Hornbill Classes

2024

# FORESTRY

## CGPSC

## STATE FOREST SERVICE

## TOOLKIT

**Detailed Syllabus Based study material** + **Linkage of Concepts with PYQs** + **Infused with Infographics & Maps**

*Paper - 2*

- Forest Soil & Conservation
- Afforestation of difficult sites
- Watershed Management
- Joint Forest Management (JFM)
- Agroforestry, Social forestry and Urban forestry


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# GENERAL FORESTRY

**MODULE – 2**


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Module - 2

# CONTENT

CHAPTER 1

# SILVICULTURE SYSTEM
# INTRODUCTION

*Silviculture* is the art and science of cultivating forest crops. It encompasses the natural laws governing tree and forest growth, the influence of environmental factors, and the techniques for both natural and artificial regeneration, as well as ongoing forest management.

Due to the diverse nature of forest types and their specific environmental conditions, a variety of silvicultural methods are required to effectively regenerate and manage different forest sub-types in varying locations. These specific methods or techniques are known as *Silvicultural Systems*.

- **SILVICULTURAL SYSTEM** : *a method of the silvicultural procedure worked out in accordance with accepted sets of silvicultural principles, by which crops constituting forests are tended, harvested and replaced by new crops of distinctive forms.*

  OR

  *Silviculture system is a planned silvicultural treatment which is applied to a forest crop, throughout its life, so that it assumes a distinctive form. It begins with regeneration fellings, tending the crop to its final felling.*

  - Silviculture system deals with the removal of a forest crop.

## 1.1 CLASSIFICATION

In India, silvicultural Systems have been classified primarily based on the ❶ *mode of regeneration* and then the ❷ *pattern of felling*.

**HIGH FOREST SYSTEMS** : All those silvicultural systems in which the *regeneration is usually of* ***seedling origin***, *either natural or artificial**** (or a combination of both). So, *rotation is generally long*. These are further classified based on *the pattern of felling*, which in turn, affects the *concentration or diffusion of regeneration* and characteristics of the new crop [Figure 1.1].

**COPPICE SYSTEMS** : In these silvicultural systems, the *crop* ***originates from coppice*** *growth****, leading to a *shorter rotation* period compared to high forest systems. Coppice systems are further categorized based on the *pattern of felling* into the following types : Simple Coppice System, Shelterwood Coppice System, Coppice Selection System, Coppice-with-Standards System, Coppice-with-Reserves System, and Pollard System [Figure 1.1].

## 1.2 NEEDS OF SUCH CLASSIFICATION ?

- ***Systematization of knowledge and precaution against wrong use*** : It helps foresters to

understand the essence of each system and the conditions under which it is applicable. In the absence of such knowledge, there is a high possibility of applying a particular silvicultural system in conditions where it may not be appropriate, resulting in failure. For example, the coppice system can be applied only to species that are strong coppicers.

- ***Direction to a planned treatment of crops*** : Adopting this systematized knowledge in the field provides direction for the planned treatment of a crop. Otherwise, over-enthusiasm or a dogmatic approach may result in failure.

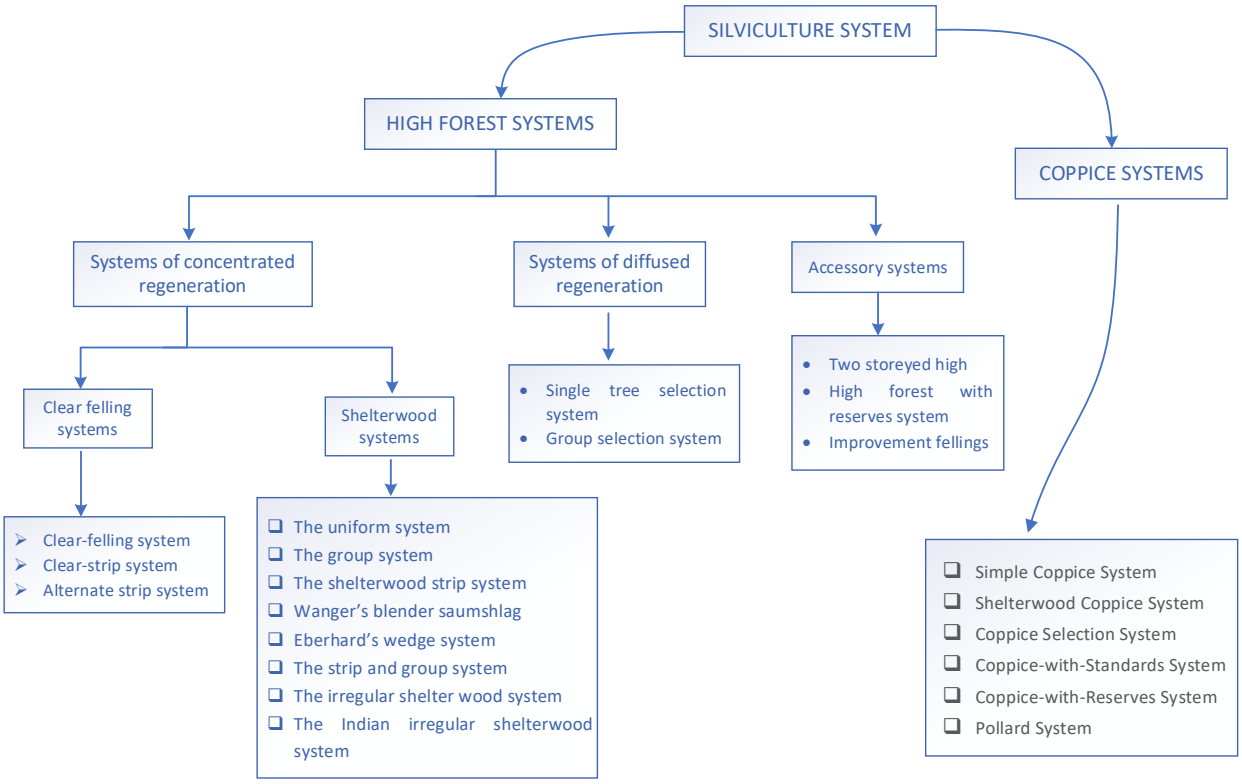



Figure 1.1 : Silviculture system classification

## EXERCISE – 1.1

**1.** What are the objects for classification of silviculture systems? [Odisha Civil (Pre) 2006]
(a) It is based on systematization of knowledge and precautions against wrong use as well as direction to planned treatment of crops
(b) On basis of need for developing the biodiversity
(c) Enhancing the productivity of forest
(d) Developing non-timber forest produce

**2.** What is the scope of silviculture systems ? [Odisha Civil (Pre) 2006]
(a) It is helpful in planting of new species
(b) It is a procedure adopted for removal of a forest crop at a given set of conditions and its regeneration
(c) Planting of exotic species
(d) It is used for developing non-timber forest produce

**3.** Primary classification of silviculture system is based on [ICAR (JRF) 2019; Nagaland PSC CTSE 2021]
(a) Mode of regeneration
(b) Pattern of felling
(c) Locality factors
(d) Species composition

**4.** High forest systems is [Nagaland PSC CTSE 2018]
(a) Seed origin and Coppice Rotation Forest
(b) Coppice and Long Rotation Forest
(c) Long rotation
(d) Seed Origin and Long Rotation Forest

CHAPTER 4

# SELECTION SYSTEM

Unlike systems of concentrated regeneration, where trees of different age-classes are found in distinct areas, natural forests consist of trees of various ages intermingled throughout. As mature trees naturally die, younger trees regenerate and take their place. The Selection System mirrors this natural pattern of tree replacement in its approach to felling.

| **SINGLETREE SELECTION SYSTEM** | GROUP SELECTION SYSTEM |
|---|---|

⇩

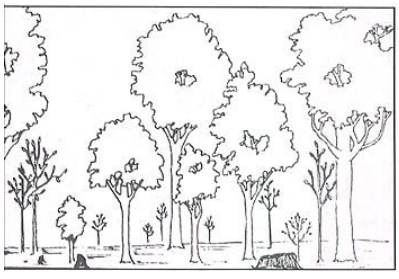
*The Selection System is a Silvicultural System in which fellings and regeneration are distributed over the whole of the areas, and the resultant crop is so uneven-aged that trees of all ages are found mixed together over every part of the area.*

- Therefore, the crop is referred to as "***Selection Forest***" or ***"all-Aged Forest"***
- Felling and regeneration works distributed over the whole area.
- Resultant crop : Completely uneven-aged as all age-classes are mixed together on every unit of area.
- In the other system of concentrated regeneration, the regeneration operations are carried out only during a part of the life of the crop, after which only thinning are done to improve the growth and form of the remaining trees, whereas in Selection System, regeneration operations are carried out throughout the life of the crop and thinning are done simultaneously for improving the growth and form of trees.

⊳ **PATTERN OF FELLING** : Scattered mature trees (having DBH above the exploitable diameter) are selected all over the area and felled.

– + Dead, dying, diseased and mis-shaped and defective trees.
– + Trees of undesirable species.

The above classes of trees are to be removed in such a way that the remaining crop has all age-classes in balanced proportion on every unit of areas.



⊳ **MODE OF REGENERATION** : Natural regeneration may further be supported by artificial regeneration.

⊳ **NATURE OF CROP** : Absolutely ***un-even-aged*** with all age-classes mixed together on each unit of areas.

⊳ **TENDING OPERATION** : weeding, cleaning, climber cutting etc.

| SINGLETREE SELECTION SYSTEM | **GROUP SELECTION SYSTEM** |
|---|---|

⇩

CHAPTER 6

# COPPICE SYSTEM

Instead of regeneration by *Seed*, here in the coppice system, we depend upon the coppicing power of tree *Stools* where the adventitious buds on the *Stump* of the felled trees produce new plants.

Difinition : Those silvicultural systems in which the new crop originates mainly from stool coppice and where the rotation of the coppice is short.

**TYPES : Based on the pattern of felling**

- The *Simple Coppice System****
- The Shelterwood Coppice System
- The Coppice Selection System
- The *Coppice-with-Standards System****
- The *Coppice-with-Reserves System****
- The *Pollard System****

## 6.1 SIMPLE COPPICE SYSTEM

*a silvicultural system based on stool coppice, in which the old crop is clear-felled completely with no reservation for shelterwood, and the new crop grows naturally through stool coppice.*

- **Pattern, Method & Season of felling** : Clear-felled a fixed area (Annual coupe).

  Season : Little before the beginning of Spring season (*November to February/March*). At this time, the roots contain ample stored food reserves.

  Method : Depending on labour availability, local topography. Ensuring the bark does not detach.

  Stup height : *15 to 25 cm*. in case of Eucalyptus – 5 to 10 cm

- **Mode of regeneration** : *Stool coppice*. But trees cannot keep on coppicing indefinitely and they progressively lose their coppice vigour at every felling and ultimately die. Therefore, in every coppice coupe, some stools do not coppice in each rotation. These blanks are filled up usually by planting stumps or container plants but seldom by sowing.

- **Tending operation** : Cleaning, Climber cutting, ***Singling*** (if the aim to produce logs), etc. Whether thinning is necessary or not depends on the management objectives. If the objective is solely fuel production in coppice crops, no thinning is required because it does not affect total volume production.

CHAPTER 9

# MANAGEMENT OF BAMBOO SYSTEM

Bamboo is considered minor forest produce and plays a crucial role in our national economy. It serves as the common man's timber, widely used in house construction and for numerous other purposes. Additionally, bamboo is a significant long-fibered cellulosic raw material for the paper and pulp industry. Among the more than 100 species of bamboo found in Indian forests, ***Dendrocalamus strictus*** stands out as the most important and widely distributed species.

- **Silviculture system** : As bamboo, fellings are done on a selection basis in such a way that the production of new culms takes place continually = ***Culm Selection System***.

  In some working plans, foresters also used the term "***Selection cutting" combined with Cleaning and Cultural Operations*** for this, but it didn't get popularity.

- **Felling (cutting) cycle and felling rules** : Bamboos are worked generally on felling (cutting) cycles of *3 or 4 years*, and of these two, four years is usually adopted in a central Indian forest. The felling rules vary from state to state. Here, we give standard felling rules that are used in north India.

  - Restriction on cutting of one year old culms (In MP it's called *Kurla*, in UP *Nauda*), and sometimes even two-year-old (*Mahila*).
  - Retention of some older bamboos for support of immature culms.
  - Prohibition on the digging of rhizomes.
  - Regulation of the height at which bamboo should be cut. The *minimum height at which the bamboo should be cut is generally 15 cm*, with the condition that at least one node should be left. The maximum height varies from place to place, *i.e.,* ***25 cm in U.P***. and 45 cm in M.P.
  - Insistence on cutting with a sharp instrument so that the stump does not split.
  - In the case of flowering, the bamboo should be cut only when the seed has been shed.
  - The period of working : in winter

- **Method of Regeneration** : by *Rhizomes*. New clumps are formed by natural *Seedlings* resulting after sporadic flowering. In the case of gregarious flowering, when all the clumps in the area die, regeneration comes up profusely from the seeds, so they need some protection against rodents before germination and against cattle grazing after germination.

- **Tending** : In fully developed clumps, bamboo does not require weeding and cleaning in the same sense as is required by tree species, as it grows very fast and attains its total height by the end of rains. But cleaning and tending of clumps have to be done to facilitate the growth of new culms. + in areas where natural seedlings appear gaps, gap-planting & three weeding also required for 1$^{st}$ year.

- **Character of the crop** : *uneven-aged* = Rhizome produces CULMS every year.

# CHAPTER 1

# COMMUNITY FOREST MANAGEMENT

Chapter outline



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

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

## 1.1 HISTORICAL BACKGROUND

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

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

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

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

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

CHAPTER 2

# WATERSHED MANAGEMENT

## 2.1 WHAT IS WATERSHED ?

*A watershed is a geohydrological unit of land that feeds all the water running under it and drains at a common point.*

Or

*A watershed is a geohydrological unit of land that feeds all the water running under it and drains at a common point.*

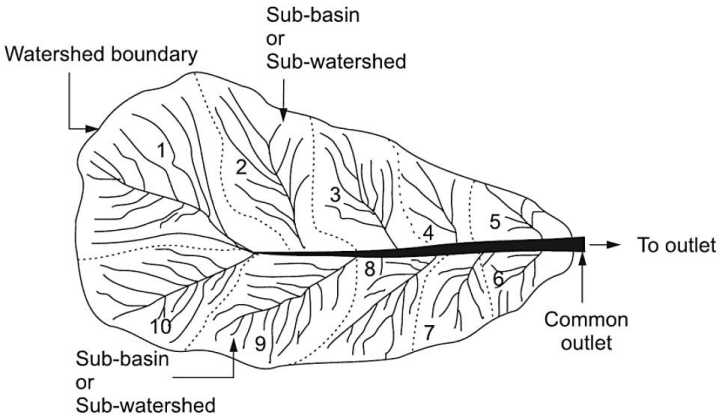


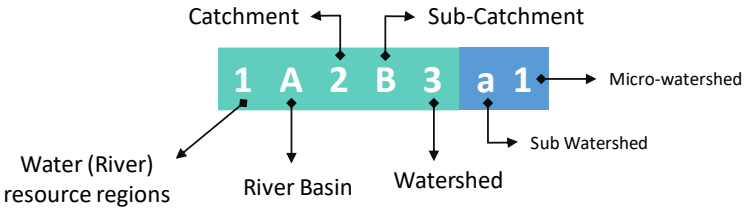

**Figure 1.1** Definition sketch of watershed.

### WATERSHED MANAGEMENT

Watershed management is the study of the relevant characteristics of a watershed aimed at the sustainable distribution of its resources and *the process of creating and implementing plans, programs, and projects to sustain and enhance watershed functions that affect the Plants, Animals, and human communities within a watershed boundary.*

### OBJECTIVES OF WATERSHED MANAGEMENT?

- Soil and water conservation by controlling damaging run-off.
- Improve the ability of the land to hold water
- Rainwater harvesting and recharging
- Employment generation
- Maintain ecological balance by Growing greeneries - trees, crops, and grasses
- Increase farmers' income (doubling income by 2022)
- Moderate floods in the downstream areas.
- Developing fuel, fodder, and timber resources for the local population.




| Hydrological Units | Code | Size range |
|---|---|---|
| Water resource region | 2 | **2.7 Crore to 11.3 Crore** hectares (Average size = 5,50,00,000 ha)<br>► Code : Indus drainage = 1; Ganges drainage = 2; Brahmaputra drainage = 3; All drainage flowing into the Bay of Bengal except Ganges & Brahmaputra = 4; All drainage flowing into the Arabian Sea except Indus drainage = 5; Western Rajasthan mostly ephemeral drainage = 6 |
| Basin | A | **30 Lakh to 3 Crore** hectares |
| Catchment | 1 | Primary river catchment covers an area of about **10 to 50 lakh** hectares |
| Sub Catchment | A | Secondary river drainage area around about **2 to 10 lakh** hectares |
| Watershed | 2 | **20,000 to 3,00,000** (A tributaries of the secondary river), (Average size = **1,00,000 ha**) |
| Sub-Watershed | a | **5,000 to 9,000 hectares***** (Average size = **7,000 ha**) *** |
| ***Micro**** Watershed | 2 | Streamlets of the 4th position (pentad) river have a drainage area of about **500 to 1500 hectares***** (Average size = **1,000 ha**) *** |

The number assigned to Water Resource Region in which *all drainage flows into the Arabian Sea except Indus drainage*, as suggested by Dr. AN Khosla in 1949, is _____ [APPSC (RFO) 2022 General Forestry – I]

(a) 2
(b) 4
(c) 5
(d) 6

Correct Answer : (c)

The delineation of Water Resource Regions into their subsequent division and subdivisions is – Basin, Catchment, Watershed, Sub watershed and Micro-watershed. Arrange them in decreasing order of their size [APPSC (RFO) 2022 General Forestry – I]

(a) Catchment > Basin > Watershed > Sub watershed > Micro-watershed
(b) Watershed > Basin > Catchment > Micro-watershed > Sub watershed
(c) Basin > Catchment > Watershed > Sub watershed > Micro-watershed
(d) Catchments > Watershed > Basin > Sub watershed > Micro-watershed

Correct Answer : (c)

less than a hectare and they were dependent on subsistence agriculture for their livelihood. Since this provided them with minimal means of livelihood, the people of Sukhomajri had to keep a large number of goats, sheep and cows to supplement and diversify their income sources. The livestock population grazed openly in the nearby hills, as the poor inhabitants had no ways or mean to provide for stall feeding. Overgrazing, along with indiscriminate lopping and cutting of trees for firewood and for other domestic needs, led to total degradation of the hillocks. As a result, practising agriculture became more and more unproductive, which added to the woes of the hill people. Initially, the approach undertaken by scientists of the Institute was to appeal to the village community to stop open grazing and overexploitation of the natural resources, which got no response. The community that was meeting its day-to-day needs and living on pittance was not interested in changing its land management practices for a greater cause.

**PROJECT STRATEGY**

This was the scenario in which soil conservationist **P R Mishra** entered Sukhomajri. In his own words, he only saw "naked hills and naked people". Mishra and his team's effort to promote soil conservation was met with stiff resistance. They were suspected to be agents of Chandigarh, sent for snatching the poor man's land. Mishra did not lose heart and worked relentlessly to bring the required change. "The people of Chandigarh are rich; they can have the mud removed from the lake", Mishra was told. Recalls Harikrishna, at the service organized in memory of P R Mishra "We used to take the wood used in controlling soil erosion for cooking purposes." Says he in his rustic style, "We were unable to perceive any sort of gain for ourselves."

This was destined to change when Mishra got water for the villagers. Water was first made available in the village for irrigation. With the support of the villagers, Mishra built two earthen dams to hold back the rain. He realized that for his efforts to bear fruit, the villagers had to be made the direct beneficiaries. The turnaround was slow but remarkable. Assured of benefits from forests and biomass production, the villager's potential was harnessed. Mishra introduced the concept of 'social fencing' whereby villagers decided to protect hills from grazing through self-restraint. He also dissuaded the villagers from uncontrolled grazing in their watershed. For the first time, there was water in plenty. Once a small water harvesting system had developed, the villagers saw the advantages of planting trees and grasses. Mishra firmly believed that once people start managing their ecosystem, problems of survival and growth get sorted on their own.

**RESULT**

The project started by Mishra saw phenomenal success. Tree density increased from 13 per hectare in 1976 to 1,272 per hectare in 1992. The milk productivity has increased manifolds. The village sold extra grass from the watershed. In 1989, Sukhomajri became the first village in India to pay Income Tax. It was Mishra who developed the concept of '***Chakriya vikas pranali***' It can be defined as the cyclic system of development,

Sukhomajri is known for which of the following initiatives? [GPSC (RFO) 2021]

(a) Natural Resource Management by local people
(b) Water Management by local people
(c) Grasslands Management by local people
(d) Wildlife Management by local people

CHAPTER 3

# AGROFORESTRY
## [INTRODUCTION]

**Agroforestry** is a collective name for sustainable land-use systems involving *trees combined with crops* *and/or animals* on the *same unit of land*. It combines the -

- The production system of food crops with protection covers of trees especially in fragile ecosystems.
- Emphasis on the use of *indigenous trees has multi-purpose uses* (MPFTs) and *High yield short rotation* (HYSR) tree varieties.
- It is structurally and functionally *more complex than monoculture*.
- It also *provides alternative investment opportunities* with insurance cover that if our main agriculture crops fail, we still have the trees cover to sell them and sustain their house economy.
- This concept is *based on our ancient tradition and Socio-cultural values*, *to grow trees* on the boundaries of the farm, protect them and harvest them at a necessary point in time to reduce village dependency on the Forest.

► **DEFINITION** : Agroforestry is a *sustainable land-use system that maintains or increases total yields by combining food crops (annuals) with tree crops (perennials) and/or livestock on the same unit of land, either alternately or at the same time* while using management practices that suit the local social-cultural characteristics of society and Economic and ecological conditions of the area.

Remember "Crop + Tree ± Domestic animals". 1st two are the essential requirement, 3rd component is optional it may be present or absent.

**Nair (1979)** defines agroforestry as a land use system that integrates trees, crops and animals in a way that is scientifically sound, ecologically desirable, practically feasible and socially acceptable to the farmers

Land use system that integrates trees, crops and animals in a way that is scientifically sound, ecologically desirable, practically feasible and socially acceptable to the farmers [**Bene, *et.al.***]

► **ATTRIBUTES OF AGROFORESTRY**

**Productivity** : maintain or increase the production of preferred crops & productivity of the soil.
**Sustainability** : By conserving the production potential of the resource base, mainly through the beneficial effects of woody perennials on soils; **Cornerstone of agroforestry**]
**Adaptability** : The word "adopt" here means "accept" (not "modify" or "change). The implication here is that improved or new agroforestry technologies that are introduced into new areas should also conform to local farming practices.

► **SCOPE/NECESSITY** : Agroforestry has an excellent scope in the context of Indian Agriculture due to its intrinsic relation with traditional agricultural practices. Agroforestry practices are beneficial in –

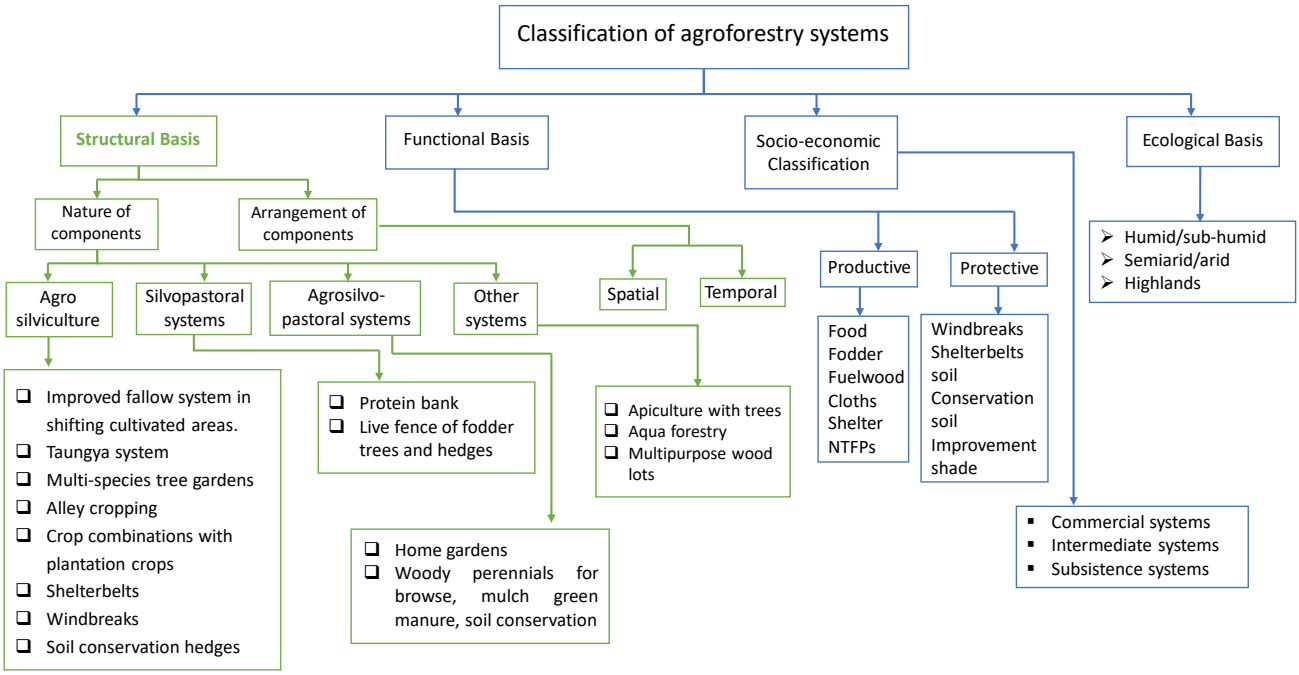
CHAPTER 4

# CLASSIFICATION OF AGROFORESTRY

According to ***Nair*** (1987), the Agroforestry system can be classified according to the following four bases -

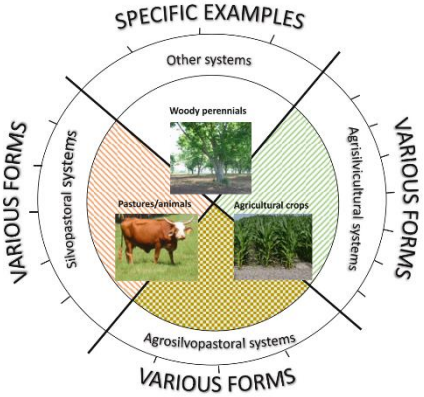
- ► Structural Basis
- ► Functional basis
- ► Socio-economic Basis
- ► Ecological basis

**Tejwani (1994)** Classified Agroforestry systems into (1) Structural Basis, (2) Functional basis, (3) Socio-economic Basis, (4) Ecological basis, and (5) Physiognomic basis.




## 4.1 | STRUCTURAL CLASSIFICATION

Based on the types of components and their arrangements, it is further divided into – (a) the nature of the component, and (b) the arrangement of components.




### 4.1.1 | NATURE OF COMPONENT

(1) Agri-silviculture system, (2) Silvi-pasture, (3) Agro-Silvi-pasture, and (4) other systems.

CHAPTER 6

# CHOICE OF AGROFORESTRY SYSTEM

## 6.1 | CHOICE OF SPECIES FOR AGROFORESTRY

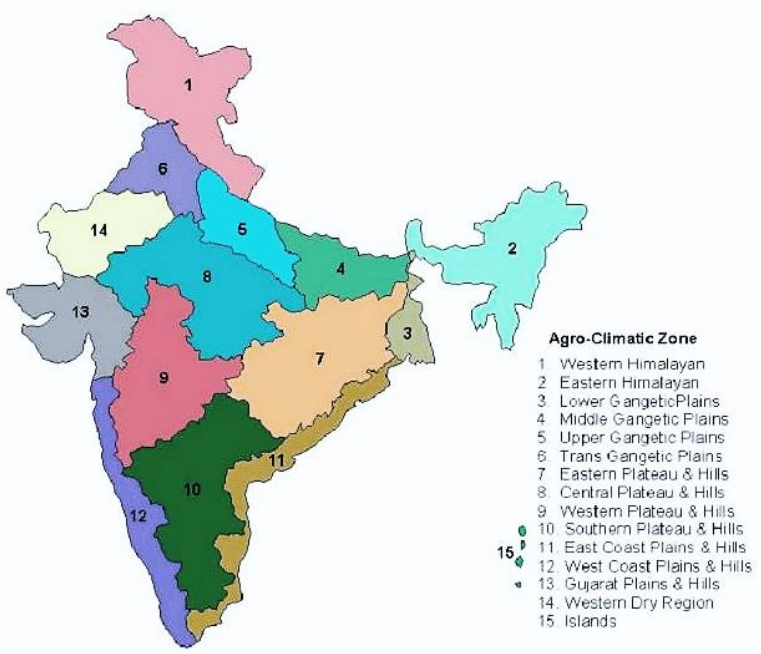
Agroforestry requires trees with special characteristics like –

- The tree should be fast growing & easy to manage
- Should have the ability to fix atmospheric nitrogen.
- Should not compete with food crops for light, Moisture, Nutrients, and space, etc.
- Do not release toxic chemicals (*i.e.*, Mimosine), allelopathy & allergy (remember the issue of Poplar in J&K).
- Excellent copping ability, also amenable for pruning and pollarding. High germination capacity and survival rate.
- Has wider adaptability & acceptability without any controversy.
- Tree species should have higher productivity, higher yield, and maximum profit.
- High market demand and local acceptability
- Multipurpose utility, *i.e.,* timber, fodder, fuelwood etc.

## 6.2 | AGRO-CLIMATIC ZONES OF INDIA

- **Agro-climatic regions** by erstwhile planning commission : **15**
- Agroclimatic zones by National Agriculture Research project (NARP, ICAR) : 127
- Agro-ecological regions by NBSS & LUP : 20

**AGRO-CLIMATIC ZONES IN MADHYA PRADESH** = 11



CHAPTER 10

# AGROFORESTRY POLICY 2014

**NEED FOR AGROFORESTRY POLICY ?**

- Our previous agroforestry and social forestry programs have failed to achieve the goal due to the absence of a dedicated and focused national policy and a suitable institutional mechanism.
- An integrated farming system is also lacking in these programs and often focuses only on growing exotic species rather than native ones.
- Restrictive regulatory regimes on forest policy, Supreme Court guidelines, and various decisions of the National Green Tribunal over the felling of trees are creating significant obstacles in the implementation and marketing of trees growing outside of forest land.
- Insufficient research, extension, and capacity building in this field.
- Institutional finance and insurance coverage.
- Weak market access for agroforestry produce.
- Industry operations at a sub-optimal level.
- Integration of our forest policy targets and goals through agroforestry practices.

*Major policy goals*

- Setting up a *National Agroforestry Mission* and an *Agroforestry Board* to implement the National Policy by bringing coordination, convergence, and synergy among various elements of agroforestry scattered in various existing missions, programs, schemes, and agencies about agriculture, environment, forestry, and rural development sectors of the Government.
- Improving the Productivity, Employment, Income, And Livelihood Opportunities of rural households, especially of the smallholder farmers through agroforestry.
- Meeting The Ever-Increasing Demand for timber, food, fuel, fodder, fertilizer, fibre, and other agroforestry products.
- Conserving natural resources and forests, protecting the environment, providing environmental security, and increasing forest/tree cover.

Which is not the major goal of the National Agroforestry Policy, 2014? [MPPSC Forest Service (Main) Exam 2022; Exam Held on 10 December 2023]

(a) Setting up a Agroforestry Mission.
(b) Improving productivity and livelihood opportunities of the smallholder farmers through agroforestry
(c) Reduce the area under cultivation.
(d) Meeting the ever-increasing demand of timber, food, fodder, fibre and other agroforestry products

*Basic objectives*

- Encourage and expand tree plantation in a complementarity and integrated manner with crops and livestock to improve productivity, employment, income, and livelihoods of rural households, especially the smallholder farmers.

CHAPTER 2

# ROCKS & THEIR FORMATION

## 2.1 INTRODUCTION

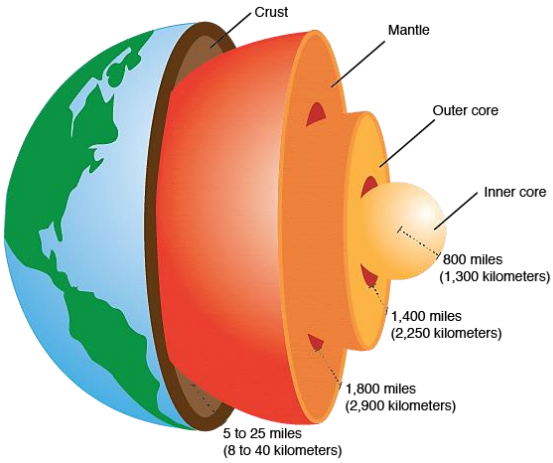
Earth formed about *4.6 billion years* ago from a mixture of gas and dust around the sun. The dust particles were drawn together by drag, forming clumps of rock called *planetesimals*. These planetesimals collided with each other, growing into Mars-sized *protoplanets*. Earth's final size was achieved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

### EARTH STRUCTURE

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

### COMPOSITION OF *Earth Crust****

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




✍ ***O–Si–Al, Fe–Ca–Mg***

## 2.2 WHAT ARE ROCKS

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

### BASED ON THE MODE OF FORMATION

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

Characteristics

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

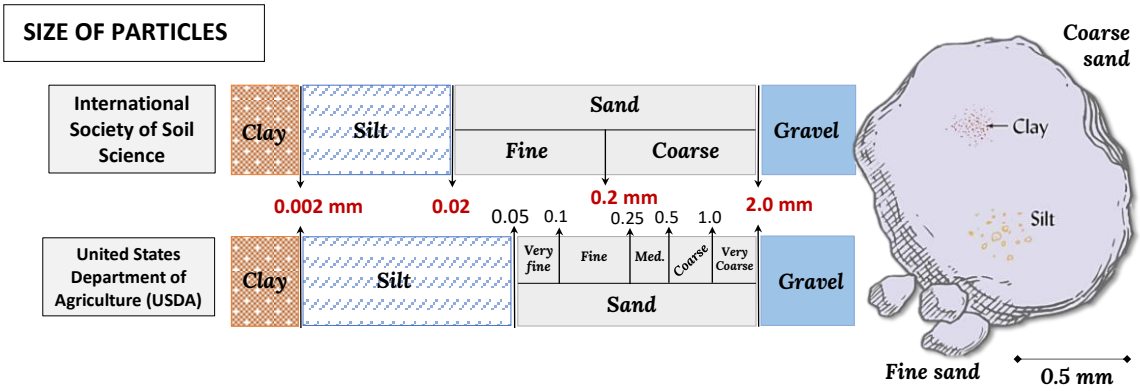
✍ Rocks are formed from the molten material known as *Magma*.
✍ *Petrology* = The study of rocks (in Greek, Petra means rock, Logos means science).
✍ *Petrogenesis* = Study of the origin of rocks.

CHAPTER 6

# SOIL PHYSICAL PROPERTIES

## 6.1 SOIL TEXTURE

The *relative percentage of sand, silt, and clay in the soil*[***]. Where *sand and silt work as a skeleton* of soil in which *clay particles fill as flesh*. The size of particles in mineral soil is not subject to change (*i.e.*, by cultural practices). Therefore, this composition is considered a permanent feature and a *basic property* of soil. Mechanical analysis of soil separates, *i.e.,* the percentage of sand, silt, and clay done by the *hydrometric method*.




- Clay particle size : < 0.002 *mm*[***]
- Soil texture refers to the relative amounts of sand, silt, and clay, and it directly affects a soil's *cohesion*, *adhesion*, and *plasticity*. Clay soils have a characteristically *fine/heavy texture*.
- **Loam soil** – (a) best suitable soil for agriculture purposes, (b) it contains *sand, silt and clay minerals in an equal property*[***] proportional and *not in equal percentage*.
- **Soil texture determination methods** : (a) Feel methods – Ball formation, Ribbon formation. (b) Laboratory method – Mechanical analysis.

### EXERCISE

**1.** The size of clay particles is [APPSC (ACF) 2022 General Forestry – I]
(a) <0.002 millimetres
(b) 0.002 to 0.003 millimetres
(c) >0.002 millimetres
(d) 0.002 to 0.004 millimetres

**2.** According to the International Society of Soil Science classification, the size of *silt particles* is [APPSC (ACF) 2022 General Forestry – I; OPSC Civil (pre) 2006]
(a) 0.02 mm
(b) 0.002–0.02 mm
(c) 0.002 mm
(d) 0.002–0.02 cm

**3.** ..... is the *size of clay particles* as per USDA classification of soil texture [APPSC (Forest Section Officers) 2019]
(a) <0.02mm
(b) <2mm
(c) <0.2mm
(d) <0.002mm

**4.** Soil separates are the size groups of mineral particles that are [APPSC (FRO) 2018 General Forestry Paper - I]
(a) Between 3 mm and 4 mm in diameter
(b) Between 4 mm and 5 mm in diameter
(c) Between 5 mm and 6 mm in diameter
(d) Less than 2 mm in diameter

1. (a), 2. (b), 3. (d), 4. (d)

CHAPTER 8

# AFFORESTATION OF DIFFICULT SITES

**CONTENT**

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

## 8.1 HOT DESERT AND SHIFTING SAND DUNES


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

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

(*Source* : Westland Atlas of India 2019)

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

- **Temperature** : 48 °C in may-June to 15°C during winter, even sometimes it goes below freezing point at several places.
- **Wind** : 100 to 150 km per hour are experienced during summer.
- **Soil** : Sandy in character with a well-developed *hardpan* of *calcium carbonate* at varying depths. Desert soils are purely mineral soils obtained by the mechanical disintegration of rocks. Characteristics : (i) Very low organic matter, (ii) High percentage of soluble salts, (iii) Low nutrient status, particularly nitrogen, (iv) High pH and calcium carbonate, (v) Structureless and coarse-textured, (vi) Very poor water holding capacity and (vii) Absolute deficiency of soil moisture.
- **Sand dunes** are the dominant form that covers around 60 % area of the Thar desert.

► **ISSUES** : (1) Poor nutrients & organic matter, (2) Unstable soil structure and often shifting of it (shifting sand-dunes) (3) poor water holding capacity, (4) High salinity and pH, (5) poor rainfall, (6) Formation of calcareous hardpan, etc.

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