- Forests play an essential role in maintaining the soil, water, and nitrogen cycle.
- Forests play an important role of carbon sequestration.
- Tribals have deep spiritual and cultural connections to forests.
- They directly contribute to the country's GDP (around 1.24 %) and indirectly reduce health costs by improving air and water quality.
- They are the in-situ conservation centre of wild animals.
- They play an essential role in preventing the expansion of desertification.
- Forests serve as critical habitats for wildlife, including endangered species.

➢ **FOREST INJURIES**

➢ **Natural**

- Volcanos, Earthquake, Fluid, Forest fires, and Sliding in hilly areas are destructive agents for the forest.

- Attack of insect pest. E.g. *Hyblaea purea, Odonotermis obesus, Agrotis ipsilon, Haplocersmbyx spinicornis*
- Injuries due to climatic factors
- Animals-elephants trample trees, bears suck the sap of trees, rodents damage plant roots, monkeys break the branches, and eat fruits and seeds.
- Grazing and browsing are caused by herbivorous animals like deer, antelope, bison, and elephants. Uncontrolled grazing and browsing results in damage to plants and their productivity.

➢ **Anthropogenic**

- Forest fire- uncontrolled forest fire results in the killing of multiple plants and animal species, increasing pathogen attacks on plants, etc
- Monoculture-causes Forest vulnerability to pest attacks and reduces regional biodiversity.
- Infrastructure (dam, roads railways) in forest area.
- Illegal hunting, pooching, honey collection.
- Shifting cultivation
- Easily availability of forest land.
- Mining alters the region's landscape by cutting down the giant forest.
- Illegal encroachment- around 54 million hectares of forest land are being illegally encroached by land mafia, tribals, etc.

➢ **Control Measures**

➢ **Preventive measures**-

- Fencing of forest land
- Increased forest region patrolling checks the forest region's human and animal activity.
- Restrict uncontrolled grazing and allow stall feeding.
- Increasing public participation in managing forests by generating awareness and providing them with training.
- Strict forest laws to tackle illicit Felling and illegal land encroachment.
- Rigorous EIA for an infrastructure project to assess the damage caused by that project.
- Use of CAMPA fund to afforest and reforest the region.

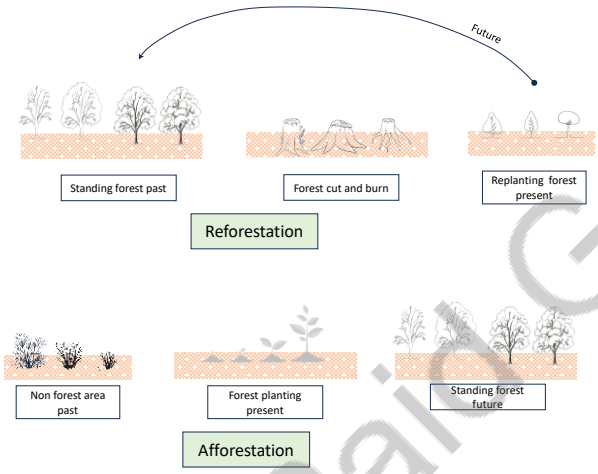
➢ **Remedial measures**

- Use of chemical insecticides and fungicides on insects and pests attacks,
- Proper inspection of the forest boundary.
- Promote agroforestry and social forestry program.
- Promote taungya system and improved fellow system in place of shifting cultivation.
- Develope alternative substitutes of wood.

- Use drones and remote sensing to assess the damage caused by forest fire and pest attacks.
- Use counterfire to control a forest fire.
- Use species with quick regeneration ability to reforest the degraded land.

IFoS 2020 : What is the significance of afforestation and reforestation in the ecosystem? How do the National Afforestation program, Green India mission, and forest fire prevention and management scheme help in forest restoration of a forest? [**Paper – 2** | 15 m].

Afforestation refers to a growing forest in a region where no forest existed, while reforestation refers to a growing forest in degraded forest land.



➢ **Significance:**

- It helps in increasing biodiversity in the region by providing an improved climate for other species to thrive.
- It helps in mitigating climate change impacts in the region e.g. Carbon Sequestration
- It improves site quality by enhancing the landscape of the region.
- It help in reducing soil erosion.thus help in arresting degradation of site.
- play a vital role in regulating the water cycle
- It provide Long-term Sustainability of ecosystem.
- It makes Cultural and Recreational Value of society.
- Air Quality Improvement.

➢ **National Afforestation program-** it is a centrally sponsored 3-tier institutional setup scheme to restore degraded land under Public participation.

- Its 3 tier setup helps in better monitoring of the reforested region.

- Public participation increases people's awareness regarding the conservation of forests.
- It does not impose an additional cost on the forest department due to its funding structure.
- It helps in improving the life of tribal communities living near the forest region.

➢ **Green India's mission**- comes under the National Action plan for Climate Change. Here a target of 10 million hectares of land to be reforested and afforest (5 million each) is set to increase forest cover.

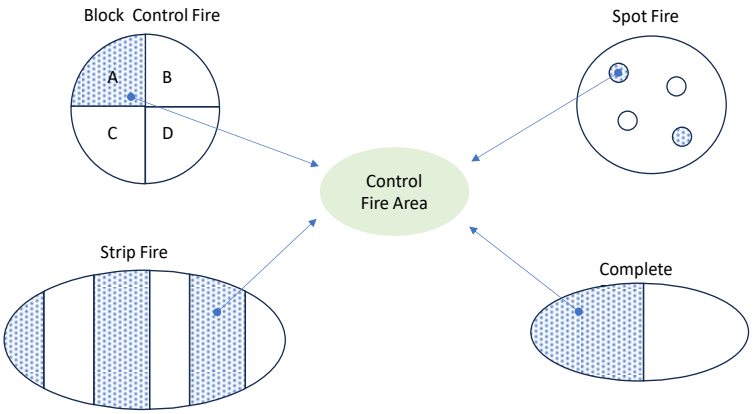
- Here a definite target is given, which needs to be achieved in a time-bound manner; thus, it accelerates reforestation in the region.
- These targets help India to achieve its Paris Climate targets of adding a Carbon sink of 3 gigatonnes.
- It helps in improving the forest quality and forest cover.

➢ **Forest fire protection and management**- this scheme assists the states in dealing with a forest fires.

- It helps in assessing the degraded sites that were created due to forest fires.
- Preventing Further Damage.
- Early Detection
- expansion of forest fire in reforested regions by taking measures like firelines, growing fires resistant trees in the sites,

IFoS 2019 : Describe how controlled fire can be used as a tool in forest management [**Paper – 2** | 8 m].

Controlled fire is an intentional fire caused by forest officials to modify forest composition.



Control Fire

It helps in forest the management by

- Removing invasive plant weeds from the forest helps reduce competition between plants.
- It kills and eliminates disease-causing pests from the forest.
- Forest fire helps in generating new shoots in the forest area. E.g. Kaziranga National Park is managed by forest officials by setting fire to the grassy plains.
- to help in removing debris like leaf litter, fallen seeds, and broken branches.
- It helps regenerate young leaves with industrial use, e.g., *Diospyros melanxylon.*
- It helps in improving soil microclimate by removing fungi and harmful pathogens.
- It helps in removing dead and affected trees from the forest.
- Control forest fire provided free space for the growth of new species.

IFoS 2019 : What do you mean by deforestation? Explain the major causes of deforestation. [**Paper – 2** | 8 m].

Deforestation is defined as the removal of tree crops from a piece of land without the intention of reforesting.

Major causes of deforestation

- Diversion of forest land for non-forestry purpose. (Dam, roads, cannel, railways)
- Forest fire
- Shifting cultivation (8400 Km^2 area is currently under Shifting cultivation)
- population explosion.
- Easily availability of forest land.
- Departm ent ignorance, no proper patrolling in forest boundary.
- Defective forest policies, act.
- Grazing, looping and illicit felling

- Climate change.

IFoS 2019 : Describe the causes of deforestation. What are the measures to be taken for the control of deforestation [**Paper – 2** | 10 m].

Deforestation is defined as the removal of tree crops from a piece of land without the intention of reforesting.

➢ Major causes of deforestation
  - Diversion of forest land for non-forestry purposes. (Dam, roads, cannel, railways)
  - Forest fire
  - Shifting cultivation (8400 Km^2 area is currently under Shifting cultivation)
  - population explosion.
  - Easily availability of forest land.
  - Department ignorance, no proper patrolling in forest boundary.
  - Defective forest policies, act.
  - Grazing, looping, and illicit felling
  - Climate change.

➢ **Measures to control deforestation**
  - Replace fuelwood with alternate fuels like CNG and LPG.
  - Ban shifting cultivation and promote the taungya system and improved fallow system.
  - Reclamation of mining areas by using CAMPA funds.
  - Amending forest laws with strict penalties for violations and increasing public participation in conserving forests.
  - Introduce fire-resistant trees with other trees in the forest.
  - Promote Agroforestry and Social forestry.
  - Replace timber with some suitable alternatives.
  - Educating people, developing ecotourism and giving the permission collection of NTFP.

IFoS 2019 : What is controlled grazing? Describe how it helps better manage forest pasture land? [**Paper – 2** | 10 m].

Where in the animal stays in the area for a long time but the size of the area is adjusted by moving fences.is called Controlled grazing.

➢ **Management of pasture land by controlled grazing**
  - It facilitates the movement of cattle and grazing them in the intended direction

- It can manage overgrazing by restricting the movement of cattle toward the already grazed site.
- It helps in maintaining uniform grazing across the fields as it has moving fences.
- It can be suitable for all types of animals.
- This grazing is not subjected to seasonal or any other constraints.
- Control grazing provided sufficient time to regenerate the area.
- Wastage of fodder is less compared to open grazing.
- Less chance of damage to new shoots of grass, plants.
- Compared to other methods, it can be easily conducted on small patches of land.

IFoS 2018 : What are the causes of a forest fire? What measures are taken to protect against damage by fire? [**Paper – 2** | 10 m].

A forest fire can be defined as any uncontrolled and non-prescribed combustion or burning of plants in a natural setting, such as a forest, grassland, brushland, or tundra, that consumes natural fuels and spreads based on environmental conditions.

- **Causes of forest fires**
- **Natural causes:**
  - Volcanic eruption- molten lava eruption burns down everything that comes in its pathway
  - Thunderstorm lightning- this lightning has very high energy. When it strikes the plants, it converts into heat which causes the burning of trees and later spreads across the region.
  - Rolling stones- these stones carry kinetic energy. When they strike with another rolling stone, it causes the conversion of this energy into light which then starts a fire.
  - Rubbing of bamboo culms- It causes friction which creates heat and eventually causes fire
- **ANTHROPOGENIC CAUSES**
- **Unintentional causes:**
  - Campfire- the adventure camp in the forest uses fire to cook food and stay warm and protected from wildlife.
  - Honey collector use fire as a tool.
  - Spark from household near the forest.
  - NTFP Collector careless.
  - Ecotourism.
- **Intentional cause:**
  - Shifting cultivation.

- Remove leaf litter (particularly conifers), dead plants, diseased plants, etc.
- Poachers used this method to trap wild animals by modifying their movement in the forest to trap wild animals.
- Forest department use a fire as tool for regeneration of new coppice of grass.
- It plays an important role in flushing of new tendu leaves.

➢ **Preventive measures**

- Proper silvicultural practices including weeding, and cleaning to remove fuel wood.
- Planted evergreen tree species, fire-resistant trees around the compartment boundaries.
- Proper cleaning and maintenance of fire lines, and forest roads.
- Draw new fire lines and fire breaks.
- Monitoring by satellite-based forest fire monitoring systems.
- Increase watch tower.
- Educating people.
- Use of chemical retardants like DAP, calcium alginate, etc.

➢ **Remedial measure**

- Three basic pillars of fire is heat, fuel and oxygen. we can eliminate any one.
- Counter firing.
- Mopping up
- Small fire case beating up by the broom of green branches and twings.

IFoS 2017 : Describe the types of forest fire, their ill effects, and preventive measures. Briefly discuss the role of forest fire on forest ecosystems [**Paper – 2** | 15 m].

A forest fire can be defined as any uncontrolled and non-prescribed combustion or burning of plants in a natural setting, such as a forest, grassland, brushland, or tundra, that consumes natural fuels and spreads based on environmental conditions.

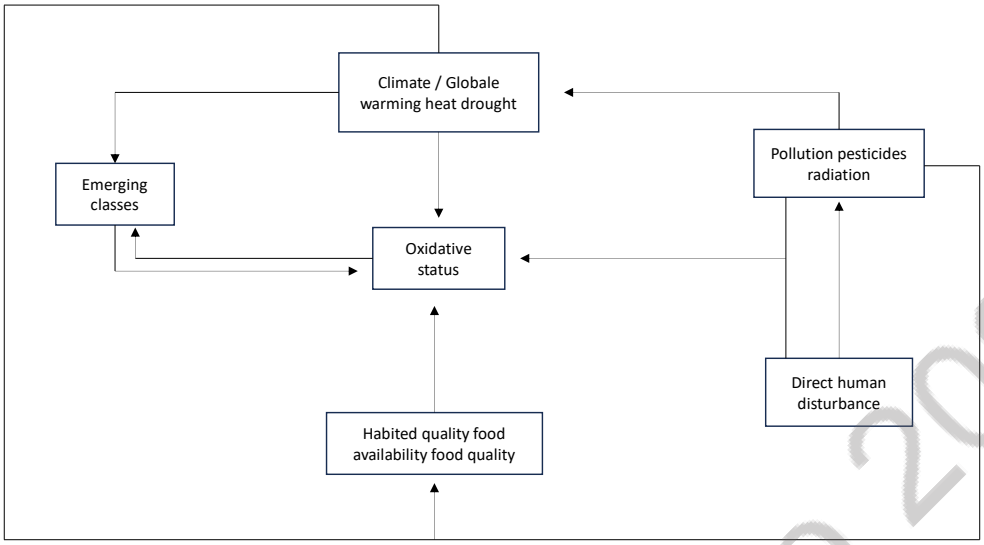
Type of forest fire

1. Ground fire: a forest fire that burns the ground cover only, usually with no flame and marked by constant black smoldering.
2. Creeping fire: fire that spreads slowly over the ground with low flame (in the absence of strong wind).
3. Surface fire: a forest fire that burns not only ground cover but also other undergrowth vegetation too, like shrubs, seedlings, and saplings.
4. Crown fire: a forest fire that spreads through the crown of trees and consumes all or part of the upper branches and foliage, Mainly in Conifers.

- **Effects of a forest fire**:
  - Release of a large amount of carbon from the carbon sink and thus carbon sink becomes a carbon source.
  - The killing of large amounts of vertebrae. E.g., in an Australian bushfire, around 3 billion vertebrates were killed.
  - The killing of important soil bacteria and promoting the growth of fungi.
  - Increase soil compaction and promote soil erosion.
  - Destroy endemic species, which are found only in this part of the forest.
  - Increase global warming gases.
- **Preventive measures:**
  - Substitute fuelwood with other renewable clean food for cooking.
  - Burning of combustible material (like leaf litter, dead trees, and fallen branches) before the fire-prone season starts.
  - Restrict human activities (like collecting honey and adventure camps) during the fire-prone season.
  - Growing fire-resistant trees along with other trees.
  - Increase public participation in protecting trees from fire by generating awareness, providing them with training, etc.
  - Creation of fire lines and firebreaks.
  - In the case of controlled fire operations by the forest department, good chemical retardants should be present at the site to prevent this controlled fire from being uncontrolled.
- **Remedial measure**
  - Three basic pillars of fire are heat, fuel, and oxygen. we can eliminate anyone.
  - Counter firing.
  - Mopping up
  - Small fire case beating up by the broom of green branches and twigs.
  - After the forest fire forest department should do work of salvage cutting.
- **Role of fire in forest management**
  - It helps in cleaning weeds and pests from the forest.
  - It helps in the regeneration of Sal trees.
  - It helps in inducing new leaf shoots.
  - Fire helps in inducing better flush of tendu leaves for tribals.
  - The forest department in *Kaziranga National Park* burns grass for better regeneration and proper growth of new grass.

IFoS 2017 : Discuss the impacts of humans on forest health briefly. Explain different measures to check forest encroachment [**Paper – 2** | 15 m].

Forest health refers to the condition of flora and fauna in the forest region in terms of population, composition, etc.



- **Impact of human activities: Positive impact**-
  - Through controlled fire, humans checked the growth of weeds, pests, etc.
  - Through silvicultural practices, it helps increase the undergrowth of trees by removing branches, defective trees, etc.
  - Promoting and performing activities like taungya, agroforestry, and social forestry reduces forest dependency on timber and fuelwood.
  - Through methods like Miyawaki, it helps in the quick regrowth of the forest.
  - It helps in forest regeneration and thus helps in the region's reforestation.
- **Negative impact-**
  - Uncontrolled forest fire causes massive loss of wildlife. E.g., Australia bushfire.
  - The introduction of exotic species may lead to increased competition between native species.
  - Mining, infrastructure (dam, roads, railway line) development in forest land.
  - shifting cultivation leads to the degradation of the forest.
  - Uncontrolled grazing, lopping, illicit felling.
- **Measures to prevent forest encroachment**
  - The forest department should patrolling around the forest boundary regularly.
  - Proper fencing of the forest boundary.
  - Strict implementation of forest laws.
  - Promote agroforestry and social forestry to fulfill timber demand to an extent.
  - Reduce dependence on fuelwood by providing them LPG AND PNG.

- Provide tribals with alternate employment and homes to reduce their dependence on forests.
- Replace shifting cultivation with the taungya system.
- If deforestation is necessary for infrastructure projects, then afforestation of community land should take place using CAMPA funds.

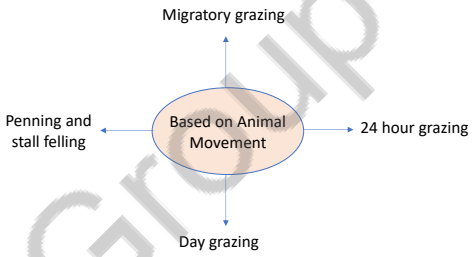
IFoS 2017 : What are the major grazing systems and grazing regions in India? Describe methods briefly to prevent pressure from grazing in the forest. [**Paper – 2** | 8 m].

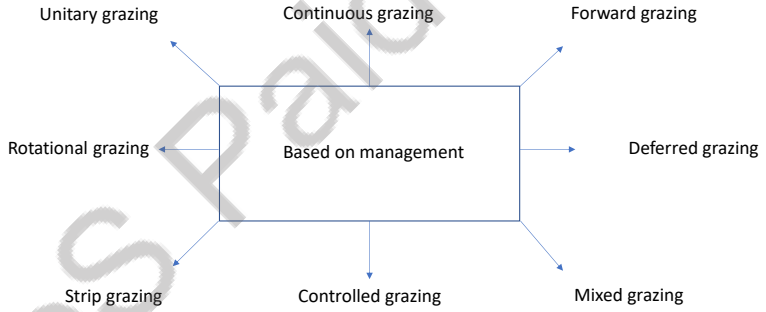
Grazing refers to feeding leaves and twigs of the plant, such as grasses and shrubs.

The grazing system is classify in two type.

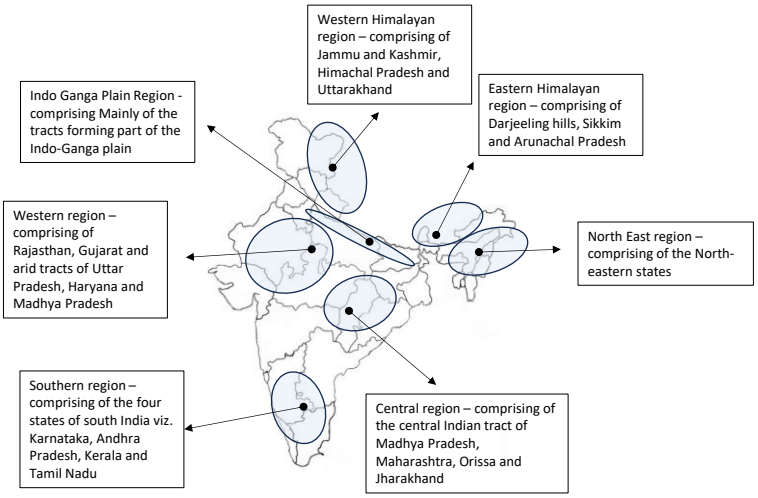
A. Based on animal movement.

B. Based on management.





➢ Grazing regions in India



- Method to prevent pressure from grazing in forests
  - Promote stall feeding instead of continuous grazing.
  - Development of fodder bank.
  - Grazing should be allowed in a planned approach.
  - Promote a silvopastoral system to reduce pressure on grazing regions.
  - Grazing capacity should be maintained to ensure sustainable forest supply.

IFoS 2016 : Forest fire remains a major threat to forest ecosystems across the globe. How do you address this issue? [**Paper – 2** | 10 m].

A forest fire can be defined as any uncontrolled and non-prescribed combustion or burning of plants in a natural setting, such as a forest, grassland, brushland, or tundra, which consumes natural fuels and spreads based on environmental conditions.

- **Threat to forest ecosystem**
  - It increases soil temperature, which helps in fungi growth.
  - It exposes soil cover and thus accelerates soil erosion.
  - It reduces forest biodiversity in terms of fauna and flora. E.g., In Australia, bushfire nearly kills three billion vertebrates.
  - It promotes the growth of invasive species as they have a quick regeneration ability.
  - It changes the status of the forest from a carbon sink to a carbon source.
  - Increase insect-pest and fungal attacks after fire injuries.
- **The solution to forest fire**
  - Proper silvicultural practices including weeding, and cleaning to remove fuel wood.
  - Planted evergreen tree species, fire-resistant trees around the compartment boundaries.
  - Proper cleaning and maintenance of fire line, and forest roads.
  - Draw new fire lines and fire breaks.

- Monitoring by satellite-based forest fire monitoring systems.
- Increase watch tower.
- Educating people.
- Use of chemical retardants like DAP, calcium alginate, etc.
- Three basic pillars of fire are heat, fuel, and oxygen. we can eliminate anyone.
- Counter firing.
- Mopping up

3

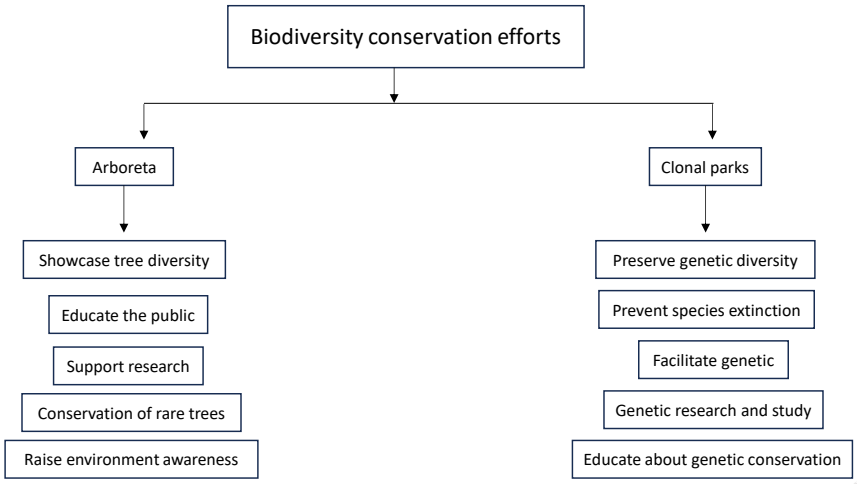
Chapter

HERBARIUM

IFoS 2021 : What are plant science's holotype, neotype, lectotype, and syntype? Describe the role of arboreta and clonal park in the conservation of biodiversity [**Paper – 2** | 15 m].

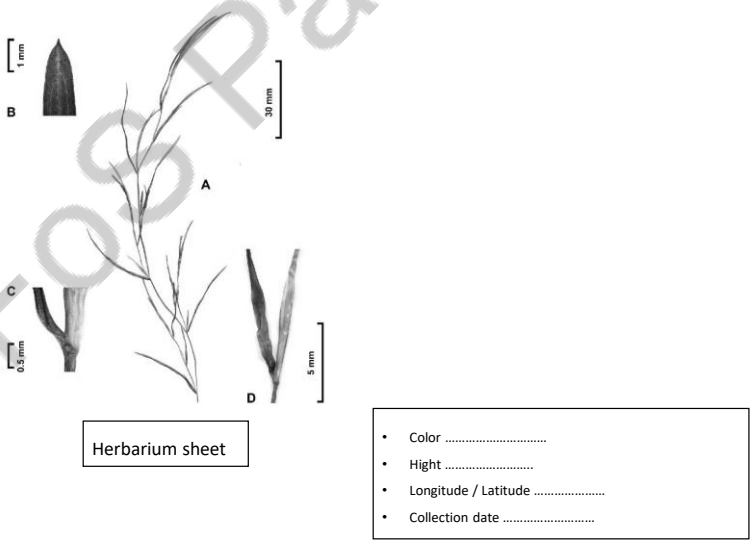
Herbarium Sheet is a paper on which we mounted different types of specimens and wrote down their name, origin, date of collection, etc. The standard size of a herbarium sheet is 11.5 × 16.5 inches.

- **Holotype** - A single specimen upon which the name and description of a newly discovered species is written.
- **Neotype** - In case of the holotype and the original plant are lost, a herbarium sheet prepared from some other plant of the same species is called a neotype.
- **Syntype** - In case of holotype and the original plant are lost, then many herbarium sheets are prepared from many plants of the same species is known as syntype.
- **Lactotype**- In case of holotype is lost, the 2nd herbarium sheet prepared from the original plant is called lectotype.
- **Arboreta** are specialized botanical gardens or outdoor spaces dedicated to the cultivation, study, and display of a wide variety of trees and woody plants. Whereas, the **clonal park** is a specialized type of park or conservation area that is dedicated to preserving and showcasing genetically identical individuals of a single species or a group of closely related species. the park is propagated through asexual reproduction methods.
- **Role of arboreta and clonal park in biodiversity conservation**



IFoS 2017 : Define herbarium and write its significance. What are the steps in establishing herbarium, and which method of plant classification is followed in herbarium arrangement? [**Paper – 2** | 8 m].

A herbarium is a collection of dried specimens and arrangements of specimens in the sequence of an accepted classification for reference or other scientific studies.



➢ SIGNIFICANCE

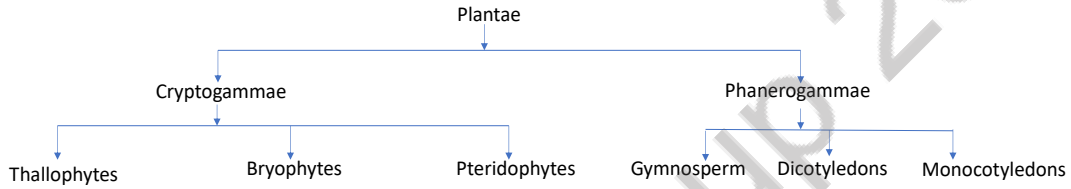
- It is an invaluable conservatory of plant material and data.
- It is a storehouse of a large collection of specimens, becomes source of taxonomic information and canter for research.

- It is an ex-situ conservation center of genotype.
- It can help in generating a digital database.
- Tag of herbarium carry all the information.

➢ Steps in establishing herbarium

- Collecting plants species
- Drying and poisoning
- Mounting, sticking, and labeling
- Identification and nomenclature of plants

➢ Methods of plant classification: here Bentham and hooker method is used, which can be understood by the diagram



4

Chapter

FOREST ENGINEERING

IFoS 2022 : Write the general principles of surveying. Describe (i) Direct methods of chaining on sloping ground, and (ii) Chaining when vision is obstructed, but chaining is free [**Paper – 2** | 15 m].

IFoS 2022 : Explain the Single-Line and Double-Line Field Books with neat sketches. Mention the steps followed in the field work of Chain Survey [**Paper – 2** | 15 m].

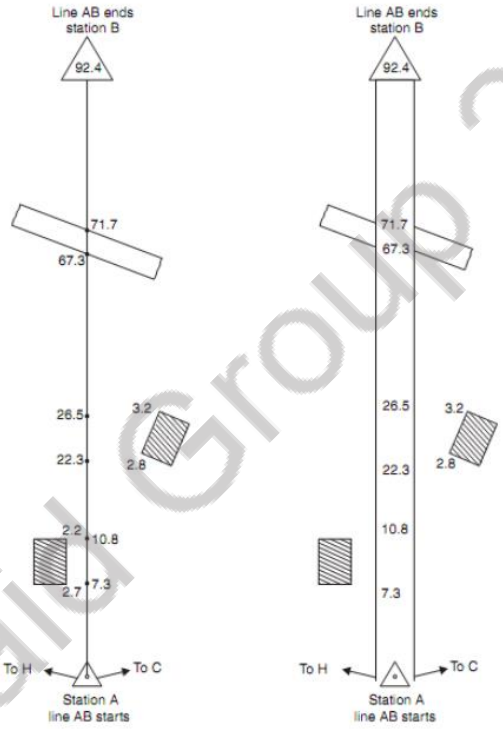
The field measurements, sketches, and relevant notes are recorded for future reference in a notebook known as a field book. It is an oblong book of size 20 cm× 12 cm. Which can be carried in the pocket.

There are two forms of field book.

A. Single-Line

B. Double-Line

- **Single-Line field book** : A single-line book has a red line along the length of the paper in the middle of the width. It indicates a chain line. The space on either side of the line is used for sketching the objects and entering offset distances.
- **Double-Line field book-** In a double-line book there are two blue lines in the space of 15 – 20 mm in the middle of each page of the book. The space between the two lines is utilized for noting the chaineges.



Steps followed in the fieldwork of Chain Survey

- Preliminary reconnaissance - surveyor walks over the whole area, examines and determines the possible arrangements of the framework of the survey, where he can establish main stations, basic requirements of laborers, ranging rods, about field boundaries.
- Index sketch- after a preliminary inspection of an area, the surveyor draws a sketch showing the arrangements and framework of an area, the name of stations & substations, major object positions, and markings of wooden pegs.
- Marking of stations on the ground.
- Chaining, Offsetting, Field book recording and error checking

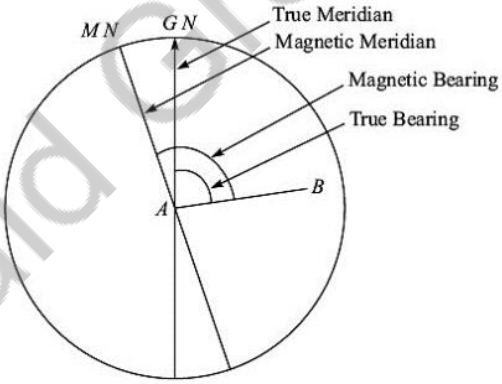
- Plotting a chain survey : before plotting of collected data on the drawing paper, it is necessary to decide the scale of the drawing.
- Inking in : after plotting, checking and filling in all the details, pencil work starts from the top downwards using conventional signs and colour.

IFoS 2021 : Explain the term (i) True meridian, (ii) Magnetic meridian, (iii) Reduced bearing, and (iv) Fore and back bearing [**Paper – 2** | 8 m].

True meridian- The line or plane passing through the geographical north pole and the geographical south pole is known as the 'true meridian' or 'geographical meridian.

Magnetic meridian- When a magnetic needle is suspended freely and balanced properly, unaffected by magnetic substances, it indicates a direction. This direction is known as the 'magnetic meridian'

- The angle between the magnetic meridian and a line is known as the 'magnetic bearing'.
- The magnetic meridian is an imaginary reference line connecting the magnetic south and north poles.



- **Reduced bearing**- the bearing of a line measured clockwise or counter clockwise, either from the north pole or south pole (whichever is nearer the line) towards the East or West, is known as the Reduced bearing.
- Four quadrants are considered and are denoted as NE, NW, SE, and SW.
- The values of quadrantal bearing lie between 0° and 90°.
- The instrument used to calculate reduced bearing is – Surveyor Compass.

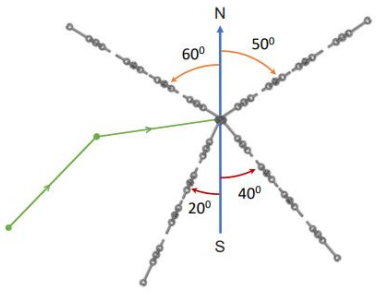
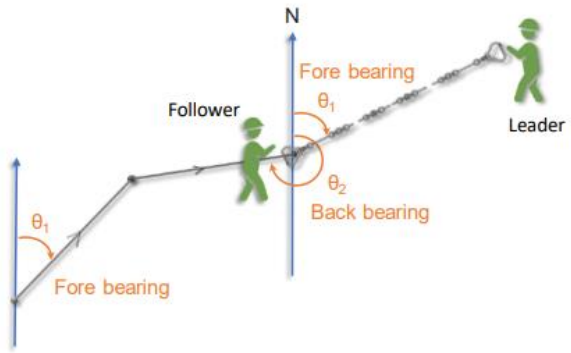


Figure : Quadrantal bearing

Fore and back bearing- Every line has two bearings, one is observed along with the progress of the survey or forward direction and is called 'fore bearing', and the second is observed in the reverse or opposite direction and is called 'back bearing'.



IFoS 2021 : What are the advantages and disadvantages of Plane Table Surveying? Describe Radiation, Intersection, Traversing and Resection methods of plane table surveying [**Paper – 2** | 15 m].

Plane table surveying is a graphical method of surveying in which field observations and plotting are done simultaneously. It is based on the principle of parallelism.

- **Advantages**-
  - It is the most rapid method of surveying.
  - There is no need for a field book as plotting is done along with the fieldwork.
  - Plotted work can be compared with actual objects regardless of whether or not they are properly represented.
  - There is no possibility of overlooking any important object.
  - There is no possibility of overlooking any measurement as plotting is done in the field.
  - Irregular objects may be represented accurately.
  - It is suitable in magnetic areas.
  - The map can be prepared easily and does not require any great skill.
  - Errors in measurement and plotting can be detected by check lines.
  - Inaccessible points can be easily located by the intersection
- **Disadvantages**-
  - The plane table is not suitable for accurate work as the fitting arrangement is not perfect.
  - Plane table surveying is not suitable in wet climates, in the rainy season, in foggy mornings, and in windy weather.
  - The number of accessories required in such a survey is large, and they are likely to be lost.

- The instrument is very heavy and difficult to carry.
- The map cannot be replotted to a different scale as there is no field book.

Method of plane table surveying

- **Radiation method** : This method is suitable for locating the objects from a single station. In this method, rays are drawn from the station to the objects, and the distances from the station to the objects are measured and plotted to any suitable scale along with the respective rays. It is helpful in large-scale work, in combination with other methods for surveying, i.e., Forest Nursery setup, Plantation plot in the plain, Mapping of Seed production area and seed orchards.

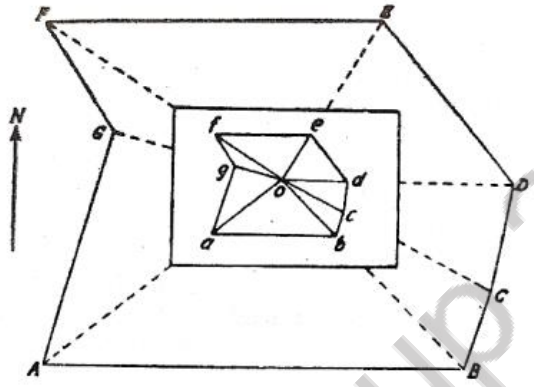
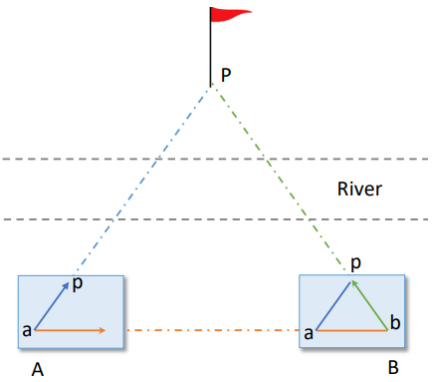


Fig. 7.4. Radiation.

- **Intersection method** : This method is suitable for locating inaccessible points by the intersection of the rays drawn from two instrument stations. This method is used for mapping details of inaccessible objects/points located on broken boundaries, riverbanks, edges of forests, and other indefinite topographic features.
  - A and B are two stations and P is an object on the far bank of a river.
  - The table is set up at A. It is levelled and cantered so that a point a on the sheet is just over station A. The north line is marked on the right-hand top corner.
  - The Alidade touching a, the object P and the ranging rod at B are bisected, and rays are drawn through the fiducial edge of the Alidade
  - The distance AB is measured and plotted to any suitable scale to obtain point b.
  - The table is shifted and cantered over B and levelled properly. Now the Alidade is placed along with the line BA, and orientation is done by back-sighting.



- The Alidade touching b, the object P is bisected and a ray is drawn. Suppose this ray intersects the previous ray at a point p. This point p is the required plotted position of P.

➢ **Traversing method-** : This method is suitable for connecting the traverse stations. This is similar to compass traversing or theodolite traversing. But here, fielding and plotting are done simultaneously with the help of the radiation and intersection methods. It is generally used to establish the main survey lines and frequently employed for locating key points and details. This method is particularly well-suited for linear surveys, such as roads, streams, and other linear features

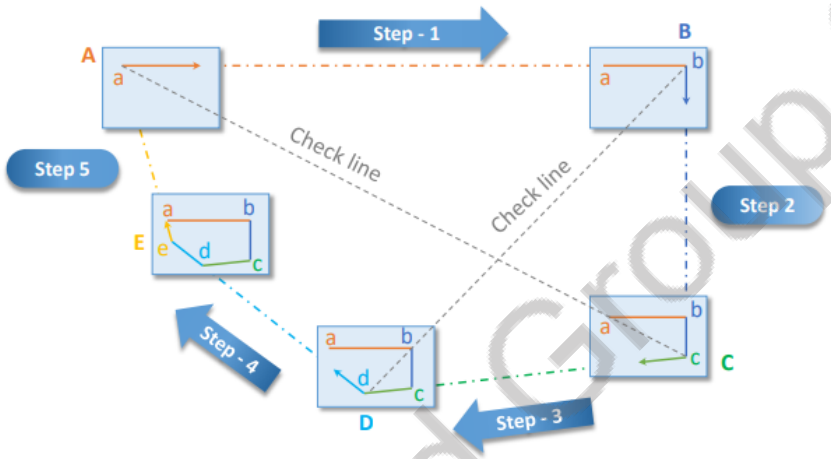


Figure : Plain tabling by Traversing

➢ **Resection method -**This method is suitable for establishing new stations at a place in order to locate missing details.

In plane table surveying, when an important object is missed, and no station pegs are present, resection methods, using (1) the two-point problem and (2) the three-point problem, are employed to establish a new station for plotting the missing object.

IFoS 2021 : Describe structure of Suspension Bridge and Cantilever bridge [**Paper – 2** | 10 m].

Bridges are constructed to provide passage over obstacles like rivers or roads, with design tailored to terrain and intended function.

Suspension Bridge-

These types of bridges are constructed over large openings where it's not feasible to erect intermediate piers, often due to swift water or other constraints. The bridge's main footing is suspended in the air by iron cables.

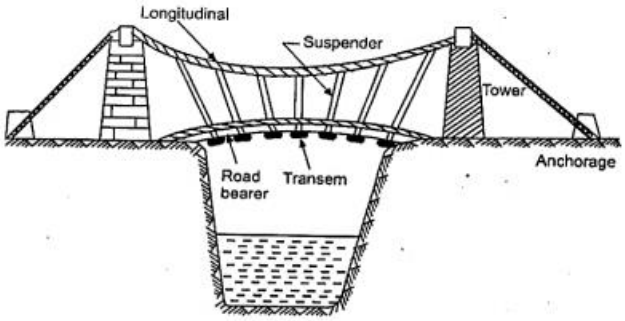


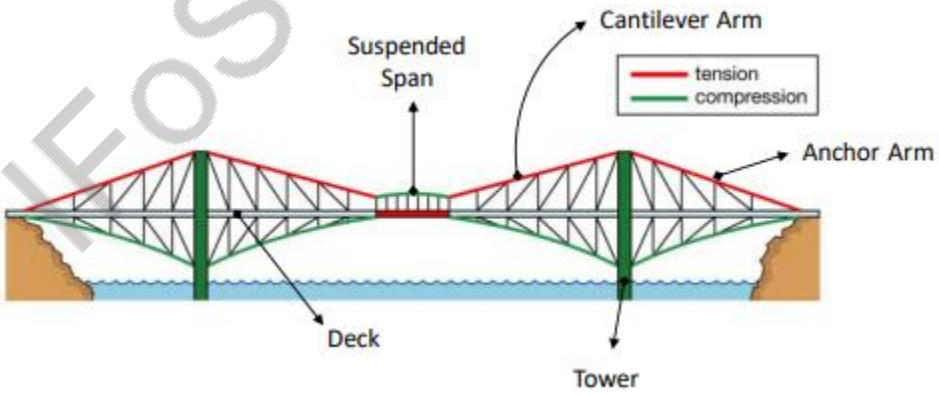
Fig. Suspension bridge

➢ **Parts of Bridge**

- Cables : Cable is primary load-bearing elements that provide support for the bridge deck. it consists of high-strength steel wires or strands bundled together to form large, strong cables.
- Tower : it supports main cables high above the bridge deck in suspension bridges.
- Anchors : Piers anchor main cables on land.
- Transoms : Transoms are horizontal components that connect the vertical suspenders or hangers to the main cables. It helps distribute the load evenly across the bridge deck.
- Suspenders : Suspenders is vertical cables or rods that hang from the main cables and support the bridge deck.

➢ **Cantilever Bridge-**

The bridge is made up of two systems of counterpoised beams built out from the abundant supporting the road bearers in the middle. Here the span gap should be shorter when both parts are connected



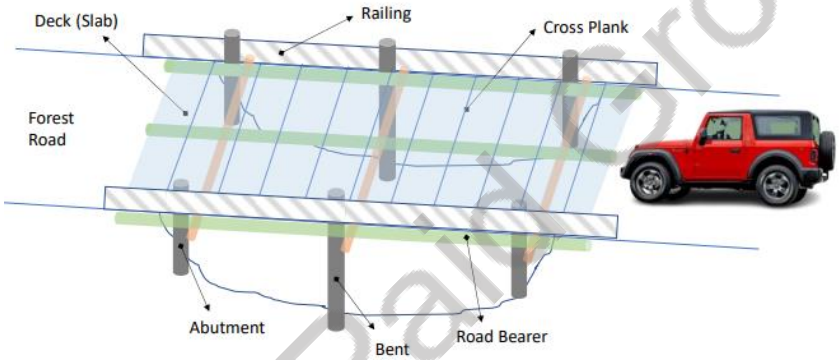
➢ **Parts of Bridge**

- Deck - Deck carries the roadway or pathway for vehicles, pedestrians, or other forms of transportation. the deck is supported by cantilever arms.

- Tower(beam)- Tower have central piers or abutments that support the cantilever arms.
- Suspended span - A suspended span in a cantilever bridge is the section of the bridge that is supported by cantilever arms and suspended in the air between two central piers or abutments.
- Anchor arm - Anchor arm are used to counterbalance the outward extending cantilever arms on both sides of the central support.

IFoS 2020 : What are the basic details of an engineering design of a timber bridge? What steps should be taken to ensure its durability? [**Paper – 2** | 15 m].

A timber bridge is a type of bridge constructed wholly or partly of timber poles and strengthened by iron cables. This bridge can be used only up to a 6-meter span. They are commonly found in rural and remote areas, providing a means to cross rivers, streams, or other obstacles.



Structure - The substructure is the portion of the bridge that transmits loads from the superstructure to the supporting rock or soil. Timber substructures include abutments and bents.

➢ **Parts of bridge**

- Deck (slab)- Deck, in a timber bridge is the roadway for vehicles and pedestrians, typically consisting of wooden beams or planks, providing passage over water, gorges, or other obstacles.
- Beam-Beams in a timber bridge distribute the load from the deck and enhance the bridge's stability and strength.
- Truss- Timber trusses support the bridge deck and distribute weight to piers or abutments, ensuring stability and integrity in timber bridge designs.
- Arch- arches in bridge construction rely on their inherent strength to span various distances and distribute loads efficiently to abutments while offering an aesthetically pleasing design

- Railing - Railings are safety barriers along the sides of the deck, preventing accidents and reflecting the bridge's aesthetics and function.
- Suspension superstructures- Timber suspension superstructures combine wooden elements and cables for support, though less common due to timber's limitations in longer spans and load-bearing capacity

Steps to ensure timber/bridge durability

- **Termite attacks** -impregnations anti-fungal and anti-termite chemicals.
- **Water** - apply Oil and organic type preservatives before use.
- Timber Selection.
- Wood tensile strength.
- Preservative Treatment.
- Adverse weather.
- Regular Inspections and Maintenance.
- Not pass a Heavy load.
- Cover in adverse weather.

IFoS 2020 : What are the factors that cause foundation failure during construction of a forest building? [**Paper – 2** | 10 m].

The lowest artificially prepared parts of the structure, which are in direct contact with the ground and which transmit loads of the structure to the ground, are known as Foundation or Substructure. It provides a base for the super-structure and distributes the structure's load on a wide area.

Causes of foundation failure

- Unequal settlement of subsoil due to the non-uniform nature of the subsoil, unequal load distribution and eccentric loading.
- Soils : Lateral escape of soft soils, like running sands.
- Drainage : Withdrawal of water from foundation soils cracking the subsoil.
- Sliding of substratum on the sloping ground.
- Weathering of subsoil due to trees and shrubs : The root of trees and shrubs penetrates. Underneath the footing and absorbs moisture resulting in void and weathering.
- Wind pressures: Extend the foundation footing of the Leeward side.
- Lateral pressures such as thrusts by beams, vaults, arches, etc.

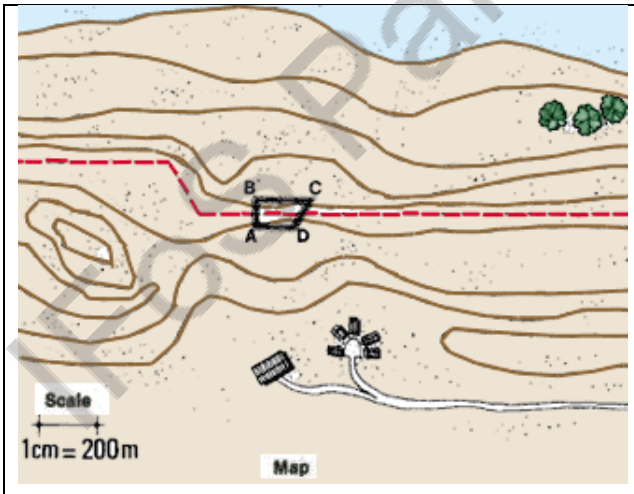
IFoS 2020 : What are the objectives of forest surveying? How does topographic survey aid in forest planning and management? [**Paper – 2** | 15 m].

Surveying is the art of determining the relative positions of different objects on the earth's surface by measuring the horizontal distances between them and preparing a map to any suitable scale

Objectives of forest surveying

- To prepare a topographic map of a forest area that shows the hills, valleys, rivers, and forest villages of a forest area.
- To prepare a cadastral map showing the boundaries of the compartment, blocks, etc.
- Prepare plantation, stock, and management maps.
- Determining the direction and distance Between different offices, plantation sites, and available water sources like rivers, streams, etc.
- Construction of forest roads and bridges.
- To map out fire burnt areas.
- To detect encroachments on the forest land, forest resources allocation.

The process of contouring large areas is known as topographic surveying, and it is used to collect information for topographic maps. The distinguishing feature of a topographic survey is determining the location of the points and objects, both in plan and in elevation.



Topographic Maps

Uses of topographic (contour) maps in forest planning and management-

- Contour maps give all important information regarding the relief features and terrain of the forest tract, whether flat, undulating, hilly, etc.

- They help the forester, engineer, and surveyor in the selection of suitable sites for the layout of roads, irrigation channels, reservoirs, nurseries, soil conservation works, plantations, etc.
- Quantities of earthwork, cut and fill, involved in various engineering projects can be computed from a contour map.
- With the help of a contour map, the boundaries of a drainage basin (Watershed) can be determined.
- The capacity of a reservoir for irrigation purposes and water supply can be estimated.

IFoS 2020 : Construction and maintenance of forest roads can be considered as an essential investment of forest growth. Comment [**Paper – 2** | 8 m].

FOREST Road is an open and wide way connecting one place to another and makes it easy to move vehicles and people. If these roads are constructed in or around the forest areas, they are called Forest roads.

The construction and maintenance of forest roads can indeed be considered essential investments in promoting the growth and sustainable management of forests.

- Access to Resources.
- Research and Monitoring- Forest roads provide access for researchers and forest managers to study and monitor various aspects of the forest, including wildlife populations, vegetation, and climate.
- Recreation and Tourism- Forest roads offer recreational opportunities such as hiking, biking, and wildlife viewing.
- Environmental Considerations.
- Proper management of pooching, illicit felling, forest fire and forest boundary.
- Silvicultural Operations- Forest roads are used to transport equipment and supplies needed for silvicultural treatments.
- Regulatory Compliance.

IFoS 2019 : Explain concrete and write the characteristics of good concrete mixture [**Paper – 2** | 10 m].

Concrete is a mixture in which a paste of binding material and water binds fine and coarse material known as aggregates into a rock-like mass as the paste hardens through

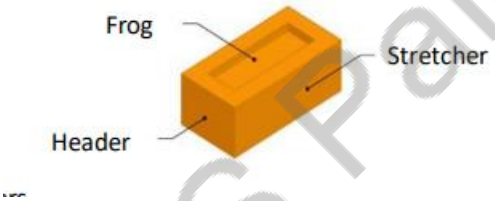
the chemical action of binding material and water. The binding material may be cement, lime or Surkhi

Characteristics of good concrete mixture

- It has high compressive strength and varies with the grade of concrete.
- Tensile strength is less.
- It hardens with age, and the rate of hardening decreases after it has attained adequate strength.
- During the process of hardening, it shrinks due to the loss of water.
- It is not impervious perfectly unless formed with special additives.
- It is free from corrosion.
- It can sustain all the normal atmospheric effects.
- It forms a hard surface, which is capable of resisting abrasion.
- It has fire resistance capacity.
- It is more economical and highly durable

IFoS 2019 : What is brick? Describe different types of bricks giving their characteristics [**Paper – 2** | 10 m].

Artificial block of burnt clay is called bricks. Which is used for building purposes.

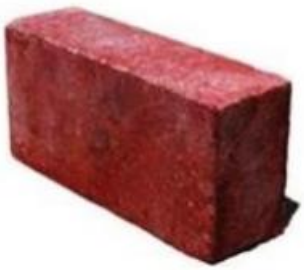


Bricks are broadly classified into two broad categories

A. Sun-dried bricks
B. Burnt bricks

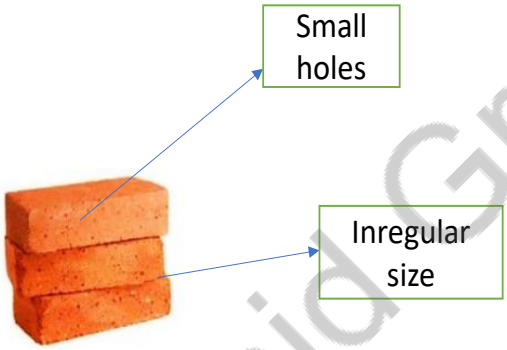
Furthermore, burnt bricks classified into four types, with its own characteristics

1. **First Class Bricks:** Bricks have standard dimensions (19 × 9 × 9 cm) with sharp edges, uniform colour, even surface, correctly burnt, hard and free from Salt deposits and cracks.
    - A metallic sound is produced when they forcefully collide with each other.
    - These bricks are used for superior quality work and work of a permanent nature.

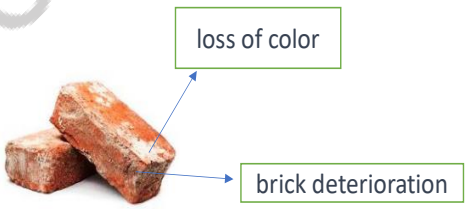


First Class Bricks (deep red)

2. **Second Class Bricks:** They may have a slight irregularity in size, shape, colour or may have slight cracks.
   - These bricks are hard and are correctly burnt.
   - Used in areas where brick masonry is to be plastered.



3. **Third Class Bricks:** They are not fully burnt bricks. They are Irregular edges with less sharpness, uneven surfaces.
   - Hardness is lower compared to first-class bricks and second-class bricks.
   - It does not create a metallic sound.
   - Used in unimportant and temporary constructions.



4. **Fourth Class Bricks:** They are either over burnt or under burnt with irregular shapes, edges and surfaces
   - These are used as aggregates for concrete in road, floor and foundation construction.

Fourth Class Bricks

IFoS 2018 : What is the importance of surveying in forestry? Discuss different methods of surveying to solve the forestry field problems [**Paper – 2** | 8 m].

Surveying is the art of determining the relative positions of different objects on the earth's surface by measuring the horizontal distances between them and preparing a map to any suitable scale.

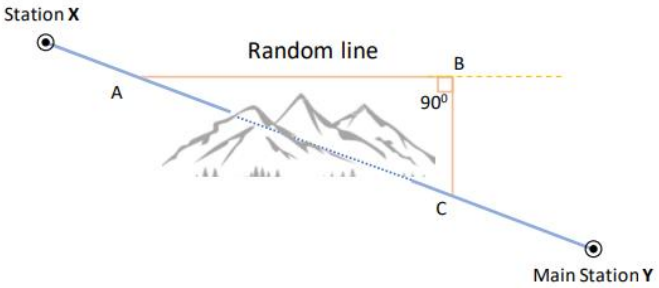
Surveying plays a crucial role in forestry for various reasons

- Inventory and Assessment
- Resource Management
- Forest Planning
- Fire Risk Assessment
- Carbon Sequestration
- Infrastructure Development
- Legal and Regulatory Compliance

Methods of surveying to solve the forestry field problems

1. By chain survey -there are three type obstacles (forestry field) in chain survey.

   A. When chaining is free, but vision is obstructed - Such a problem arises when a hill or a Forest area (dense plantation) interrupts the chain line. Here the end stations are not intervisible from the intermediate points.

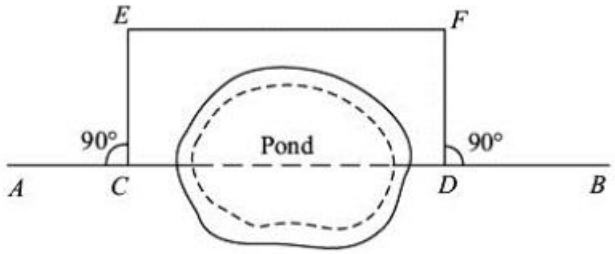


$(AB)^2 = (AC)^2 + (CB)^2$

AB = $\sqrt{AC + CB}$

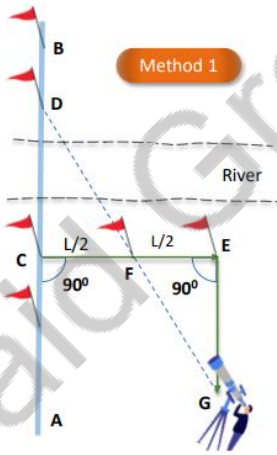
B. When chaining is obstructed, but vision is free - Such a problem arises when a pond or a river comes across the chain line

CASE – 1 : when a pond interrupts the chain line, it is possible to go around the obstacle



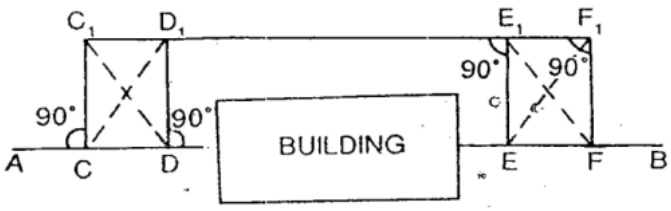
CD = EF

CASE – 2 : When a river interrupts the chain line



$\frac{CD}{CF} = \frac{GE}{EF}$, here CF = EF, as the point F is fixed at the mid-point of the line. Therefore, CD = EG.

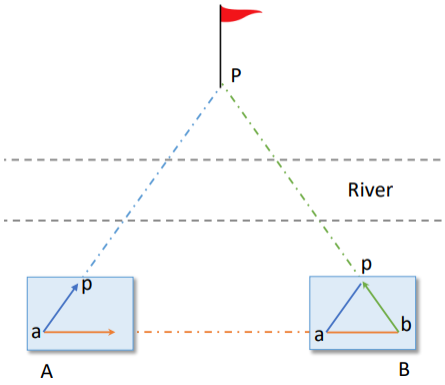
C. When both chaining and vision are obstructed- Such a problem arises when a building comes across the chain line.



$DE=D_1E_1$

2. By Plane table surveying is a graphical method of survey in which the field observations and plotting are done simultaneously. A plane table survey does not involve the use of a field book.

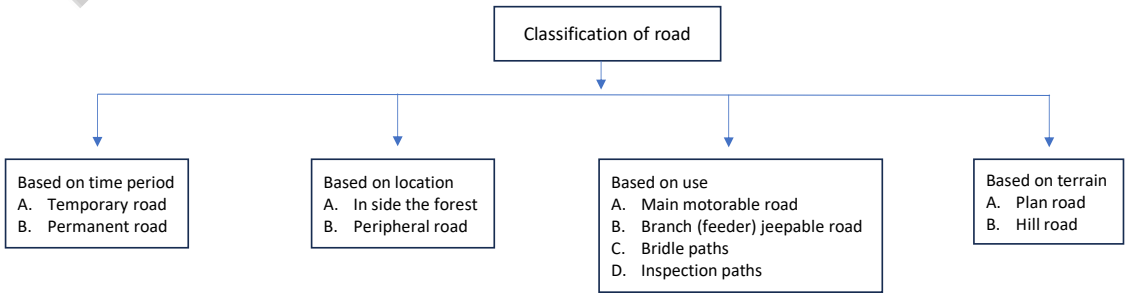
- Suppose A and B are two stations and P is an object on the far bank of a river. Now it is required to fix the position of P on the sheet by the intersection of rays drawn from A and B.



- The table is set up at A. It is levelled and centered so that a point a on the sheet is just over station A. The north line is marked on the right-hand top corner. The table is then clamped.
- With the Alidade touching a, the object P and the ranging rod at B are bisected, and rays are drawn through the fiducial edge of the Alidade.
- The distance AB is measured and plotted to any suitable scale to obtain point b.
- The table is shifted and centered over B and levelled properly. Now the Alidade is placed along with the line ba, and orientation is done by back-sighting. At this time, it should be remembered that the centering, levelling, and orientation must be perfect simultaneously.
- With the Alidade touching b, the object P is bisected and a ray is drawn. Suppose this ray intersects the previous ray at a point p. This point p is the required plotted position of P

IFoS 2018 : Give the classification of forest roads. What features are required for a reconnaissance for forest roads? [**Paper – 2** | 8 m].

FOREST Road is an open and wide way connecting one place to another and makes it easy to move vehicles and people. If these roads are constructed in or around the forest areas, they are called Forest roads.



Features that should be considered during a reconnaissance survey to construct a forest road

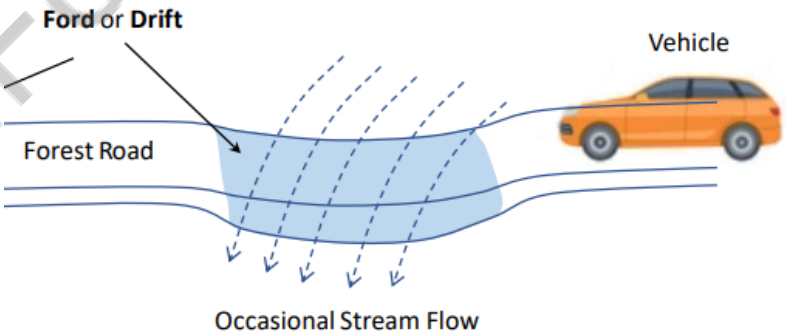
- Obstacles from which road will pass away, i.e., ridge, steep, river valley, etc
- Rough elevation of the hills, saddles, passes, valleys, and the other important geographical positions and locations like water holes, wells, and rivers.
- Among the number of routes that have been selected.
- Climate and precipitation regime.
- Environment & Social impact on the proposed location.
- Rough elevation of the hills, saddles, passes, valleys, and the other important geographical positions and locations like water holes, wells, and rivers.
- Among the number of routes that have been selected.
- Climate and precipitation regime.
- Environment & Social impact on the proposed location.

IFoS 2018 : Define bridge and explain different types of bridge with sketches [**Paper – 2** | 8 m].

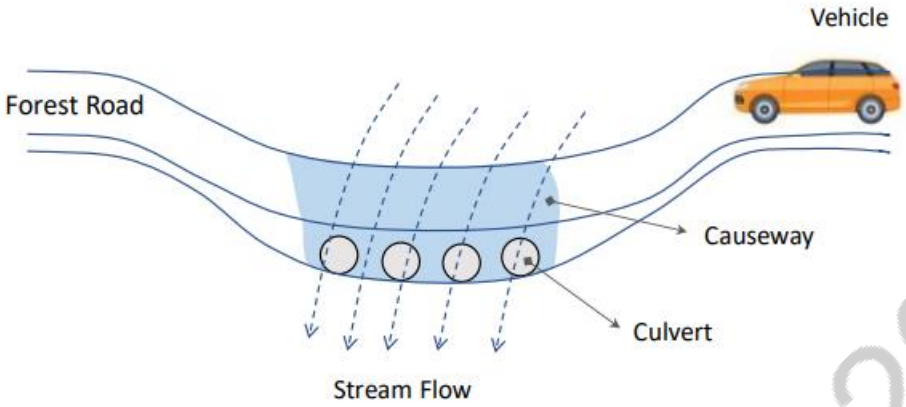
A bridge is a structure built to cross a gorge, valley, road, railroad track, river, body of water, or any other physical obstacle to provide passage over the barrier. Designs of bridges will vary depending on the function of the bridge and the nature of the terrain where the bridge is to be constructed

Types of bridge

- **Fords or Drifts** - A Ford is a concrete pad in a riverbed that provides a firm place to cross a dry or low-flow river. Here, a river/stream bed serves as a carriageway, all potholes on the bed are filled, and the bank of the stream is cut down to provide a gentle slope for the vehicles



- **Causeways, Culvert Drifts or Submersible Bridges** -Designed in such a way that during the normal dry season, the river flow goes through culverts under the roadway, and during floods, it also flows through culverts and over the road.



- **Irish Bridge or paved ford** -This is a paved dip surface of stones or bricks which is built only where there is a low water level and has a span of 7 m or more.

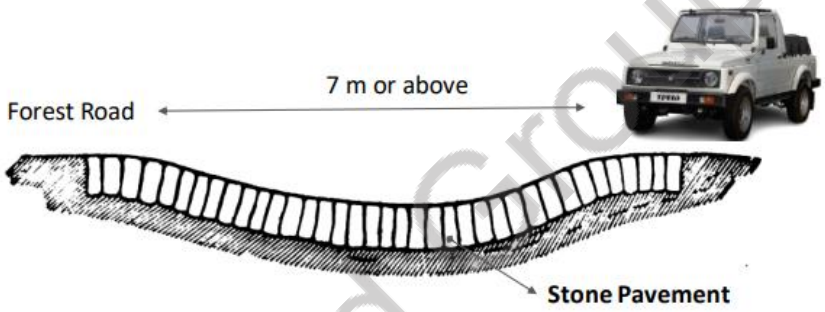


Figure : Irish Bridge or paved ford

- Road Dam : Small dam that is constructed for crossing small shallow streams.
- Suspension Bridge : bridges of this type are constructed over large openings that do not permit to erect of intermediate piers due to swift water or any other reasons. The main footing of the bridge is suspended in the air by iron cables.

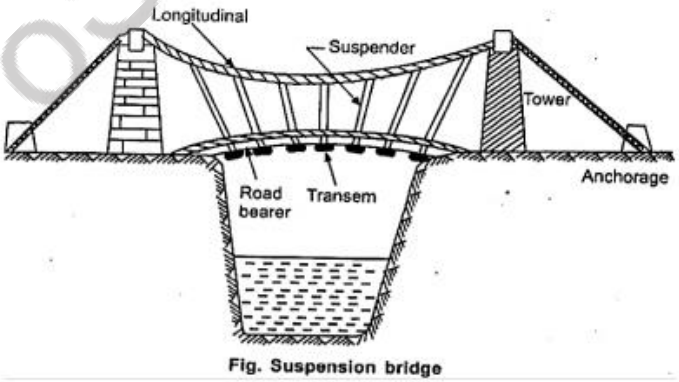
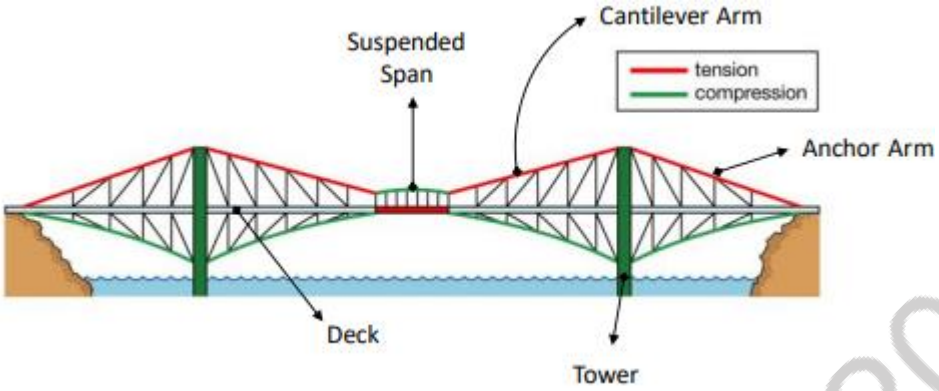
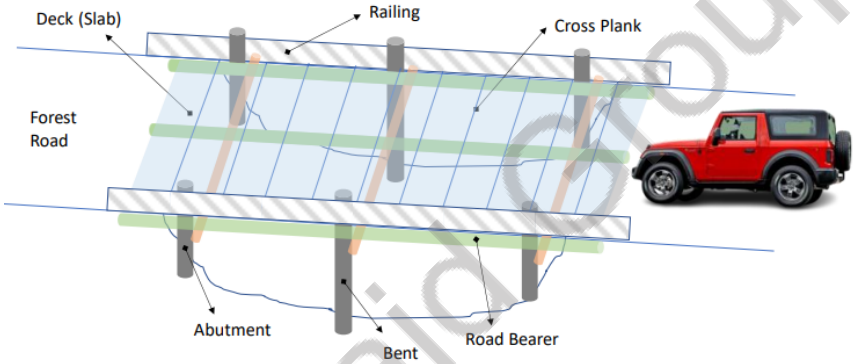


Fig. Suspension bridge

- CANTILEVER BRIDGE : the bridge is made up of two systems of counterpoised beams built out from the abundant supporting the road bearers in the middle. Here the span gap should be shorter when both parts are connected.



- **Simple Wooden Bridge** : made up of wholly or partly of timber poles and strengthened by iron cables. This bridge can be used only up to a 6-meter span, as beyond that span, they become bulky.



IFoS 2015 : Give a list of Survey methods adopted in Forest. Describe the survey of forest when a river comes in the way of Survey line [**Paper – 2** | 15 m].

Surveying is the art of determining the relative positions of different objects on the earth's surface by measuring the horizontal distances between them and preparing a map to any suitable scale.

Different method of surveying

A. Chain survey

B. Compass surveying

C. Plan table surveying

➢ **Chain survey-** Chain surveying is the method of land surveying in which only linear measurements are taken with the help of a chain and no angular measurements

are recorded. The principle of chain surveying is **Triangulation**. Tie lines and check lines control the accuracy of work.

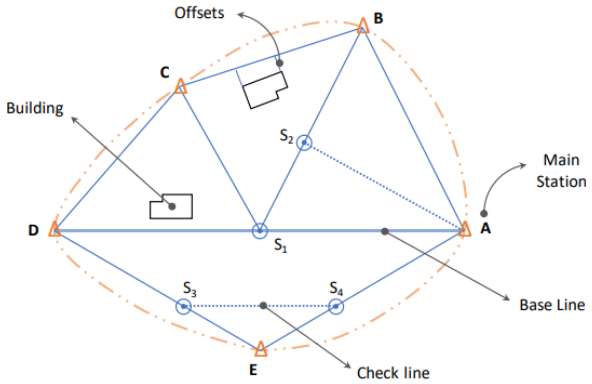


Figure : A network of triangles

- **Compass surveying -** Compass surveying is a type of surveying in which the directions of surveying lines are determined with a magnetic compass, and the length of the surveying lines is measured with a tape or chain, or laser range finder.it is based on principle of **Traversing.**
- **Plan table surveying -** Plane table surveying is a graphical method of survey in which the field observations and plotting are done simultaneously.it is based on the principle of **Parallelism**. A plane table survey does not involve the use of a field book. There are four methods of plane tabling
  a. Radiation
  b. Intersection
  c. Traversing
  d. Resection

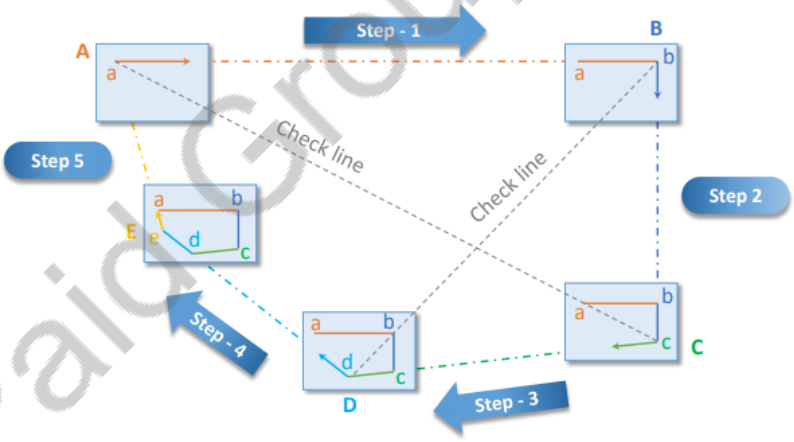
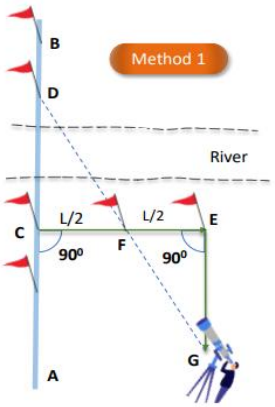


Figure : Plain tabling by Traversing

When a river comes in the way of Survey line

- **CHAIN SURVEYING** –
  - Imagine a small river comes across the chain line.
  - Suppose AB is the chain line. Two points C and D are selected on this line on opposite banks of the river.
  - At C, a perpendicular CE is erected and bisected at F.

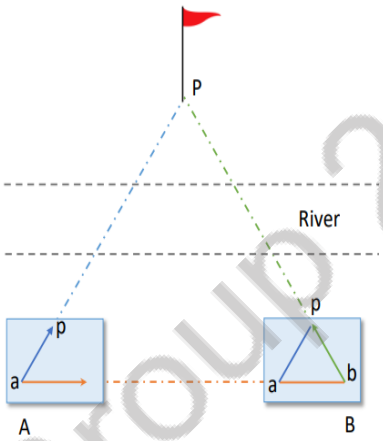


- A perpendicular is set out at E, and a point G is so selected on it that D, F, and G are in the same straight line.
- From triangles DCF and GEF,

  $\frac{CD}{CF}=\frac{GE}{EF}$, here CF = EF, as the point F is fixed at the mid-point of the line.

  Therefore, CD = EG. This distance GE is measured, and thus the distance CD is obtained indirectly.

➢ **Plan table surveying-** When a river comes in the way of Survey line. We mainly used Triangulation method of plan table surveying.



- Suppose A and B are two stations and P is an object on the far bank of a river. Now it is required to fix the position of P on the sheet by the intersection of rays drawn from A and B.
- The table is set up at A. It is levelled and cantered so that a point a on the sheet is just over station A. The north line is marked on the right-hand top corner. The table is then clamped.
- With the Alidade touching a, the object P and the ranging rod at B are bisected, and rays are drawn through the fiducial edge of the Alidade.
- The distance AB is measured and plotted to any suitable scale to obtain point b.
- The table is shifted and cantered over B and levelled properly. Now the Alidade is placed along with the line ba, and orientation is done by back-sighting.it should be remembered that the centring, levelling, and orientation must be perfect simultaneously.
- With the Alidade touching b, the object P is bisected and a ray is drawn. Suppose this ray intersects the previous ray at a point p. This point p is the required plotted position of P

5

Chapter

FOREST MENSURATION

IFoS 2022 : Explain (i) Artificial Form Factor, (ii) Absolute Form Factor, (iii) Normal Form Factor, and (iv) Form Quotient [**Paper – 2** | 8 m].

Form factor is the ratio of the volume of a tree or its part to the volume of a cylinder having the same length and cross-section as the tree.

Form factor (F) = $\frac{V}{sh}$

(i) Artificial Form Factor : The basal area is measured at Breast height and the volume refers to the whole tree both above and below the point of measurement.it is also called a breast hight from factor.

- University accepted and most commonly used form factor.

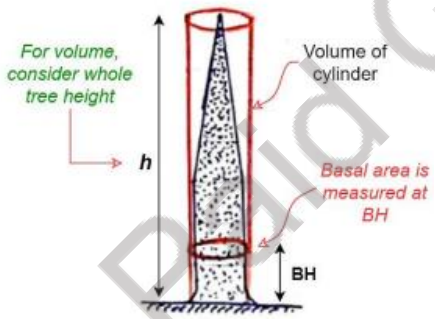


Figure : Breast height form factor.

(ii) Absolute Form Factor : The basal area is measured at any conventional height and the volume considers only above that point of measurement.

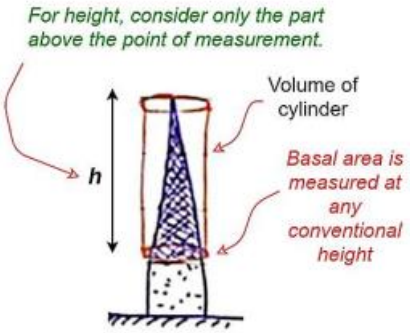


Figure : Absolute form factor.

(iii) Normal Form Factor : The basal area is measured at a specific proportion of total height 1 /10th, 1/20th of total height, and for the volume, we consider the whole tree above ground level. It is also called a true from factor.

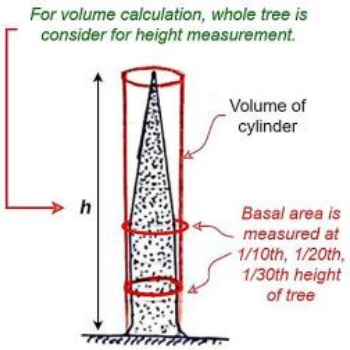


Figure : True form factor

(iv) From Quotient : It is the ratio between the mid-diameter and the dbh.

FQ = $\frac{Mid\ dimeter}{dbh}$

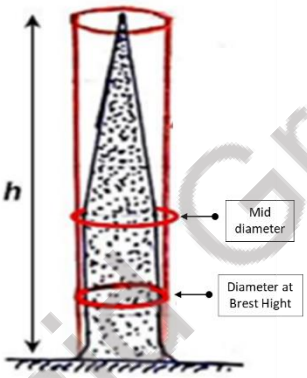


Fig : From quotient

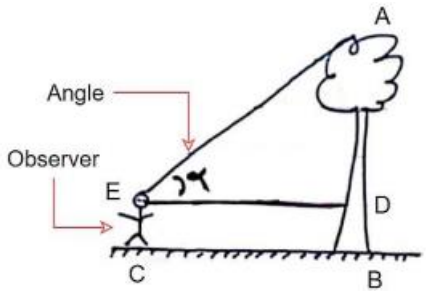
IFoS 2022 : Describe the tangent method used to calculate height of trees on (i) Level ground, and (ii) Sloping ground [**Paper – 2** | 15 m].

The tangent method is primarily associated with trigonometric functions (tangent function), The tangent of an angle in a right triangle is defined as the ratio of the length of the side opposite the angle to the length of the side adjacent to it. Indian forestry based on the trigonometric principle. Once modern digital technology begins to take hold in this area, Mathematically, it's expressed as

$$Tan\theta = \frac{opposite}{adjacent}$$

Instruments based on this principle are – Brandis Hypsometers, Abney level, Hega altimeter, Blume-Leiss hypsometer, Spiegel relascope, Suunto Clinometers, Electric clinometer.

(i) Level ground: Where the observer is standing at level Ground. The observer's height is represented by 'EC,' and the tree heights are represented by 'AB. First, we see a tree stem in the line of sight, which intersects the tree stem at point D So EC=BD. Then observe see a top of tree and calculated the angle.



AB = AD + DB

By tangent function in triangle EDA

Tan α = $\frac{AD}{ED}$

So AD = ED tan α

AB = ED tan α + EC

Because ED = CB and DB = EC,

AB = BC tan α + EC

(ii) Sloping ground:

- On sloping ground, where the observer is standing at such a place that the top of the tree is above the eye level and the base below it. Tree heights represent by AB. First, we see a tree stem in the line of sight, which intersects the tree stem at point D. Then observe see a top of tree and calculated the angle. Then after measures a angle with base.

  AB = AD + DB

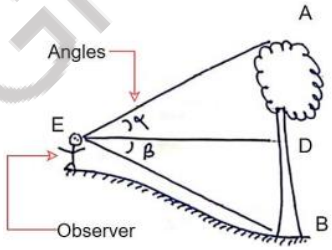
  By tangent function in triangle EDA and EDB

  Tan α = $\frac{AD}{ED}$, tan β = $\frac{BD}{ED}$

  So AD = ED tan α, BD = ED tan β

  AB = ED tan α + ED tan β

  AB = ED (tan α + tan β)



  But we know that measuring ED is difficult, but we can be measure EB,

  AB = EB cos β (tan α + tan β)

- On sloping ground, where the base and top of the tree are below the eye leve. Tree heights represent by AB First, we see a tree stem in the line of sight, which intersects the tree stem line at point D. Then observe see a top of tree and calculated the angle. Then after measures a angle with base.

  AB = DB – AD

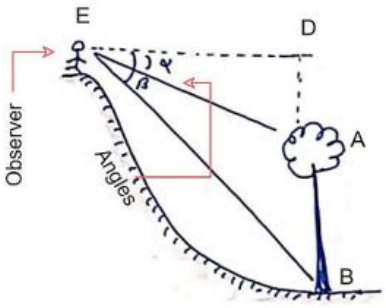
  By tangent function in triangle EDA and EDB

  Tan α = $\frac{AD}{ED}$, tan β = $\frac{BD}{ED}$

  So AD = ED tan α, BD = ED tan β

  AB = ED tan β – ED tan α

  AB = ED (tan β –tan α)



Here we know that it is not possible to measure ED, but we can measure EB,

∴ AB = EB cos β (tan β – tan α)

- On sloping ground, where the top and base of the tree are above the eye level

AB = AD – BD

By tangent function in triangle EDA and EDB

Tan α = $\frac{AD}{ED}$, tan β = $\frac{BD}{ED}$

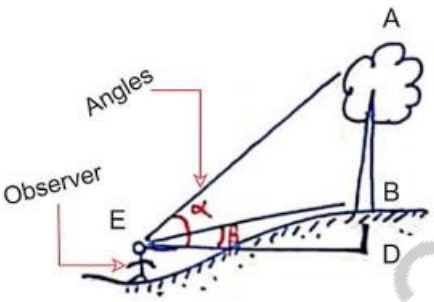
So AD = ED tan α, BD = ED tan β

AB = ED tan α – ED tan β

AB = ED (tan α – tan β)

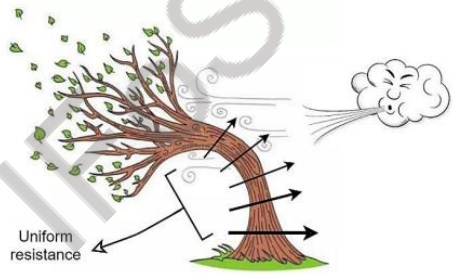
Here we know that it is not possible to measure ED, but we can measure EB,

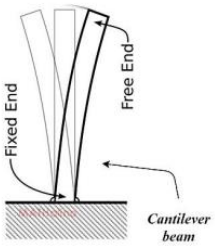
∴ AB = EB cos β (tan α – tan β)



IFoS 2019 : Explain Metzger's theory of tree form and its significance in volume calculation [**Paper – 2** | 8 m].

Metzger proposed that the tree stem should be considered as a cantilever beam of uniform resistance against the bending force of the wind, anchored at the base and functioning as a lever arm. Horizontal wind pressure will exert a strain on the crown that increases toward the point of anchorage, and if the beam is composed of homogeneous material, the most economical shape would be a beam of uniform taper. Corresponding growth material is also lower. A tree growing in complete isolation has a larger crown and is subjected to the most lateral wind pressure. Therefore, it should allocate most of the growth material towards the base, even though it may have to be done at the cost of height growth. In dense conditions less wind pressure and have long and nearly cylindrical boles.





Significance in volume calculation

- Simplified Volume Estimation : Viewing the tree as a uniform tapering beam simplifies the process of estimating its volume.
- Consistency in Measurement : A uniform taper in the stem provides a more consistent and predictable basis for volume calculation.

- A uniform taper helps in quickly and accurately estimating the volume of timber resources.

IFoS 2019 : Describe the procedure for estimating the volume of standing and felled tree [**Paper – 2** | 8 m].

OCULAR ESTIMATION : Experience person can make a relatively accurate estimation of the volume of a standing tree.

- DIRECT METHODS : the diameters of the tree at different heights are measured by a man climbing the tree with the help of a ladder, and then the volume will calculate by using the following methods.
  (i) Standard section method
  (ii) Gray's taperline method

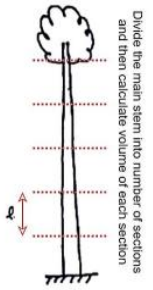
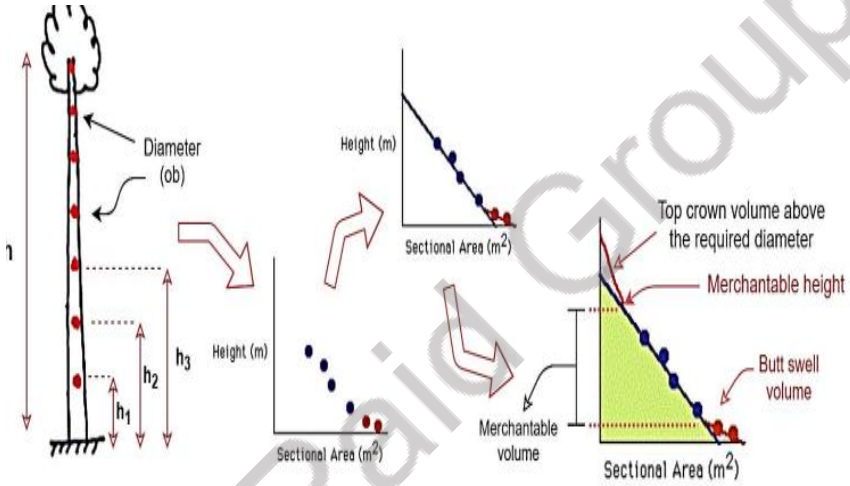
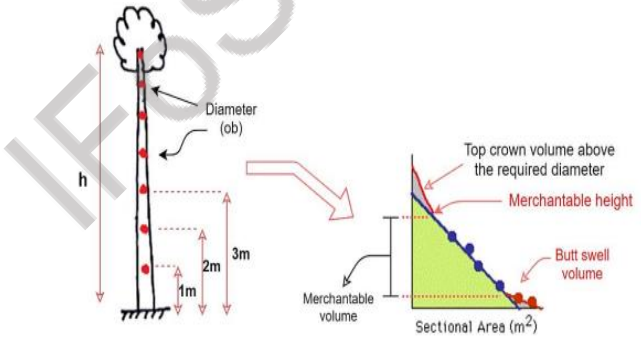


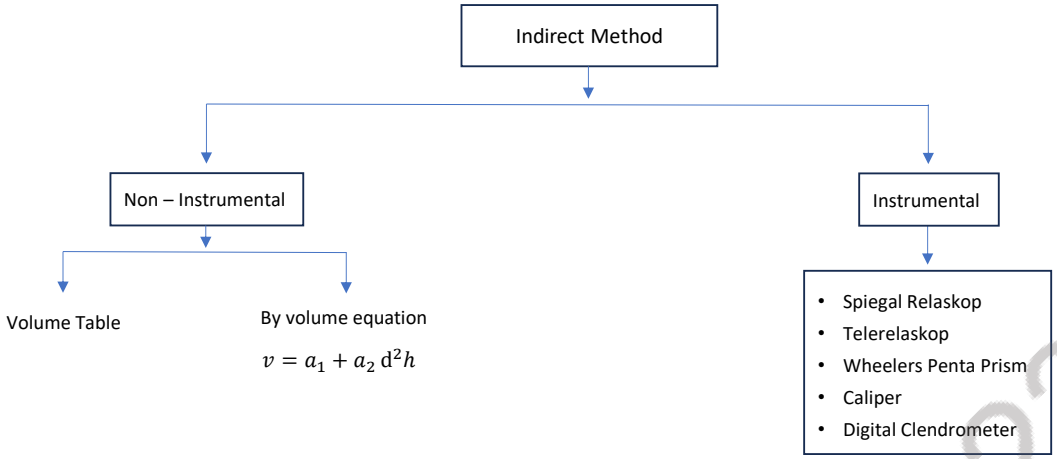
Figure : Standard section method



(iii) Graphical method :

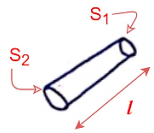
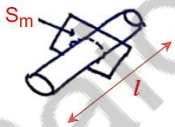
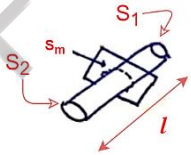
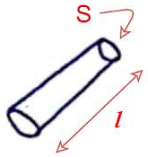
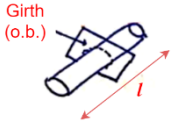


- INDIRECT METHODS –



Procedure for estimating the volume of felled tree

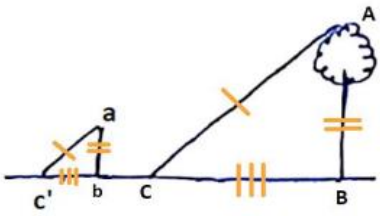
The shape of felled log volume may be : Cylindrical, Paraboloid, Cone, or Neiloid, and they may be scatted on the ground or stocked during measurement.

SN	Method	Point of measurement	The volume of a frustum of solid	Applicability	Remarks
1.	***Smalian's*** formula		$V = \frac{S_1 + S_2}{2} \times l$ *l = Log length* *S = Cross-section area*	For solids of *Paraboloid* shape.	Only ends diameter are required.
2.	***Huber's*** formula		$V = S_m \times l$ Where, S_m = Cross-section area at log mid-point	*Paraboloid* shape	Difficult to measure S_m in stock condition
3.	***Newton's*** formula or ***Prismoidal*** method		$= \frac{S_1 + 4S_m + S_2}{6} \times l$	*Neiloid* shape	Most accurate method
4.	Small end diameter		$V = S \times l$	*Cylinder*	Only one diameter is required for measurement.
5.	***Quarter girth*** formula		$V = \left[\frac{g}{4}\right]^2 \times l$		Known as *Hoppus rule* in Britain.

IFoS 2019 : Explain the principles of the height measuring instruments giving suitable examples [**Paper – 2** | 10 m].

The height of a tree is the measurement of the vertical distance from the base of the tree to the top of the tree.

- Based on the principal of similar triangle : Two triangles are said to be similar if their corresponding angles are congruent and the corresponding sides are in proportion.



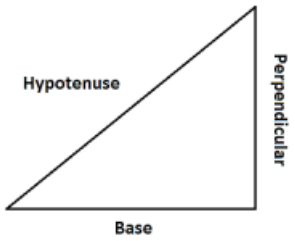
In triangle abc and ABC

$$\frac{AB}{ab} = \frac{BC}{bc'}$$

Therefore, AB= $\frac{BC \times ab}{bc'}$

1. The basic assumption in applying these principles for tree height measurements are : (a) the tree is vertical and (b) the tip and the base of the trees are simultaneously visible.
2. Instruments based on this principle are : Christen hypsometer, Smythies hypsometer, and Improvised caliper.

- Based on Trigonometric principles : Trigonometric principles can be applied to estimate the height of a tree when you have a clear line of sight to the top of the tree and can measure the horizontal distance from your location to the base of the tree. In a right-angled triangle, the trigonometric ratios for an ∠ABC will be.



Sin θ = $\frac{\text{Perpendicular}}{\text{Hypotenuse}}$

Cos θ = $\frac{\text{Base}}{\text{Hypotenuse}}$

Tan θ = $\frac{\text{Perpendicular}}{\text{Base}}$

Instruments based on this principle are Brandis Hypsometers, Abney level, Hega altimeter, Blume-Leiss hypsometer, Spiegel relascope, Suunto Clinometers, Electric clinometer.

IFoS 2019 : What is point sampling? How is it helpful to find out the basal area of a forest? [**Paper – 2** | 15 m].

Sampling is the process in which enumeration is to be done only in a representative portion of the whole area.

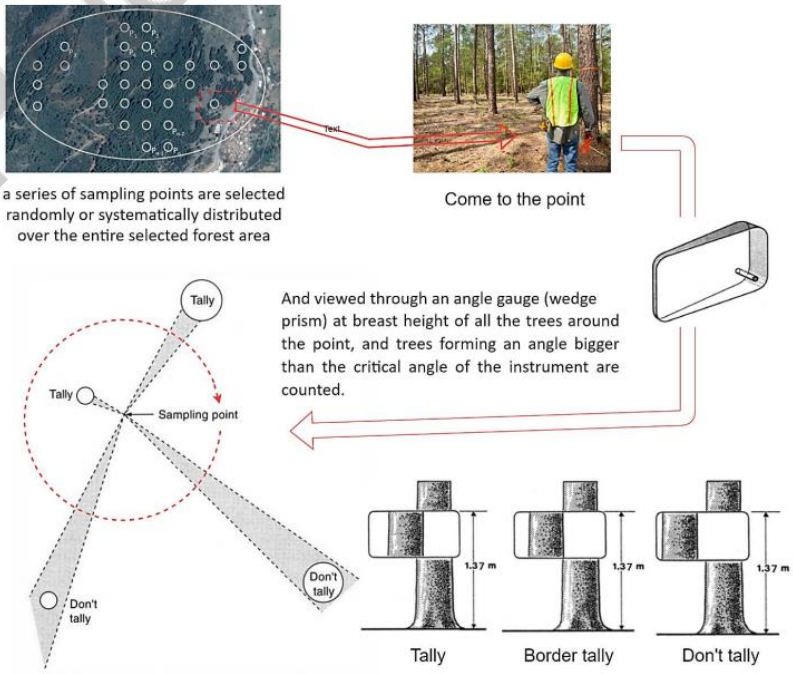
Point sampling is a method of quickly estimating basal area per hectare directly by standing at a point to selecting trees on the basis of their size rather than by their frequency of occurrence through using angle gauge or wedge prism of known basal area factor (BAF).

There are two type of point sampling

- Horizontal point Sampling : Given by Bitterlich, and useful in the estimation of basal area or diameter.
- Vertical point Sampling : Given by Hirata, and useful for Tree height measurement.

Process to find the basal area

- A series of sampling points are selected randomly or systematically distributed over the entire area.
- Trees around these points are viewed through an angle gauge (wedge prism) at breast height and all trees forming an angle bigger than the critical angle of the instrument are counted.
- All the trees are of the same basal area, some are counted in the tally while others are not because being far away from the sampling point they did not form an angle higher than the critical angle of the instrument.
- On the other at the same distance from the sampling point, a bigger tree is counted while a smaller tree is not.
- The inclusion of trees in the tally for a given angle depends upon the sizes of trees and their distances from the observer or sampling point.



- The number of trees counted when multiplied by a constant factor, which depends only on the angle's size, gives the basal area per ha.
- It means that each tree counted regardless of its DBH represents the same basal area per ha.

Basal area per hectare

Basal area per hectare = basal area factor (F) × number of tally trees (n)

For calculating basal area factor (F) –

F = Basal area of tree ×Factor to convert it to per hectare basis

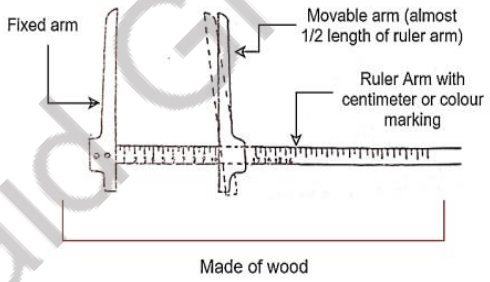
$F = \text{Basal area of tree} \times \frac{\text{Are of 1 hectare}}{\text{Area of circular plot}}$

$F = \frac{K2}{4} \times \frac{10,000}{1}$

$F = 2500\ k^2$

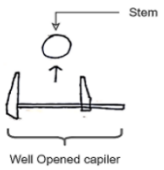
IFoS 2018 : What are the precautions required for diameter measurements with calipers ? Discuss the errors that occur due to non-observation of the precautions [**Paper – 2** | 15 m].

Diameter measurements play a important role to estimate the quantity of timber, firewood, and other forest produce, and Measure the rate of tapering. The calipers consist of a graduated rule and two arms. A fixed arm is attached at a right angle to one end of the rule, while the other is movable along with it

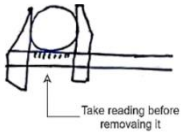


Precautions during use of calliper

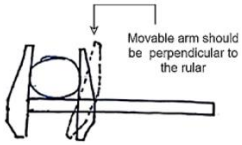
- The caliper must be placed on the tree with a well-opened movable arm and must not be forced on the tree.



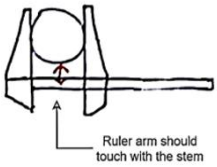
- Reading must be taken before removing the caliper.



- If the stem cross-section is elliptical, the two diameters must be measured in the proper orientation.



- The caliper must be placed at the right angle to the axis of the trees.



- Both arms and ruler must be in touch with the stem, and the movable arm should be perpendicular to the stem.

Errors that occur due to non-observation

- Parallax Error : The most common errors. This happens when the user's line of sight is not perpendicular to the caliper scale.
- Instrument Calibration : Calipers lose their accuracy, and not calibrating them lead to incorrect measurements.
- Proper Zero Setting : For digital calipers, ensuring that the zero point is correctly set at the beginning of each measurement is essential.
- Cleanliness and Lubrication : Dust, debris, or contamination on the caliper's measuring faces can lead to errors.
- Incorrect Measurement Position : Calipers should be positioned perpendicular to the surface being measured to obtain accurate results.
- Instrument Wear and Tear : Wear and tear affect their accuracy, and regular maintenance or replacement is necessary to prevent errors.

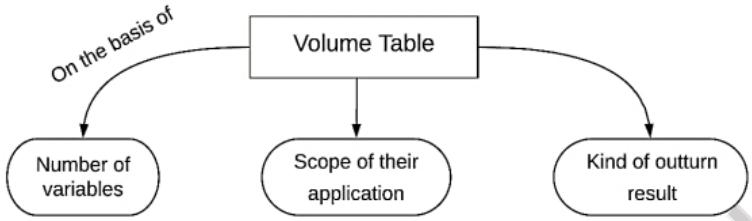
IFoS 2018 : Define volume tables and give their classification [**Paper – 2** | 10 m].

A table showing the average volume of tree logs or sawn timber of a given species, based on different variables.

These variables may be –

- DBH alone – easier to prepare and use but not accurate.
- DBH and height
- DBH, height, and tapering – most accurate but very difficult to prepare.

Classification of volume table



- **On the basis of Number of variables**
  - Volume table based on single variable : these volume tables show the average volume of trees by diameter classes.
  - Volume table based on two variables : These volume tables give volumes of trees by diameter classes as well as by height classes. It is based on two variables so applied to a larger area is also called the General volume table.
  - Volume table based on three variables: It is based on diameter, height, and form quotient. Thus are the most accurate but difficult to prepare and time-consuming. Not prepare in India.
- **Classification based on the scope of application**
  - General volume tables : These volume tables are based on the average volume of trees growing over a large geographical area, and generally based on two variables, DBH and tree height. Types Standard volume table, Commercial volume table,
  - Regional volume tables : These volume tables prepared from measuring trees growing in a region and therefore have limited application.
  - Local volume tables : Volume tables are prepared from the measurement of trees growing in the restricted locality.
- **Classification on the basis of the kind of outturn**
  - Commercial volume tables : These volume tables give us the volume of timber that we gain after putting the diameter of thin end and log length data. The

outcome volumes may vary from industry to industry as per their level of capability to utilize it.

- Standard volume tables : These volume tables give us the volume of standard size timber, from ground level to 20 cm diameter
- Sawn outturn tables : These volume tables show the data of sawn timber volume.
- Assortment tables.
- Sawn outturn assortment table.

IFoS 2018 : Define forest sampling. Give advantages of sampling Discuss different types of non-random sampling methods used in forestry [**Paper – 2** | 15 m].

Forest Sampling is the process in which enumeration is to be done only in a representative portion of the whole area. This representative portion of the forest area called sample plot.

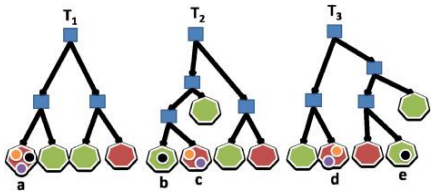
➢ **Advantages of sampling:**

- Frequently determine the volume of timber growing in the forest .
- Estimating the return to be expected from clear-felled coupes.
- Determine the current periodic annual increment.
- Prepare map of area showing regions of high or low volume production per unit of area and confirm the supply information of forest-based industries.
- Required to assess the feasibility of a project from economic, social, or any other considerations.
- Cost benefit is more compare to other method of enumeration.

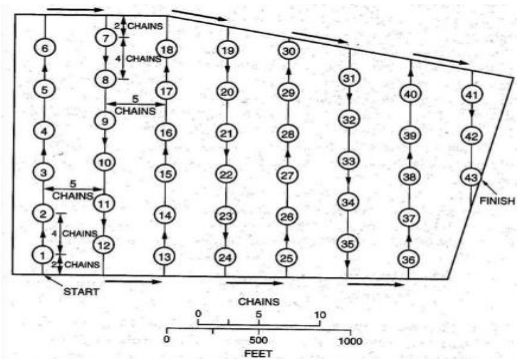
Non-Random Sampling : Methods of sampling in which 'samples are selected according to the subjective judgment of the observer' on the basis of specific rules/guidelines indicating what sample should be chosen.

Type of non-random sampling

1) Selective Sampling : Choosing samples according to the subjective judgment of the observer. Selective sampling may give good approximations of population parameters if it is properly used by a persons with intensive knowledge.



2) Systematic Sampling : Sampling units are selected according to a predetermined pattern, i.e., Select saplings to cut after every 3 meters.



3) Sequential Sampling : A non-probability sampling technique wherein the researcher picks a single or a group of subjects in a given time interval, conducts his study, analyses the results then picks another group of subjects if needed and so on.

6

Chapter

FOREST UTILIZATION

IFoS 2022 : Mention any eight specialized uses of wood with examples? [**Paper – 2** | 8 m].

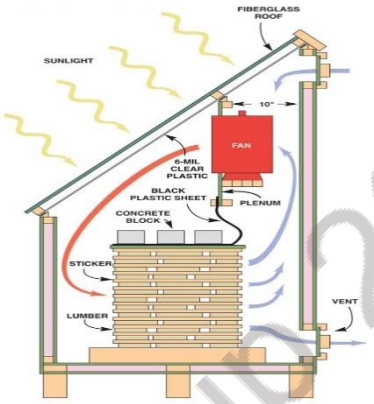
Wood is a hard, fibrous, and porous structural tissue found in the stems and branches of trees and shrubs. It is primarily composed of cellulose, hemicellulose, and lignin.

Specialized uses of wood

- Aircraft industry : It required light wood with straight fibers and great strength, Picea sitchensis, Picea smithiana, Ochroma pyramedelis*** spices are fulfil industry demand.
- Agriculture implements : Strongest, toughest and hardest wood can be suitable to hold pressure developed during uses in bullock carts, Plough, handles, etc. Example : Babool (Acacia nilotica), Xylia xylocarpa, Anogeissus latifolia.
- Battery separators : wood should be light, sufficiently strong, straight grain, and especially free from volatile acids, tannins and resinous material so it couldn't affect electrolytes. Examples : Conifers*** – Abies pindrow, deodar, pines, spruce.
- Boat and shipbuilding : should be strong, elastic, durable and free from defects to stand the enormous strains and marine environment. Examples : Teak*** , Ochroma pyramidalis & Bombax ceiba for life-saving apparatus.
- Furniture: : The essential qualities required are good color, handsome grain or figure, non-liability to crack, split, warp or ease of working and finishing. Examples : Teak, Rosewood, Siris.
- Matchwood industry : required wood should have straightness of grain, good fissility, strength, good white color, freedom from knots, easily peelable, and capacity to absorb paraffin Examples : *Boswellia serrata**** *Populus tremula*, *Ailenthus excelsa, Bombax ceiba* .
- Musical instruments : Teak in harmonium making***, Guitar = Canarium euphyllum, Veena making = Artocarpus heterophyllus.
- Packaging industry : would be light, free from knots and should have straight fibres to provide excellent packaging with not increasing packaging weights. Examples : Conifers

IFoS 2022 : Explain the role of renewable energy sources like solar energy in wood seasoning [**Paper – 2** | 8 m].

Renewable energy sources, such as solar energy and heat generated through Hydro/ Solar /wind electricity or Biomass burning. Can play a significant role in wood seasoning by providing a sustainable and environmentally friendly (Sulpher-free) energy supply for the process.



Solar energy enters the kiln through the fiberglass roof. The sun's radiant energy hits the dark interior and heats the kiln. A timer is set to run the fan from about one hour after sunrise to one hour after sunset. As the kiln heats up during the day, the fan circulates warm air through the lumber stack. A plastic sheet forms a baffle that forces air only through the stack. The moving air picks up moisture from the wet wood and is vented out the back.

Role of renewable solar energy in wood seasoning

- Reduced Environmental Impact : Solar/Hydro.
- Cost Savings.
- Consistency in Energy Supply = Energy security.
- Off-grid Scalability.
- Time/Space saving.
- Energy Efficiency.
- Consistent Drying Conditions.
- Customization.

IFoS 2022 : Trace the History of logging in India. Explain how mechanization in harvesting and extraction helps in reducing the wastage and improving efficacy of logging [**Paper – 2** | 15 m].

Timber extraction history of India was divided into three phases.

Upto year 1860 : Forest clearing and timber extraction was common for fuel and construction purpose. It is largely unorganized. The extraction itself was limited to a few specific species such as Teak, Sal, Sandalwood, and Rosewood (Dalbergia latifolia). Axes served as the primary tools for cutting, resulting in significant wastage.

From 1860 to 2nd World War : The establishment of state forest departments during this era aimed at systematic forest management and conservation.

Post Independence Period : To address timber supply challenges and rising prices, the Indian government sought foreign expertise and established a Logging branch at FRI, Dehradun, in 1957, with a training center in Batote, J&K,

Mechanization in harvesting and extraction plays a crucial role in reducing wastage and improving the efficiency of logging operations

- Precision Cutting = Higher percentage of harvested timber. Minimized wastage during logging, transport and storage.
- Minimizing the chances of damaging the local watershed, ecosystem, surrounding trees, or leaving valuable timber behind.
- Increased Productivity : Machines can fell, delimb, and process trees at a faster rate, reducing the time required for logging operations = reducing per unit production cost.
- Improved working Safety : safety features such as operator cabins and protective guards help mitigate risks associated with logging operations.
- Access to Challenging Terrain : Mechanized logging equipment is designed to operate in difficult terrain, including steep slopes and remote areas.
- Feller buncher machine : A machine for the mechanical felling of trees with a saw device.
- Feller director : A machine for mechanical felling and controlling the direction of felling.
- Feller forwarder : A machine for mechanical felling and transporting = help in reducing wastage during tree felling.
- Chain flail de limber/ de-barker : A machine used for delimbing and debarking a tree.
- Harvestor forwarder : A machine that is designed to fell, delimb, crosscut, and carry tree parts to the landing site

IFoS 2021 : Write the general principles of wood seasoning. How is electrical kiln seasoning advantageous over air seasoning? [**Paper – 2** | 15 m].

Wood seasoning is a method of removal of the moisture that presented in timber in its green state. It reduce the probability of pest attack and increase workability.

➢ **Principles of wood seasoning**

- Temperature : It influences the drying state by increasing the moisture holding capacity of air and accelerating the rate of diffusion of moisture through the wood.
- Relative humidity : Lower RH results in higher drying rates.
- Air circulation : The higher drying rate is obtained by the rapid circulation of air across the surface of the wood.

- Species : Some species dry much faster.
- Initial moisture content : The wood dries at a faster rate when green. The rate decreases with decreases in moisture content under constant drying conditions.
- Grain direction : wood dries much more rapidly in the longitudinal direction than in the transverse direction.
- Thickness : Thicker timber requires more time to reach a given moisture content than the thinner timber.

➢ **Advantages of electrical kiln seasoning over air seasoning**

- Suitable for every type of wood irrespective of its refractory status
- Independent of outside weather condition.
- Require less time in seasoning.
- Require less stacking space.
- More uniform wood seasoning.
- Maximum temperature at which timber can season will be achieved easily.
- It maintains uniform moisture across the wood.
- It can work across 24*7 around the year.
- To save freight weight.
- Green wood which is susceptible to fungus attack can be better seasoned in electrical seasoning than air seasoning.

IFoS 2021 : What are gums, Resins, Oleoresings and gum resings? Classify and give at least two examples under each group [**Paper – 2** | 15 m].

Gum: gums are hydrophilic complex carbohydrate polymers of high molecular weights, generally composed of monosaccharide units joined by glucosidic bonds. They are generally insoluble in oils; and soluble in water.

Classification of gum

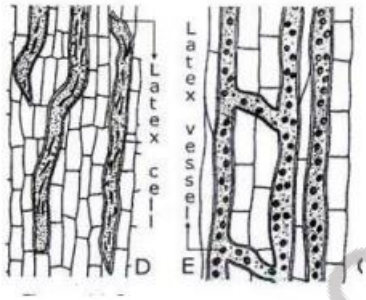
- Exudate gum: Acacia gum (Acacia nilotica, Acacia senegal), ghatti gum (Anogeissus latifolia)
- Plant seed gum: Guar gum (Cyamopsis tetragonolobus)
- Microbial gum: Xanthan gum (Xanthomonas campestris)
- Mucilage gum: Psyllium gum (Plantago ovata)

Resins: Resins are the sticky flammable organic substance that originates through the reduction and polymerization of carbohydrates and normally ooze out through bark, predominantly those of the Pinaceae family and harden on exposure. Insoluble in water. Plants secrete resins for their protective benefits in response to injury. The resin protects the plant from insects and pathogens.

Classification of resin:

- Hard resin: contain no or a tiny amount of essential oil. As they solidify, they become a hard substance that has a high degree of transparency. Amber is a hard resin. E.g., amber
- Oleoresin: contain so much essential oil that they may remain liquid once they're secreted. As a liquid, they have a viscosity resembling honey. If they do solidify, the solid is very soft and breaks easily. Turpentine and balsam are oleoresins.
- Gumresin: it comprised of gum along with resin, also with a small amount of essential oils.

E.g., Gamboge (*Garcinia morella*), Indian belladium(*Commiphora mukul)*



LATEX or **RESIN** canal

IFoS 2020 : What are the recommended practices for strategic harvest planning?
[**Paper – 2** | 8 m].

A Strategic Harvest Plan explains why, where, when, and what type of harvesting is proposed. It cannot be undertaken without considering the issues which affect the management of the forest more widely and should rely upon knowledge of:

- The area of forest that has been zoned for wood, bamboo, or other production Objectives
- Should exclude all areas that as protected for maintaining forest ecosystem, wildlife and endemic species, including buffer zones.
- Local watershed.
- Tribal economy and its level of dependency on the forest.
- Carbon sequestration & REDD+ obligations
- The annual or periodic cut for woody produce.
- The silvicultural system to be applied.

Recommended practices for strategic harvest planning –

- The silvicultural system to be applied, and why.
- An explanation of how harvesting is expected to achieve silvicultural objectives, especially its effect on the next crop.
- A brief description of the types of harvesting equipment to be used in specific felling areas and why these are selected.
- A schedule showing the year when each felling area is to be harvested.

- A summary of special problem areas shown on the strategic harvest plan map, with notes on how these might be overcome.

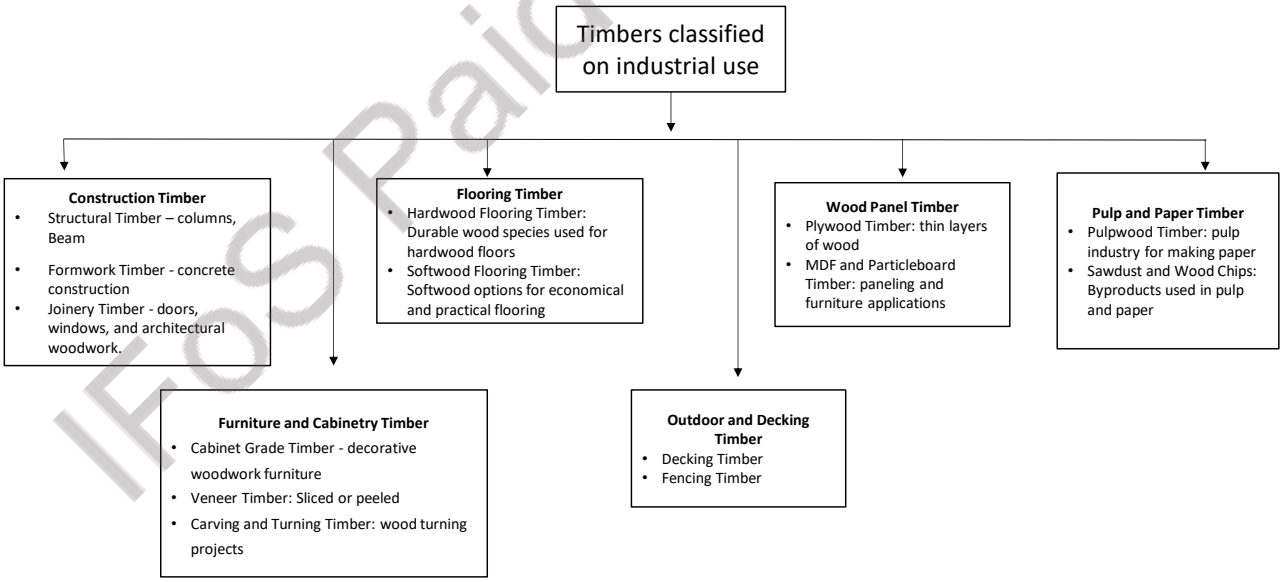
IFoS 2020 : What are the rules laid down for efficient felling? Classify the timbers based on industrial use [**Paper – 2** | 8 m].

Efficient felling, in the context of forestry and logging, refers to the systematic and skillful process of cutting down trees with a focus production of the maximum amount of sound timber, Avoid damage to the surrounding vegetation.

Rules laid down for efficient felling

- Trees should be felled as near the ground as possible.
- Felling direction : in which they will do the least damage to themselves + surrounding vegetation (Young regeneration). In hilly areas felling begin from the top of the slope and proceed toward the downhill direction = the smallest angle to fall + low damage.
- Branchy tree : lopping before felling = minimize damages.
- The tree should not be felled from that place where it is not possible to convert or extract the timber.
- Not felled during Strong wind = Not ensure the fall of trees in the desired direction.

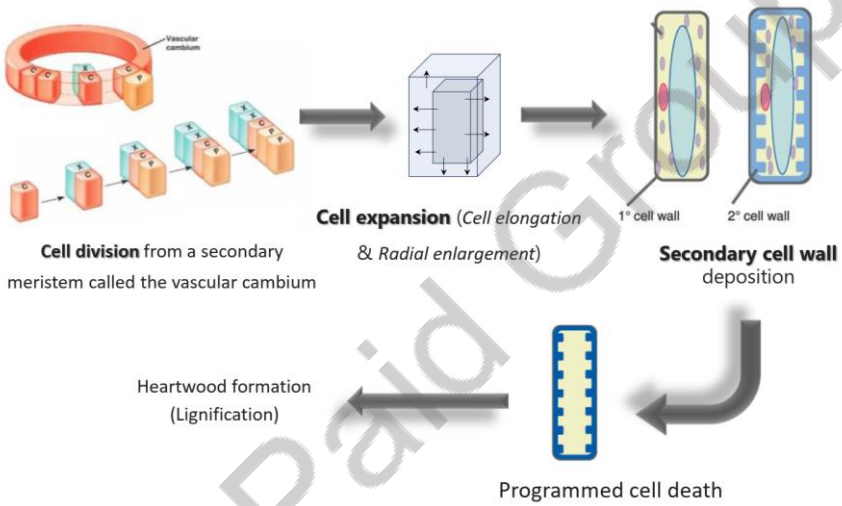
Timbers based on industrial use



IFoS 2020 : Describe the process of wood formation. Write in details about the physical, chemical and mechanical properties of wood [**Paper – 2** | 15 m].

Wood is the porous and fibrous structural tissue found in the stems and roots of plants. It basically comprises cellulose fibers that are strong in tension and embedded in a lignin matrix that resists compression.

Wood formation (Xylogenesis) is a complex biological process, involving five major developmental steps, including (1) cell division from a secondary meristem called the vascular cambium, (2) cell expansion (cell elongation and radial enlargement), (3) secondary cell wall deposition, (4) programmed cell death, and (5) heartwood formation (Lignification).



Properties of wood

(I) Physical Properties: The physical properties of woods refer to the measurable characteristics that describe the behaviour and attributes of wood as a natural material.

- Colour : due to gum, resin, and lignin deposition.
- Odour : Tannins, fatty acids, etc. Act as bearers of scent in wood.
- Lustre : the ability of the cell walls to reflect light.
- Texture : the relative size of cells, large size cells coarse texture v/s small size cell makes smooth texture wood.
- Weight

- Density
- Specific gravity
- Sound
- Heat / Thermal conductivity

(II) Chemical Properties: The chemical properties of wood refer to its composition and reactivity with various substances.

- Major component : Cellulose [$C_6H_{10}O_5$] = 40 to 50 %
- Hemicellulose is another polysaccharide found in wood.
- Decay Resistance.
- Chemical Treatability.

(III) Mechanical Properties: These properties determine the ability of wood to resist various types of external forces acting on it.

- Hardness : The hardness of wood depends upon its anatomical structure.
- Elasticity : Elasticity is the ability of wood to regain its original shape after the external forces are released.
- Elasticity : Elasticity is the ability of wood to regain its original shape after the external forces are released.
- Fissibility : Fissibility is the capacity of wood to be split along the fibers, by means of implements such as an axe or a wedge.
- Strength : the ability of the wood to withstand various stresses such as tension and compression.
- Durability : indicates the service life of the wood

IFoS 2019 : What is Reduce impact logging (RIL) ? What is its composition? Explain the benefits of RIL [**Paper – 2** | 8 m].

Reduced impact logging (Ril) is the intensively planned and carefully controlled implementation of timber harvesting operations to minimize environmental impacts on forest stands and soils. It involves a number of practical measures.

Composition

- Forest organization : Operational plan, compartments, blocks.
- Planning : Pre-harvest inventory and mapping of individual crop trees and terrain. Cutting of vines. Pre-harvest planning and an indication of roads, skid trails, and landings (on maps).
- Pre-harvest activities : Determine the felling direction for each tree based on skid trail layout and environmental guidelines. Mark protected trees (potential crop trees, seed trees) near trees to be felled. Pre-construct skid trails and roads.

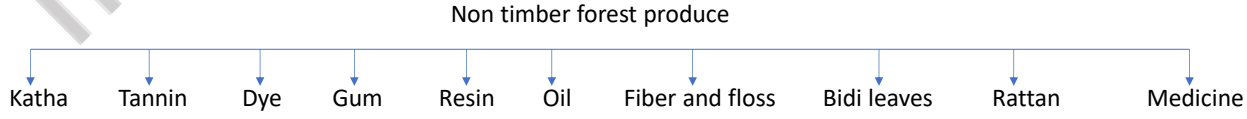
- Harvesting : Use directional felling and proper bucking techniques, to minimize damage to the residual stand, to avoid waste, and to maximize volume and value recovery
- Post-harvest : Restore drainage of this area, conduct post-harvest assessments.

Benefits of RIL

- Pre-harvest Forest inventories and the mapping of individual crop trees
- The pre-harvest planning of roads, skid trails, and landings to minimize soil disturbance and to protect streams and waterways with appropriate crossings
- Pre-harvest vine-cutting in areas where heavy vines connect tree crowns
- The construction of roads, landings, and skid trails in accordance with environmentally friendly design principles
- The use of appropriate felling and bucking techniques, such as directional felling, cutting stumps low to the ground to avoid waste, and the optimal cross-cutting of tree stems into logs in ways that maximize the recovery of useful wood
- The winching of logs to planned skid trails, ensuring that skidding machines remain on trails at all times
- Where feasible, the use of yarding systems that protect soils and residual vegetation by suspending logs above the ground or by otherwise minimizing soil disturbance
- Conducting post-harvest assessments to provide feedback to resource managers and logging crews and to evaluate the degree to which RIL guidelines have been applied.

IFoS 2019 : Define Non-timber forest products (NTFPs). Explain their importance to human societies and economy [**Paper – 2** | 8 m].

Non-timber forest consist of timber, small wood, and fuelwood. It specifically includes grass, fruit, leaves, bark, animal, and mineral products found in the forest and collected therefrom.



➢ Importance to human society

- Livelihoods and Income Generation: NTFPs are often collected and processed by local communities, providing a source of income for millions of people,

- Food Security: Many NTFPs, such as fruits, nuts, mushrooms, and wild game, contribute to local diets and food security.
- Medicine and Health: Forests are a source of numerous medicinal plants and herbs, contributing to traditional and alternative medicine systems.
- Cultural and Traditional Practices: NTFPs preserve cultural heritage: vital in ceremonies, rituals, and crafts for indigenous and local communities.
- NTFP-Based Enterprises: NTFP processing and marketing spur local entrepreneurship and economic growth through small and medium-sized enterprises
- Income Diversification: NTFPs provide an opportunity for rural communities to diversify their income sources.

➢ Importance to economy

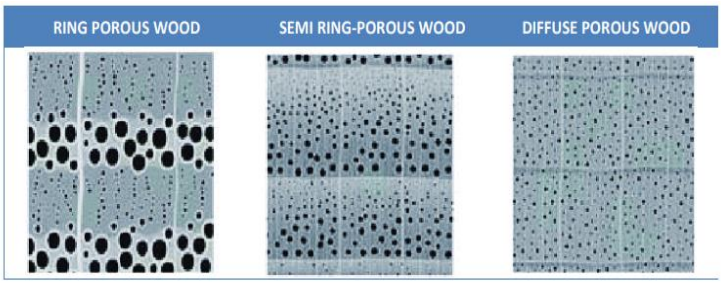
- They provide important raw material in paints, pharmaceutical, and confectionary industries
- They contribute about .5 -.7% of GDP
- They provide financial independence to gatherers by giving them employment
- It provides a livelihood to tribal people living near forests.
- Increased Export Potential.

IFoS 2019 : Define wood. Explain the microscopic/Anatomical features which aid in identification of timber species in details [**Paper – 2** | 15 m].

Wood is the porous and fibrous structural tissue found in the stems and roots of plants. It basically comprises cellulose fibers that are strong in tension and embedded in a lignin matrix that resists compression

Wood anatomy

- Vessels or Pores
- Fibres : fibers are spindle shape elongated cells with pointed ends and thick walls. Its function is to provide mechanical support to the plant.
- Tracheids : These are also elongated cells, but their ends are connected with each other to make a pipeline for conducting food and water.
- Rings :



- Gummy Deposits & Tylosis : The majority of timbers contain chemical deposits in their pores; the wood character, i.e., color, texture, shininess, smell, etc. Is the result of this deposition.

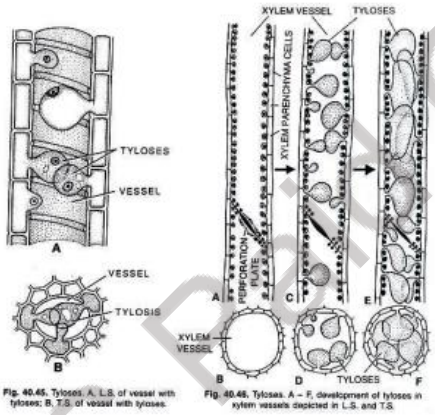
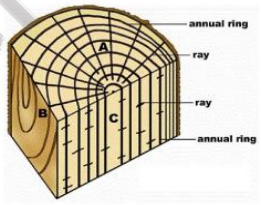


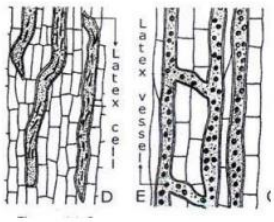
Fig. 40.45. Tyloses. A, L.S. of vessel with tyloses; B, T.S. of vessel with tyloses.

Fig. 40.46. Tyloses. A – F, development of tyloses in xylem vessels depicted in L.S. and T.S.



WOOD RAYS

- Pith Flecks : central pith part
- Wood Rays or Medullary Rays : horizontally arranged fibers that help in the mechanical support of branches, conduction of food and water.
- Ripple Marks : waviness on the outer boundary (Tangential surface) of sapwood.
- Resin Canals and Gum Ducts



LATEX or **RESIN** canal

Wood classification based on wood anatomy

- Non-Porous Wood : Conifers i.e. Chir-pine, deodar, oak.
- Ring Porous Wood : Vessels of the spring (early) wood are larger and more numerous less in summer (late) wood. There is an abrupt change in the size of

vessels; large in earlywood, small and thick-walled in latewood. Example :Tectona grandis (teak), Toona ciliata (toon)

- Semi Ring Porous Wood : Walnut
- Diffuse Porous Woods : The ducts (both early and late) are very small in size and are scattered evenly throughout the seasonal ring.
- Softwood and hardwood-Softwood lacks pores, and tracheids are found in abundance. Also, rays are found in less in number and have a narrow width. Also, tyloses are absent in it. Ex conifers
- On the other hand Hardwood contains pores, have rays flecks, lacks tracheids, and rays have wide width and contain gummy deposits. Ex teak, sal.

IFoS 2019 : What are particle boards ? Explain the features of different types of particle boards [**Paper – 2** | 15 m].

Particles means wood chips/chisels that are glued with a synthetic resin or some other binder and make a core of wood surrounded by a veneer face on both sides. Particleboard can be used as a substitute for plywood for making furniture, the interior lining of walls and ceilings, interior decorative paneling.

Different types of particle boards

- **Single-layer particle-board** : consists of wood particles of the same sizes, which are pressed together. It is a flat and dense board that can be veneered or plastic laminated but not painted. This is a waterresistant type of particle board but is not waterproof. Single-layer particle boards are suitable for interior applications.
- **A three-layer particle board :** consists of a layer of large wood particles sandwiched between two layers made of very small and highly dense wood particles.

Single-layer particle-board

Three-layer particle board

- **Graded-Density particle board :** consists of a layer of coarse wood particles which is sandwiched between two layers made of fine wood particles. This type of particleboard is used to make cabinets and wooden furniture.
- **Melamine particle board :** where the wood particles bonded together by using melamine-urea formaldehyde resin and wax emulsion under high heat and pressure.

Graded-Density particle board

Melamine particle board

- **Cement-bonded particle board** : the board has magnesium-based cement or Portland cement as the bonding agent. Cement content is 60%, while wooden particles such as wooden shavings, sawdust, and wood chips make up 20% of the composition. The remaining 20% is water. Due to the presence of cement, this type of particleboard is resistant to moisture, fire, termites, and rotting.

- **Laminated particleboard :** When a thin laminate sheet is attached to the surface of a plain particleboard, it becomes laminated particleboard.

Graded-Density particle board

Melamine particle board

IFoS 2019 : List different system and methods of sale of forest produces. What are the different methods of sales adopted in state forest department? [**Paper – 2** | 15 m].

There are many different systems under which timber and other forest produce may be disposed to purchasers

System of Sale

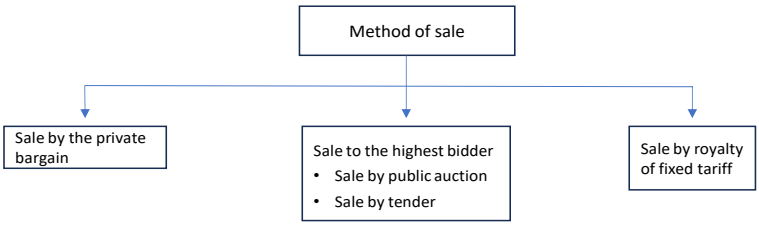
(i) Lump-sum sale

(ii) Payment on outturn (Royalty)

LUMP SUM SALE : A fixed sum is paid for the product, whether the exact quantity of such product is known or not.

PAYMENT ON OUT TARN : the actual amount of products sold or extracted.

Method of Sale



Practices of the state forest department

State forest departments employ methods such as auctions, tenders, online auctions, fixed prices, timber sale agreements, and permits for sales of forest products to generate revenue for conservation and management. The choice of method depends on the product type and local regulations.

Auctions: Public auctions allow competitive bidding on forest products; the highest bidder obtains harvesting rights, supporting revenue generation for state forest departments.

Tenders: tenders solicit bids for forest products or areas with set conditions; the highest compliant bidder secures the contract for sales in state forest departments.

Online Auctions: State forest departments use online auctions for efficiency and broader accessibility, encompassing timber and non-timber forest products.

Fixed Prices: State forest departments establish fixed prices based on market rates and product quality, allowing buyers to purchase forest products at these set prices

Timber Sale Agreements: State forest departments engage in negotiated agreements with specific buyers for large-scale timber harvesting, specifying volume, quality, and sustainable practices.

Forest Product Sales Permits: State forest departments issue permits for harvesting specific forest products, imposing sustainability and regulatory compliance on permit holders.

Direct Sales to Industries: State forest departments supply forest products directly to industries with established demands, such as pulp and paper mills or sawmills.

Cooperative Marketing: State forest departments partner with cooperatives for collective marketing, benefiting small-scale producers with improved access and pricing in the market.

Marketing and Retail Outlets: Some state forest departments establish their own retail outlets or stores to sell forest products directly to consumers.

Joint forest management: here the forest department and tribal gatherers formed a cooperative which will sell the product directly to consumers.

Minimum support price: here, 23 non-timber forest products are classified on which the ministry of tribal affairs declared MSP. So tribals sold these minor forest produce to the state government.

IFoS 2018 : What are the industrial uses of gums and resins ? Discuss the factors affecting the production and supply of gums and resins [**Paper – 2** | 8 m].

Natural gums (gums obtained from plants) are hydrophilic complex carbohydrate polymers of high molecular. They are generally insoluble in oils and soluble in water.

USE OF GUM

- Acacia, Tragacanth gum, and Karaya gum are used in cosmetics.
- Tamarind gum is used in textiles.
- Acacia gum used as adhesive.
- Manufacturing paints, paper, and others.
- Ladoo and other food products.
- Used in Petroleum industries.

Resins are the sticky flammable organic substance that originates through the reduction and polymerization of carbohydrates and normally ooze out through bark.

USE OF RESIN

- Adhesives, paints, and coatings
- Electronic components and replacements for metal parts
- Decoration
- Gears, pipes, and tubes
- Intricate models and parts
- Jewelry, Medical devices, Consumer goods

Factors affecting the production and supply of gums and resins

- Genetic factors : Certain plants yield more gum or resin than others
- Size : trees with large diameters are supposed to have more resin material than small-diameter trees
- Climatic factors : Temperature, Rainfall during monsoon season, tree growth takes place due to the availability of water.
- Humidity : lower humidity is required to produce.
- Tapping season : maximum production of resin takes place in the summer season.
- Method : All methods have a different rate of extraction of gum and resin.
- Pest attack : though pest attacks on bark facilitate gum oozing out from plants, these pests affect the supply of gum.

IFoS 2018 : Write down four advantages of timber seasoning and suggest which one is commercially suitable over other methods, with suitable examples [**Paper – 2** | 8 m].

Seasoning meant removal of the moisture that presented in timber in its green state.

Advantage of timber seasoning

- To reduce the risk of fungal and insect attacks
- To reduce weight = ↓ transportation cost
- To avoid seasoning defects like shakes, splits, and cracks.
- To secure proper penetration of preservatives.
- To make timber fit to receive painting and
- Controlling the rate of drying and regulating it within limits so that the wood seasons with the least possible damage.

Commercially suitable in wood processing optimizes cost, sustainability, and quality while maintaining wood's natural properties, ensuring proper seasoning without altering the wood's natural color, luster, or other intrinsic properties. It ensures precise control, adapts to all wood types, supports sustainability, and meets industry and consumer demands so all these demand is full by the chemical seasoning.

Soaking in chemicals in place of common salt, i.e., Calcium chloride, molasses, and various sugars. Soaking in chemicals before stacking for air seasoning can sometimes be very effective.

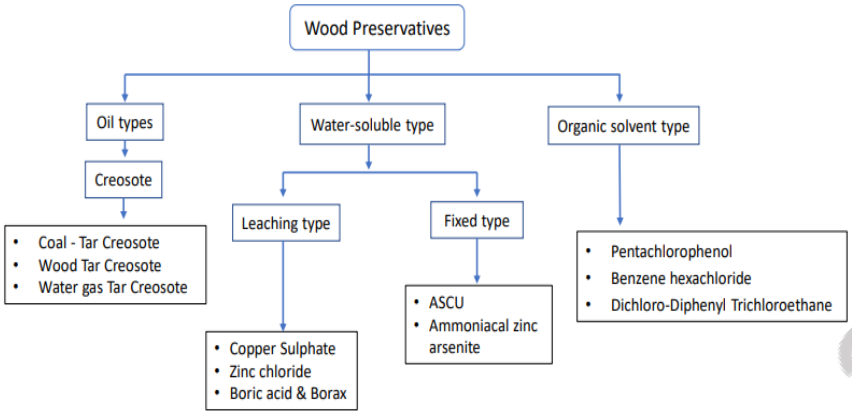
IFoS 2018 : List out different types of preservatives used for protection of timber against fungi and insects and classify them based on solvent used [**Paper – 2** | 15 m].

The process of improvement of wood's natural durability by treatment with chemicals that are toxic to insects, fungi and other decaying agents.

Type of preservatives

- Oil type
- Organic solvent type
- Water soluble type

The oil type: here, Creosote is a brownish-black oily distillation with Coal tar, Water tar, and Water gas tar. It is used in admixture with petroleum oils. These are generally applicable on the surface of the wood. This is effective against borers, marine organisms, and termites.



Organic solvent type: these are organic acids of copper and zinc salts. These preservatives have high penetrability and insolubility in water and require moderate to low pressure in application. Common solvent-type preservatives are

- Pentachlorophenol
- Benzene hexachloride
- Dichloro diphenyl trichloroethane

The organic type solvents have a certain advantage over other methods like their non-leaching property, easy to paint.

Water solvent type: Here, preservatives are soluble in water, and after applying the solvent, the water evaporates, leaving the preservative behind. It is of two types

- Leaching type
- Fixed type

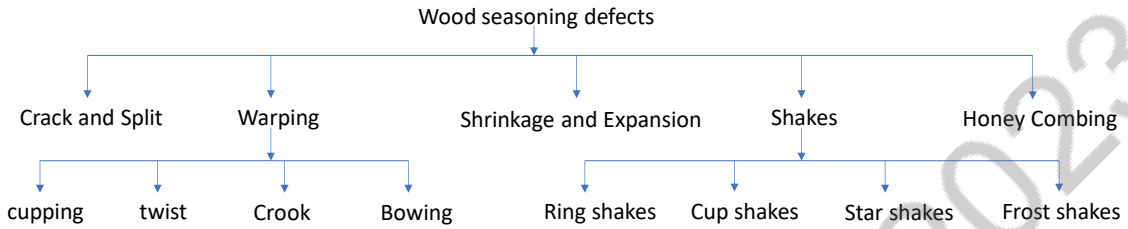
Leaching type: here, the preservatives used are boric acid, borax, Sodium pentachloro phenate, and zinc chloride. These preservatives has a leaching ability, thus making them not suitable for outdoor timber. However, they can be used in indoor timber works.

Fixed type: in this, the preservative reacts with wood and makes insoluble salts, thus eliminating leaching. They are suitable for all timber types. The preservative used here are

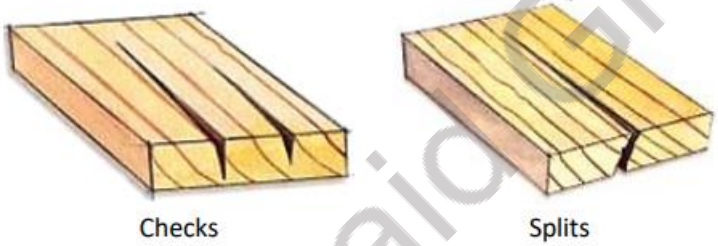
- Copper chrome arsenic composition
- Ammonical copper arsenate
- Acid cupric chrome composition

IFoS 2018 : Describe the defects that appear during seasoning in timbers [**Paper – 2** | 10 m].

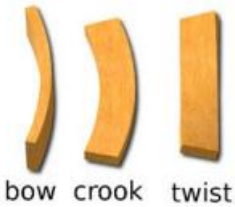
Wood seasoning is a method of removing excess moisture that presented in timber in its green state in order to reduce the probability of pest attack and increase workability. However, during seasoning, timber may encounter defects.



- **Crack and Split**: it is caused by more rapid drying of wood, resulting in the splitting of fibers from one another. E.g., highly refractory species like *Diospyros melanxylon*, and *Syzygium cumini* are more liable to split than non-refractory species *Boswellia serrata.*



- **Warping**: it is caused due to unequal shrinkage or expansion across the grain. Further classified in four part .



Cupping: warp across the width of the face in which edges are not aligned with the center of the wood.

Bowing: curvature along the length of the broad face.

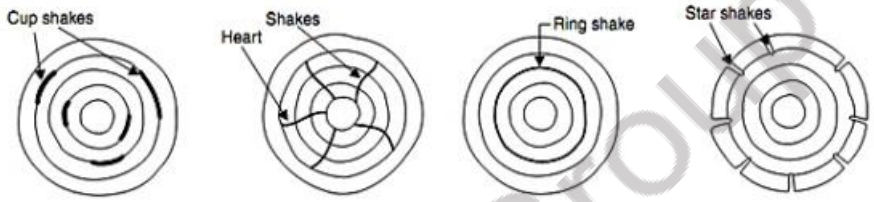
Crook: a warp along the length of the edge of the wood.

Twist: a distortion in which two ends do not lie on the same plane.

- **Honey combing**: during the drying process, timber may develop internal stress, which forms checks in the interior of the wood.

HONEY-Combing

- **Shrinking and swelling:** when wood gains or loses water, it changes the dimension of wood, which causes shrinking and swelling.
- **Shakes**: there are cracks developed in the fiber. It develops due to uneven or poor seasoning. It is of the following type.



7

Chapter

REMOTE SENSING

IFoS 2022 : "Application of Remote sensing and GIS helps in continuous forest cover monitoring and efficient forest management activities". Explain with Examples [**Paper – 2** | 15 m].

Remote sensing is a technique of acquiring information about some property of an object with the help of recording devices such as camera, laser, radio frequency receiver, radar system without physical contact.

Application of Remote sensing and GIS helps forest cover forest management activities

FOREST MANAGEMENT

The main application of Remote sensing and GIS forestry involves

- Preparation of a base map,
- Identification of tree species,
- Quantitative measurements about the density of trees in a given.
- Forest classification
- Forest certification
- Mapping stand structure, susceptibility and vulnerability.
- Wildlife management : habitat pattern and fragmentation analysis.
- Forest hydrology and watershed management.
- Monitoring Wetland Dynamics.
- Carbon Cycle modelling for forest and terrestrial ecosystem.

TREE SPECIES CLASSIFICATION : Timely and accurate acquisition of information on the status and structural change of forest composition is crucial to developing strategies for sustainable management of natural resources and ecosystem modeling.

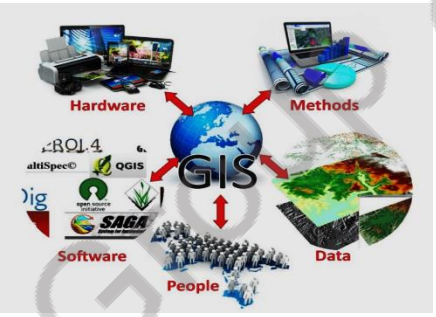
FOREST FIRE MONITORING : The FAST system automatically processed and disseminated fire hotspots' information directly to the registered end users. The Forest Survey of India (FSI) assesses forest resources in a two-year cycle and implements a Central Sector scheme, which includes an Early

Warning system for forest fires, mapping of fire-affected areas, fire danger rating system, and remote sensing and GIS technology for fire risk zonation, aiding in disaster response and management.

LAND USE/LAND COVER MAPPING : The term land use refers to the human activity associated with a specific piece of land. The term land cover is related to the type of feature present on the surface of the earth. The land use/land cover types can easily be delineated on aerial photos seen under stereoscopic vision. Colour photos enhance the features identification and hence give much more information

IFoS 2021 : Define Geoinformatics. What are its elements? Explain its role in management and monitoring of forest resources [**Paper – 2** | 15 m].

Geoinformatics, or geospatial informatics or geographic information science (GI Science), is a multidisciplinary field that focuses on the acquisition, management, analysis, interpretation, and visualization of geographic and spatial data. Geoinformatics uses geocomputation and geovisualization to analyze geoinformation. It collects and organizes data and then analyzes it through computation and geo-visualization. It combines principles from geography, computer science, mathematics, and other related disciplines to study and understand the Earth's surface and its various phenomena.



Elements : GIS/GPS + Remote sensing + Computer system + Cartography soft + Geo special applications + User.

Role of Geoinformatics in the management and monitoring of forest resources

FOREST LAND MANAGEMENTUSING GIS

- Land Conservation Planning, Monitoring, and Control
- Mobile App for Forest Land Survey
- Satellite Image classification for Land Encroachment Analysis

FOREST MANAGEMENT

- Working Plan preparation : Logistical Plan for Transport Plants + NTFPs
- Monitoring irregular forest boundaries
- Identifying forest cover changes
- Drone/Satellite Image Classification Based Plantation Monitoring
- Geo-Enabled details of e-Auctions on Map
- Geo-Enabled estimate Growth and Productivity
- Geo-Locations of Saw Mills

- Web-Enabled Forest Guard Dynamic Route Planning
- Forest guard : Route Tracking and Analysis
- Geo-Tag Photograph & Video, Measurement Tool
- Geo-Enabled Web Portal for Eco-Tourists

WILDLIFE MANAGEMENT

- Wild Life Conservation Planning and Monitoring.
- Geo-Enabled Wild Life Incident Mapping.

IFoS 2020 : What are the application of remote sensing in forestry? [**Paper – 2** | 15 m].

Remote sensing is a technique of acquiring information about some property of an object with the help of recording devices such as camera, laser, radio frequency receiver, radar system without physical contact.

Application of Remote sensing in forestry.

FOREST MANAGEMENT

The main application of Remote sensing and GIS forestry involves

- Preparation of a base map,
- Identification of tree species,
- Quantitative measurements about the density of trees in a given.
- Forest classification
- Forest certification
- Mapping stand structure, susceptibility and vulnerability.
- Wildlife management : habitat pattern and fragmentation analysis.
- Forest hydrology and watershed management
- Monitoring Wetland Dynamics
- Carbon Cycle modelling for forest and terrestrial ecosystem

MONITORING INVASIVE SPECIES :

- Papped and analyzed the abundance, distribution, and impact of invasive species on the local vegetation.
- Determine how they occupied the habitat.
- Determine the level of compositional changes in native ecosystems and prediction of what possible future dispersal at local, regional, and national levels.

TREE SPECIES CLASSIFICATION : Timely and accurate acquisition of information on the status and structural change of forest composition is crucial to developing strategies for sustainable management of natural resources and ecosystem modeling.

FOREST FIRE MONITORING : The Forest Survey of India (FSI) assesses forest resources in a two-year cycle, which includes an Early Warning system for forest fires, mapping of fire-affected areas, fire danger rating system, and remote sensing and GIS technology for fire risk zonation, aiding in disaster response and management.

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IFoS 2020 : Why should GIS be considered as a 'Pure Science'? [**Paper – 2** | 8 m].

Geographic Information Systems (GIS) are both a tool and a science. GIS is a computer based tool that stores visualizes, analyzes, and interprets geographic data.

- It uses location as the key index variable to relate seemingly unrelated data.
- It stores information as a collection of thematic layers that can be linked together by geography.
- A GIS user uses certain algorithms to fulfil a purpose - extract all roads from a remote sensing image

GIS is a science because it encompasses a body of knowledge and research methods related to the study of spatial relationships, patterns, and processes. For instance, developing a new algorithm to process remote sensing imagery and extract certain feature.

IFoS 2019 : Describe the role of remote sensing and GIS in monitoring forest resources [**Paper – 2** | 15 m].

Remote sensing and Geographic Information Systems (GIS) play crucial roles in monitoring and managing forest resources. They provide valuable tools for assessing, understanding, and conserving forests in a variety of ways.

Application of Remote sensing in monitoring forest resources

- **Tracking Timber Sources:** GIS can be used to create spatial databases that track the origin and transportation routes of timber. This is particularly valuable in verifying that certified timber products come from sustainably managed forests and are not mixed with uncertified or illegal timber.
- **Certification Auditing:** Remote sensing data and GIS maps can be used during certification audits to provide visual evidence of compliance with certification standards. This adds transparency to the auditing process and helps ensure the accuracy of the certification.
- **Timber Chain-of-Custody Tracking:** GIS can be used to create a detailed chain-of-custody system for timber products. This system tracks the movement of timber from the forest to the end consumer, ensuring that certified timber remains segregated from non-certified sources.
- **Harvest Planning and Monitoring:** GIS aids in planning timber harvesting operations to minimize environmental impact. It determine optimal routes for extraction, buffer zones, and protection areas. Remote sensing provide data on the current forest structure and density, assisting in sustainable harvest planning.
- **Forest Inventory and Management:** Remote sensing, such as satellite imagery and aerial photography, assist in creating detailed forest inventory maps. These maps provide information about the location, extent, and characteristics of forests, helping forest managers and certification bodies assess the current state of the forest.
- **Deforestation and Illegal Logging Detection:**Remote sensing and GIS help monitor forests for signs of illegal logging and deforestation. Changes in forest cover, such as clear-cut areas, can be detected and investigated, ensuring that timber harvesting is in compliance with certification standards.
- **Forest Cover Mapping:** Remote sensing technologies, such as satellite imagery and aerial photography, are used to create detailed maps of forest cover. These maps help in identifying the extent and distribution of forests, including deforestation and reforestation trends over time.
- **Biodiversity Assessment:** it can be used to assess forest biodiversity by analyzing vegetation types, tree species, and their health. Different species exhibit distinct spectral signatures, and remote sensing can help identify and monitor their distribution.
- **Forest Health Monitoring:** Remote sensing and GIS tools like LiDAR (Light Detection and Ranging) provide detailed information about forest health by measuring tree height, canopy structure, and other parameters.
- **Fire and Pest Management:** GIS and remote sensing used to monitor forest fire risk and identify areas susceptible to wildfires.

IFoS 2018 : Define remote sensing. Discuss its application in forest management along with GIS applications [**Paper – 2** | 10 m].

Remote sensing is a technique of acquiring information about some property of an object with the help of recording devices such as camera, laser, radio frequency receiver, radar system without physical contact.

Application of Remote sensing and GIS in forest management

- Remote sensing and GIS applications use Working Plan preparation : Logistical Plan for Transport Plants + NTFPs
- It use Monitoring irregular forest boundaries.
- It use Identifying forest cover changes
- Remote sensing and GIS applications use drone and satellite image classification for plantation monitoring in the context of wildlife management.
- Remote sensing and GIS applications use Geo-Enabled Wild Life Incident Mapping.
- It use Geo-Enabled details of e-Auctions on Map, location of saw mill and growth and productivity of forest.
- It use Identification of tree species,
- Remote sensing and GIS applications use Quantitative measurements about the density of trees in a given.
- Remote sensing and GIS applications use Forest certification.
- Remote sensing and GIS applications use Forest fire monitoring.

Congratulations

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GURLEEN KAUR

Apoorv Dixit

Mohammed Abdul Rawoof Shaik

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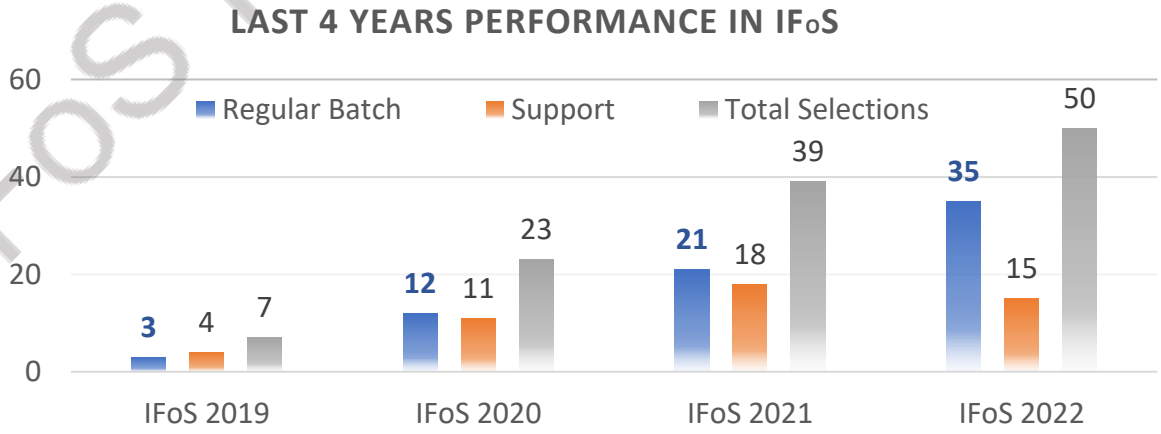

Gwalior

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Yash Dhoble

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