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CGPSC

CHHATTISGARH

STATE FOREST SERVICE

Module - II

Single-Source Solution for *Forestry Optional*

This study material not only covers the entire syllabus and previous years' questions in a structured, topic-wise manner but also includes several emerging and important areas that are not explicitly mentioned in the **APPSC RFO/FSO 2025** examination syllabus but from which questions are likely to be asked.

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11 Out of 12 Total Selections in

Assistant Conservator of Forest (ACF) – 2023

CGPSC

STATE FOREST SERVICE (ACF/RFO)

FORESTRY

MODULE – 2

EDITION : 2026

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MODULE 2

PREVIOUS YEAR QUESTIONS

SYLLABUS

- ***Silviculture System*** : Introduction, Clear felling system, Shelterwood, Selection and coppice wood systems.
- ***Agroforestry, Social Forestry & JFM*** – Important commercial tree species of India and CG.
- Tree Improvement.
- Soil & water conservation & Watershed management.
- Forest management & Working plan.

CGPSC के आधिकारिक पाठ्यक्रम (Syllabus) में तो वानिकी के इन विषयों के केवल नाम दिये गये हैं। यहाँ उनके साथ संक्षेप में दिया गया पाठ्यक्रम, इन्हीं विषयों से संबंधित PYQs के विश्लेषण के आधार पर तैयार किया गया है, ताकि परीक्षार्थियों को एक सामान्य समझ विकसित हो सके।

AGROFORESTRY & SOCIAL FORESTRY

1. In Agroforestry, D and D approach was developed by [CGPSC Ass. Professor 2019]
(a) CRIJAF
(b) CAFRI
(c) ICRAF
(d) ICAR

2. Who has coined the term 'Social Forestry' [CGPSC Ass. Professor 2019]
(a) Jack Westoby
(b) Fair child
(c) J.L. Holechek
(d) R.D. Pieper

3. Ration between mid-height and width of shelter belt should be [CGPSC Ass. Professor 2019]
(a) 1:5
(b) 1:10
(c) 1:15
(d) 1:20

4. Silvi pasture means [CGPSC Ass. Professor 2019]
(a) Growing trees with grass
(b) Growing trees with annual crops
(c) Growing trees with fruit crops
(d) Growing trees with crops and horticultural crops

5. Integration of trees with pasture grasses and crops is called [CGPSC Ass. Professor 2019]
(a) Agri horticulture
(b) Agri pasture
(c) Agri silvipasture
(d) Agri silviculture

6. Shading effect of trees can be overcome by [CGPSC Ass. Professor 2019]
(a) Canopy management
(b) Root management
(c) Water management
(d) Fertilizer management

7. International center for research in agroforestry is located at [CGPSC Ass. Professor 2019]
(a) Nairobi, Kenya
(b) Vienna, Austria
(c) Bogor, Indonesia
(d) Ibadan, Nigeria

8. The components of agri silviculture are [CGPSC Ass. Professor 2019]
(a) Trees + Crops
(b) Trees on boundary + Crops
(c) Fruit trees +crops
(d) Block of trees + Crops

9. Tree crop modelling approach developed by CIFOR is [CGPSC Ass. Professor 2019]
(a) WaNuLCAS
(b) SBELTS
(c) SCUAF
(d) None of these

10. Which of the following is not under the development of social forestry programme? [CG Vyapam Ass. Project Ranger 2021]
(a) Farm Forestry
(b) Community Forestry
(c) Strip Plantations
(d) Control of Government

JOINT FOREST MANAGEMENT

11. How many areas (in lakh hectare) covered in joined forest management in the Chhattisgarh State? [CGPSC SFS 2016]
(a) 40.5
(b) 23.3
(c) 18.2

(d) 30.4
(e) None of these

TREE IMPROVEMENT

12. The term 'Heterosis' was first used by [CGPSC Ass. Professor 2019]
(a) Shull (1914)
(b) Jenkins (1940)
(c) Bateson (1903)
(d) Davenport (1908)

13. Which branch of genetics is concerned with study of frequencies of mating population [CGPSC Ass. Professor 2019]
(a) Population genetics
(b) Cytogenetics
(c) Eugenetics
(d) Behavioral genetics

14. The most commonly used method in crop improvement programme is [CGPSC Ass. Professor 2019]
(a) Intraspecific hybridization
(b) Interspecific hybridization
(c) Interparietal hybridization
(d) Both (a) and (c)

15. The method for quickest development of plant breeding varieties is [CG Vyapam Project Ranger 2021]
(a) Selection
(b) Hybridization
(c) Mutation breeding
(d) Introduction

SOIL & WATER CONSERVATION

16. Secondary macronutrients in plant fertilizers are [CGPSC SFS 2016]
(a) Ca, Mg, S
(b) H, O, C
(c) B, Cl, Zn
(d) Cu, Fe, Mn
(e) None of these

17. The percentage of CO_2 present in soil air is [CGPSC Ass. Professor 2019]
(a) 0.035
(b) 0.003%
(c) 0.3%
(d) 0.1%

18. Horizon A+B+C together is known as [CGPSC Ass. Professor 2019]
(a) Pedon
(b) Regolith
(c) Solum
(d) Soil surface

19. Law of minimum was given by [CGPSC Ass. Professor 2019]
(a) O.W. Willcox
(b) J.V. Liebig
(c) Jethro Tull
(d) Wallace

20. Laterization is a problem of accumulation of _____ in soil. [CGPSC Ass. Professor 2019]
(a) Iron oxide
(b) Aluminum oxide
(c) Both iron and aluminum oxides
(d) Silica

21. A soil with a pH of 3.2 is [CGPSC Ass. Professor 2019]
(a) Neutral
(b) Acidic
(c) Alkaline
(d) Saline

22. In soil forming process, Podzolization occurs when [CGPSC Ass. Professor 2019]
(a) Humus, sesquioxide and clay go down in horizon B by percolation from horizon A
(b) Humus, sesquioxide and clay go down in horizon C by percolation from horizon A
(c) Humus, sesquioxide and clay go down in horizon C by percolation from horizon B
(d) None of these

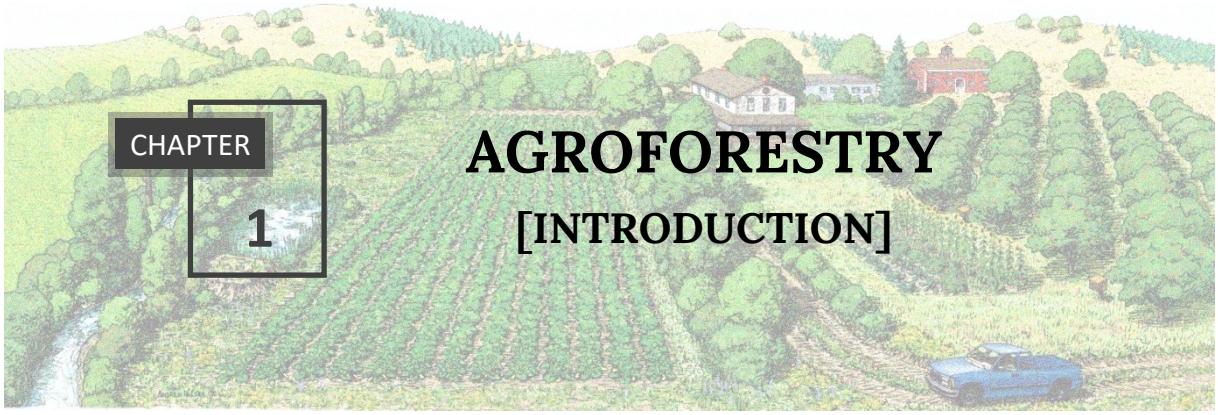
23. The S.I unit of cation Exchange capacity is [CGPSC Ass. Professor 2019]
(a) Cmol $(p^+)kg^{-1}$
(b) Cmol $(e^-)kg^{-1}$
(c) meq / 100g
(d) meq/100mg

24. Which of the following is a soil moisture constant [CGPSC Ass. Professor 2019]
1. Field capacity
2. Available soil moisture
3. Hygroscopic coefficient
4. Permanent wilting point
(a) 1,2 and 3 only
(b) 1 and 4 only
(c) 2 and 3 only
(d) 1,2,3 and

Silvicultur systems

25. System of successive regeneration felling is known as [CGPSC Ass. Professor 2019]
(a) Improvement felling
(b) Tree improvement
(c) Shelterwood system
(d) Pastoral system

26. Which law is used for estimating the proportionate distribution of trees in selection forests? [CGPSC Ass. Professor 2019]
(a) Mayer's law
(b) De Liocourt's law
(c) Wallace's law
(d) Fastman's law



CHAPTER 1

AGROFORESTRY
[INTRODUCTION]

Agroforestry is a ***sustainable land-use system*** that integrates ***trees***, ***crops***, and/or ***livestock*** on the ***same unit of land*** in a ***complementary*** and ***interactive*** manner. It enhances ***productivity***, ***sustainability***, and ***resilience*** of rural landscapes.

Historically, the concept is rooted in ***ancient Indian farming tradition***, where farmers planted trees along field boundaries and used them for ***timber***, ***fuelwood***, and ***fodder***. Modern agroforestry merges these traditional practices with ***scientific land management approaches***.

- Agroforestry systems are ***ecologically & functionally more complex than monocultures***, as they integrate multiple plant strata such as trees, shrubs, and crops.
- The integration of trees offers ***economic security*** and ***alternative investment opportunities*** to farmers by serving as a ***natural insurance mechanism***—even if agricultural crops fail due to drought or pests, trees continue to generate income through timber, fruits, or fuelwood.
- Rooted in indigenous traditions and socio-cultural practices.

KEY DEFINITIONS

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 ***simultaneously*** (*at the same time*), using ***management practices*** that are compatible with the ***local socio-cultural, economic,*** and ***ecological conditions*** of the area.

- ***Bene et al.*** (1977) : Agroforestry is a land-use system ***integrating trees***, ***crops***, and ***animals*** in a manner that is ***scientifically sound***, ***ecologically desirable***, and ***socially acceptable***.
- ***P.K.R. Nair*** (1979) : Agroforestry is a ***sustainable land-management system*** which ***increases the overall production*** yield by combining ***agricultural crops*** (annuals) with ***tree crops*** (perennials) ***and/or livestock simultaneously*** or ***sequentially*** on the ***same land unit***, using management practices that are ***compatible with the local social, economic,*** and ***ecological conditions***.

KEY ATTRIBUTES OF AGROFORESTRY

- ***Productivity*** : Maintains or increases overall yield and soil productivity.
- ***Sustainability*** : Conserves and enhances the production potential of resources. ***Cornerstone of agroforestry******
- ***Adaptability*** : The term *"adopt"* in this context refers to ***acceptance***, not *modification* or *change*. It implies that any **improved** or **newly introduced agroforestry technology** should be **compatible with local farming practices**, **traditions**, and **socio-economic conditions**, ensuring easy adoption by farmers.

IMPORTANCE AND SCOPE IN INDIA

Agroforestry holds vast potential in India because of its **synergy with traditional agriculture** and its contribution to multiple national commitments.

- **National Forest Policy (1988)** : Achieve 33% forest and tree cover through farm forestry and agroforestry.
- **India's NDC (Paris Agreement)** : Create an additional **2.5–3 billion tonnes of CO_2-equivalent carbon sink** through tree cover expansion.
- **UNCCD Target** : Restore **26 million hectares of degraded land** by 2030.
- **Agroforestry Policy 2014** : Encourages tree-based farming through simplified regulations, financial incentives, and convergence with national missions.

SCOPE IN DIFFERENT SECTORS

> *In one line*
> Agroforestry = Crop + Tree ± Livestock.
> The first two components are essential; ***livestock is optional***.

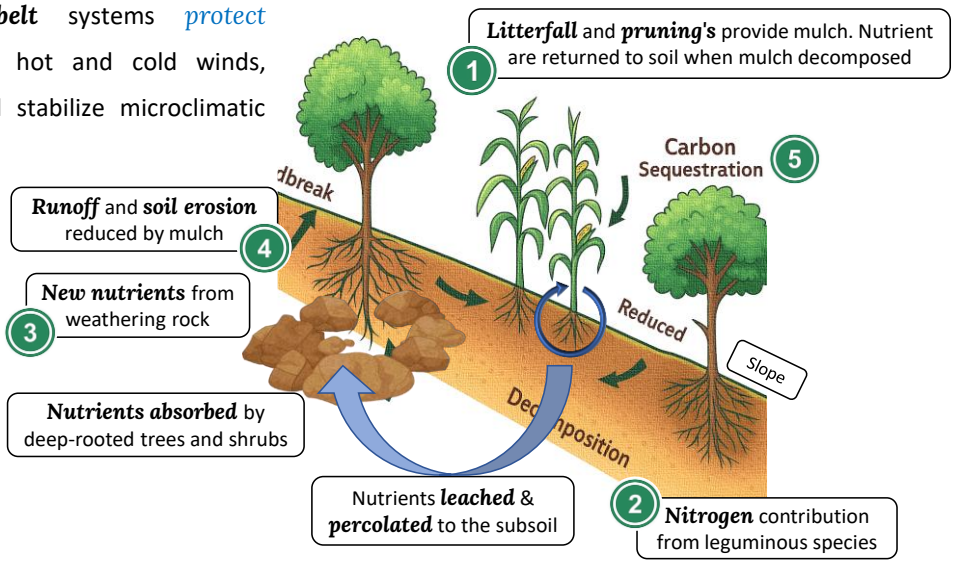
- **Agricultural Sector** : Enhances soil fertility and moisture, stabilizes yields. Meeting the domestic needs, *i.e.*, Food, fibre, fuel, and fodder.
- **Industrial Sector** : Provides raw materials for paper, pulp, plywood, and furniture industries.
- **Social Sector** : Creates rural employment and reduces migration.
- **Environmental Sector** : Acts as a buffer for biodiversity conservation and carbon sequestration.

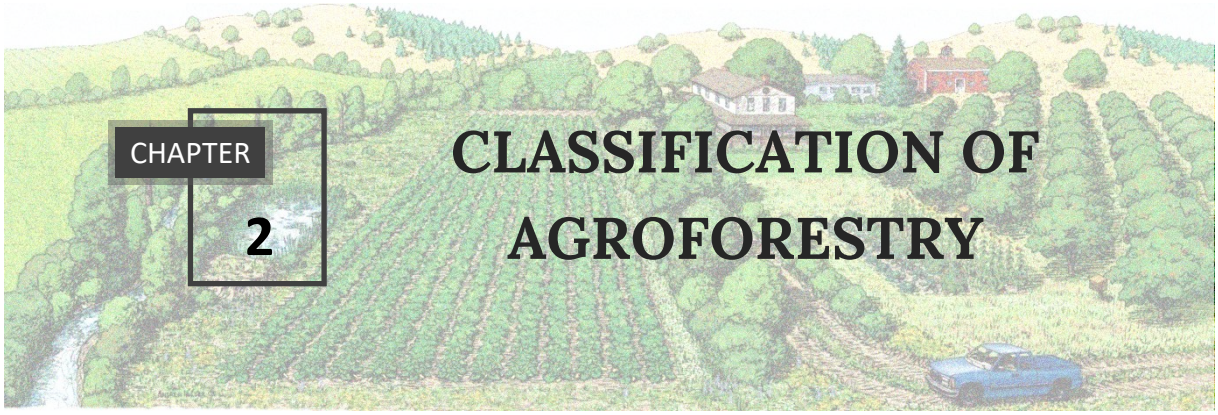
1.2 BENEFITS/ROLES OF AGROFORESTRY

Agroforestry promotes the cultivation of ***Indigenous Multipurpose Tree Species* (MPTS)** that supply fuelwood, fodder, timber, fruits, and medicinal products, along with ***High-Yielding Short-Rotation* (HYSR)** species that provide faster economic returns and livelihood security to farmers.

ENVIRONMENTAL BENEFITS OF AGROFORESTRY

- ***Reduced Pressure on Natural Forests*** : By meeting local demands for *fuel*, *fodder*, and *timber* from farm-grown trees.
- ***Climate Regulation and Mitigation*** : Tree components act as *carbon sinks*, contributing to *climate change mitigation* and overall improvement in ecological stability.
- ***Windbreak & Shelterbelt*** systems *protect agricultural crops* from hot and cold winds, reduce crop lodging, and stabilize microclimatic conditions.
- ***Soil & Water Conservation*** : The presence of tree roots and litter cover *reduces surface runoff*, *soil erosion*, and *nutrient leaching*, thereby conserving soil fertility and water resources.





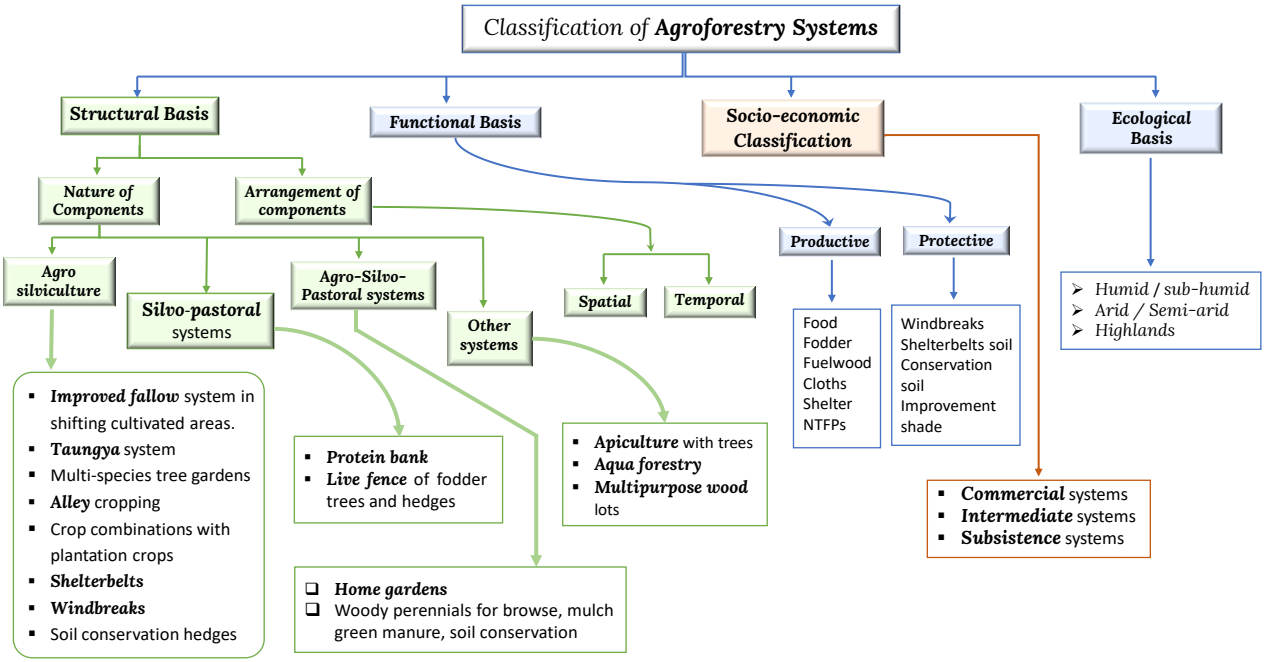
CHAPTER 2

CLASSIFICATION OF AGROFORESTRY

Agroforestry systems can be classified based on ***Structure***, ***Functions***, ***Socio-Economic*** settings, ***Ecological*** conditions, and ***Vegetation*** appearance. Two major scientists proposed widely accepted classification systems :

- **PKR Nair (1987)** : Classified agroforestry on **4 bases** :
  - ***Structural*** basis,
  - ***Functional*** basis,
  - ***Socio-economic*** basis, and
  - ***Ecological*** basis,
- **Tejwani (1994)** : Added a 5th category — ***Physiognomic basis***, making classification more comprehensive.

These classifications help understand **tree–crop–livestock arrangements**, **resource flow**, and **productivity interactions**.



- ***Physiognomic Classification*** : Based on ***appearance*** and ***ecological adaptations*** of vegetation – Xeromorphic, Mesomorphic, Hydromorphic, etc.

2.1 | STRUCTURAL CLASSIFICATION

2.1.1 | NATURE OF COMPONENT

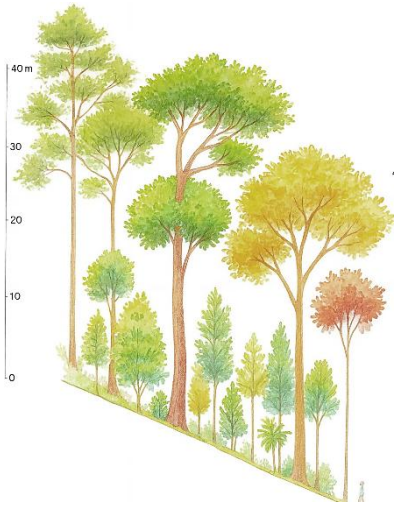
Agroforestry systems under this include : ◈ ***Agri-silviculture*** – Crops + Trees, ◈ ***Silvi-pasture*** – Trees + Pasture/Animals, ◈ ***Agri-silvi-pasture*** – Trees + Crops + Livestock, ◈ ***Other systems*** – Silviapiculture, Aqua-forestry, etc.

— *Microclimate Modification* : on the leeward side, reduce wind speed by ≈ 20–50% = ↓ soil moisture loss / evapotranspiration, and crop lodging = Improve crop yields by 5–25%.
— Minimize wind erosion = *Soil Conservation*.
— Increase *pollinator presence* and support beneficial biodiversity.
— Safeguard homes, farm buildings, livestock sheds, and roads from dust storms, cold and hot winds.
— Provide *timber*, *fuelwood*, *poles*, and *fodder* as an additional farm income source.
— *Require less land area* than shelterbelts → ideal where land prices are high.

► MULTI-SPECIES TREE GARDENS

A traditional agroforestry system in which *many different types of trees are grown together in a mixed and natural-looking manner*. There is *no fixed planting pattern*. Trees of *different heights*, *shapes*, and *growth habits* form a ***multi-layered canopy***, much like a ***small man-made forest***.

In these gardens, the ***overstorey*** is made up of tall timber or fruit trees, while medium-sized trees and shrubs form the ***middle layer***. The ***understorey*** usually has *very little herbaceous growth* because the shade is heavy, but *shade-tolerant plants such as spices, medicinal herbs, or small crops* may be grown where possible.



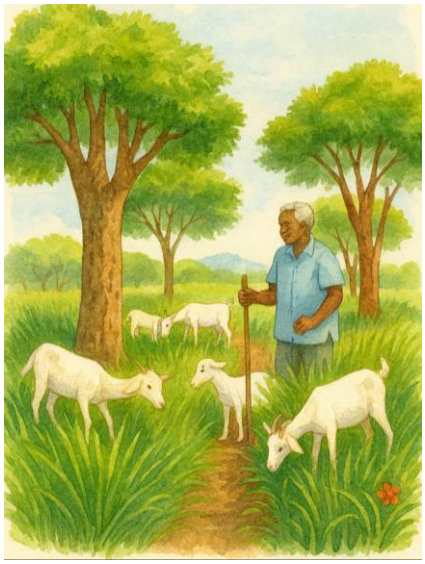
This system is mostly found in areas with ***fertile soils***, ***good availability of labour***, and ***high population density***, where people manage their land intensively. The main purpose of multi-species tree gardens is to produce *food*, *fodder*, *fuelwood*, and *timber* for daily ***household needs***.

B | **SILVI - PASTORAL** System

A *Silvopastoral system* is an agroforestry practice that integrates ***woody perennials (trees/shrubs)*** with ***pasture*** and ***livestock*** on the same land unit. This system optimizes land use by combining *tree production*, *fodder availability*, *soil improvement*, and *livestock grazing*.

► PROTEIN BANK

A *Protein Bank* is a specialized component of *silvopastoral systems* where *high-protein fodder trees* and *shrubs* are planted systematically in *farmland*, *field boundaries*, or *adjacent wastelands*. These plantations provide a *reliable source of protein-rich fodder*, particularly crucial *during lean periods*, *droughts*, or *fodder scarcity* seasons.



COMMON SPECIES

Protein banks mostly include ***fast-growing***, ***multipurpose***, ***nitrogen-fixing*** species, such as : Acacia nilotica, Albizia lebbeck, Azadirachta indica (Neem), Leucaena leucocephala, Gliricidia sepium, Prosopis spp., etc. These species are chosen for their *high crude protein content*, *coppicing ability*, *adaptability*, and *drought tolerance*.



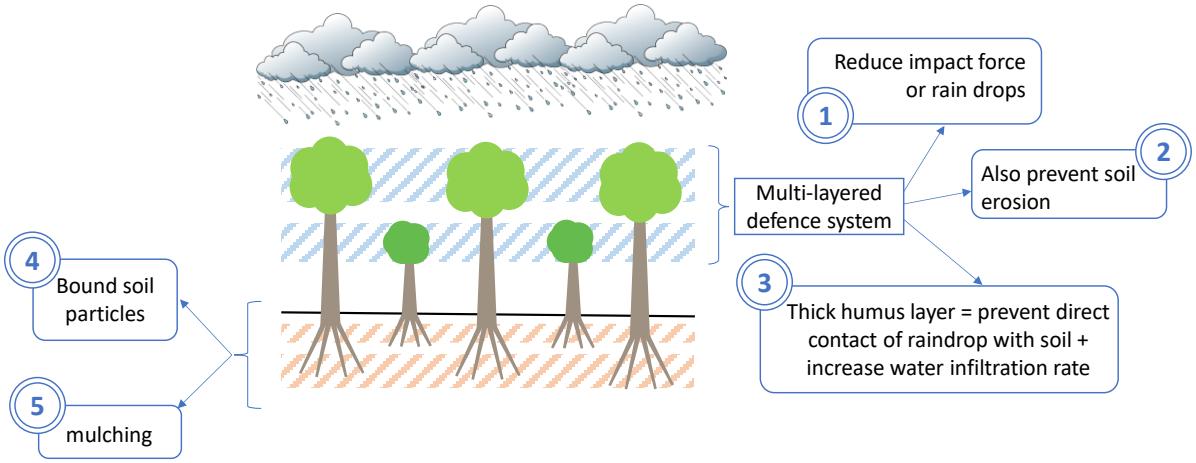
CHAPTER 3

ROLE OF TREES IN AGROFORESTRY

Trees form an *integral component* of agroforestry systems and contribute significantly to *ecological stability*, *agricultural sustainability*, and *livelihood diversification*. Their presence modifies the microclimate across *vertical (canopy–soil profile)* and *horizontal (field–landscape)* dimensions, thereby improving soil health, regulating microclimate, supporting biodiversity, and enhancing ecosystem resilience.

► ROLE IN SOIL AND WATER CONSERVATION

Agroforestry integrates *trees* with *crops/livestock* systems, creating a *multi-layered vegetation structure* that plays a critical role in *soil & water conservation*, especially in *erosion-prone*, *dryland*, and *hilly watershed* landscapes.



- ***Multi-tiered canopies*** (upper, middle, lower foliage) reduce *kinetic energy of rainfall*. Prevents *soil particle detachment*, *splash erosion*, and *crust formation*. Acts as the *first line of defence* against soil degradation.
- Hedgerows act as ***windbreaks***, lowering wind speed on the leeward side = Reduces ***wind erosion, desiccation***, and protection of food crops.
- Continuous deposition of litter forms ***natural mulch*** = Enhances ***soil aggregation***, reduces ***compaction***, and increases *infiltration* (↑ Porosity) = Improves *soil water-holding capacity*, reduce *run-off*, and evaporation loss.
- Deep roots : enhance ***vertical water percolation*** + ***Reinforcing soil*** = Act as bio-drainage systems in waterlogged areas + Supports groundwater recharge and base flow.

► ROLE OF TRESS IN NUTRIENT RECYCLING / PRODUCTIVITY

Trees significantly enhance soil fertility and overall productivity by ***improving nutrient cycling***. Their key functions include :–

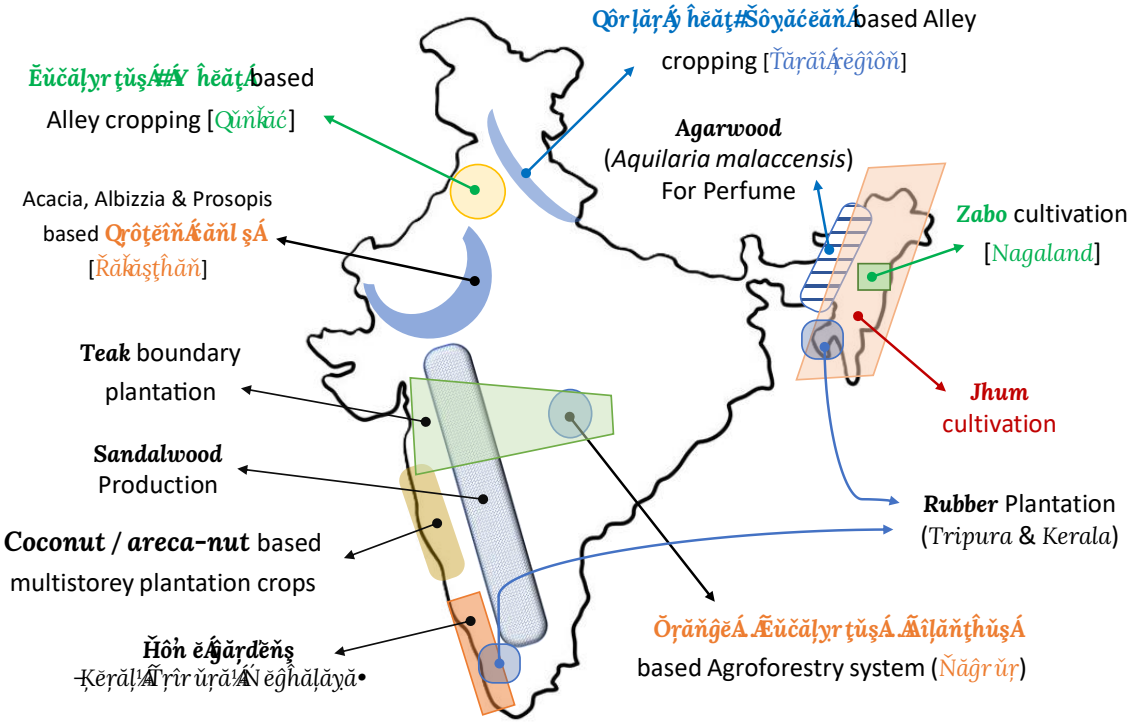


CHAPTER 5

COMMERCIAL AGROFORESTRY SYSTEMS

5.1 | COMMERICAL AGROFORESTRY

Commercial agroforestry refers to *high-density*, *market-oriented plantation* systems integrating trees with crops/livestock to maximize productivity, profitability, and sustainability. In India, this approach has expanded due to ***industrial raw material demand***, ***climate commitments***, and ***farmers' income diversification goals***.



▶ North India (Temperate & Sub-tropical Zone)

States	Major Tree Species	Commercial Focus / Industry Linkages
Punjab, Haryana, Western UP	*Populus deltoides* (Poplar), *E. tereticornis* (Eucalyptus), *Melia dubia*, etc.	Plywood, Matchwood, Packing cases, Paper mills, Agro-based industries
Himachal Pradesh, Uttarakhand	Walnut, Chilgoza, Apple-based agroforestry	Dry fruit & horticulture processing industries

▶ Central India (Tropical area)

States	Major Species	Commercial Use
MP, CG	Teak, Bamboo, Subabul (Leucaena), Gamhar (Gmelina arborea)	Furniture, construction timber, paper & pulp
Maharashtra	Melia dubia, Sandalwood (Santalum album), Bamboo, etc.	Medical, perfumes, plywood & pulp

CHAPTER

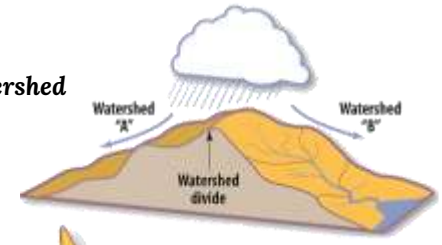
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WATERSHED MANAGEMENT

9.1 | WHAT IS WATERSHED ?

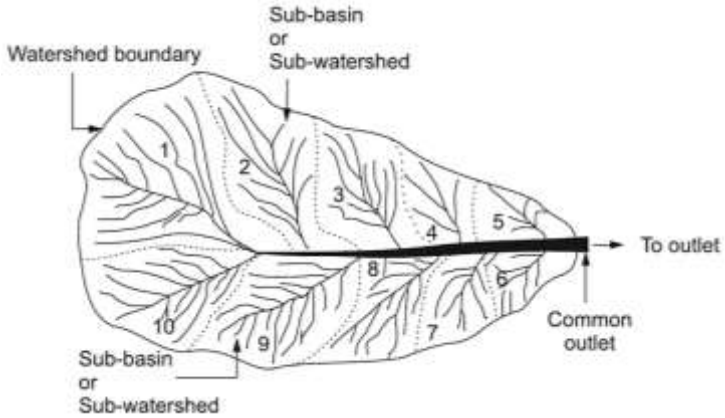
A ***watershed*** is a *natural geo-hydrological unit* of land within which *all precipitation* —rainfall or snowmelt—*collects and drains through a common outlet* such as a stream or river, following the natural slope of the terrain. It encompasses both *surface water flows* (runoff through streams and channels) and *subsurface flows* (groundwater movement).

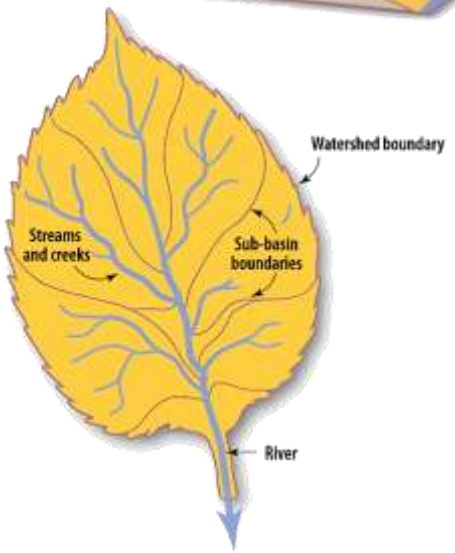
It forms a natural hydrological system integrating *physical*, *biological*, *socio-economic*, and *human* components, making it a holistic approach to natural resource management.



Key Features

— Defined by natural ridges and hilltops acting as boundaries (or ***watershed divide***).
— Converts precipitation into runoff and groundwater recharge
— It includes both surface & ground water flow



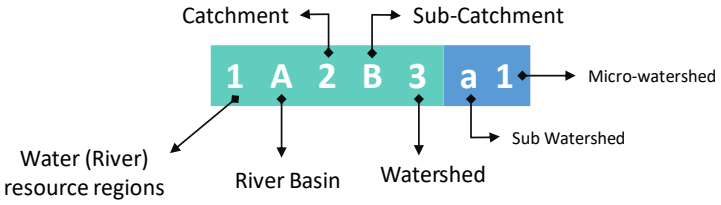


WATERSHED MANAGEMENT

Watershed Management refers to a scientific process of planning, utilization, and conservation of land, water, and vegetation within a watershed area to ensure sustainability. It integrates ecological stability with socio-economic welfare and resource governance.

Objectives

— *Conservation of soil and water* by controlling damaging runoff.
— Enhance *water retention capacity* of land.
— Promote *rainwater harvesting* and groundwater recharge.
— Improve agricultural productivity and *rural livelihood*.
— Increase *vegetative cover* (trees, crops, grasses).
— Control *droughts and floods* through hydrological balancing.



Hydrological Units	Code	Size range
Water resource region	2	2.7 Crore to 11.3 Crore hectares. ***Codes*** : 1 = Indus drainage; 2 = Ganges drainage; 3 = Brahmaputra drainage; 4 = All drainage flowing into the Bay of Bengal except the Ganges and Brahmaputra; 5 = All drainage flowing into the Arabian Sea except the Indus drainage; 6 = Western Rajasthan (mostly ephemeral drainage).
Basin	A	Each water resource region is divided into several basins (A, B, C, D, etc.) **Size range** : 30 lakh to 3 crore hectares.
Catchment	1	Represents the drainage area of a ***primary river***, usually covering **10 – 50 *lakh hectares***.
Sub Catchment	A	Represents the drainage area of a ***secondary river (tributary)***, usually covering **2 – 10 *lakh hectares***.
Watershed	2	Drainage area associated with ***tributaries of the secondary river***, ranging from **20,000 – 3,00,000 *hectares***.
Sub-Watershed	a	Area between **5,000 – 9,000 *hectares***.
Micro Watershed	2	Final stage of delineation. ***Streamlets of the 4th-order (pentad) river*** have a drainage area of about **500 – 1,500 *hectares***.

EXAMPLE : Match List-I (Drainage Unit) with List-II (Watershed code) and select the correct answer using the code given below [CGPSC Forest Service (Combined) Examination 2020]

List-I (Drainage Unit	List-II (Watershed code)
(a) Watershed	(i) 4B2A3a1b
(b) Catchment	(ii) 4B2
(c) Basin	(iii) 4B
(d) Micro watershed Gr-1	(iv) 4B2A3

Code :

	(a)	(b)	(c)	(d)
(A)	(i)	(ii)	(iii)	(iv)
(B)	(iv)	(iii)	(ii)	(i)
(C)	(iv)	(ii)	(iii)	(i)
(D)	(i)	(iii)	(ii)	(iv)

Correct Answer : (C)

— **Land capability & suitability assessment** using surveys for soil depth, slope, erosion status, and crop suitability.



Class	Colour code	Limitations	Suitable to use
Land Suitable for Cultivation			
I	*Green*	Excellent cultivable, deep, nearly level and productive land with almost no limitations. *Special management practices are not required*	*Required good soil management practices only = Suitable for the most of crops.*
II	*Yellow*	Moderate conservation practices necessary.	Suitable for crops like wheat, barley, and cotton.
III	*Brown*	Intensive conservation practice necessary	Suitable for many crops. Unsuitable for vegetable crops.
IV	*Pink*	Fairly good land or moderately steep slopes.	Suitable for *perennial vegetable only*.
Land Unsuitable for cultivation but suitable for permanent vegetative cover (for grazing)			
V	Dark grey	The *land is not suitable for arable farming*. Have No *limitations for use*.	Very suitable for ***Grazing*** or ***Forestry***
VI	Orange	Non-arable land. Have *moderate limitations in use*, e.g., steep slopes.	Suitable for ***grazing*** *or* ***Forestry***
VII	Red	Non-arable land. Have *severe limitations in use*, e.g., steeply sloping land.	Fairly well suitable for ***grazing or forestry***. However, required careful management.
VIII	Purple	Non-arable, extremely rough, rocky, arid, wet or extremely saline soil. Have very severe limitations	Suitable only for ***wildlife or recreation purposes***.

— **Problem identification** related to soil erosion, water scarcity, degraded forests, flood hazards, gully formation, and roadside erosion.

— **Recommended management interventions** for agricultural lands, forest lands, grazing lands, wastelands, and water bodies (structural + vegetative measures).

- ***Macro-catchment*** *rainwater harvesting* : involves collecting runoff from a relatively large catchment area, often located outside the cultivated fields. The catchment may consist of : Natural rangelands, Degraded forest lands, Rocky slopes, Steppe or mountainous areas.

  Runoff from these areas is then **diverted, slowed, or stored** and used for agriculture, forestry, pasture, or recharge.

  - ***Wadi-Bed Systems*** : A **wadi** (or nala / seasonal stream) is a natural channel that carries water only during rainy periods. In **wadi-bed rainwater harvesting**, the **bed of the seasonal stream itself** is used to store and utilize water.
    - Water is held **on the surface** by constructing **check dams, weirs, earthen bunds or gabion structures**, which slow down flow and create temporary ponds.
    - Water is also stored in the soil profile, as slowing the flow allows more infiltration into the wadi bed, recharging **shallow aquifers and root zones**.
  - ***Off-Wadi (Off-Channel) Systems*** : Under this, the runoff that flows through wadis or small streams is **diverted to areas outside the channel**, which are more suitable for cultivation or plantation.
    - Diversion structures, small canals or field channels are built to **guide water from the wadi** to nearby **agricultural fields**, **pasture lands**, or **tree plantations**.
    - This allows using seasonal floodwater for **supplemental irrigation**, soil moisture recharge, and **plantation establishment** without cultivating directly on the wadi bed.

TRADITIOONAL WATER HARVESTING SYSTEMS

- ***Tanka***[***]*(or* ***Kund/Kundi)*** : In the ***desert & arid regions of Rajasthan***[***], well or kund type structure build around in almost *every* ***house***, *near* ***schools*** *and* ***temples***, ***agricultural fields***, *and* ***barren lands***. They serve both individual households and village communities, using locally available materials.



Traditional Tanka with Treated Catchment in Churu District



An Improved Tanka Designed & Constructed by CAZRI

Tankas are typically built with stone masonry or cement/lime plaster, while some *kuccha* structures use wooden covers with mud plaster. Inlets at ground level allow rainwater to enter, and *pacca* Tankas have walls raised above the ground for water entry.

Before the monsoon, the catchment area is cleaned, and grazing or human activity is restricted to avoid contamination. Despite very low rainfall (200–300 mm annually, sometimes only 120 mm), these structures can store sufficient drinking water for summer months, and often for the entire year.

- ***Khadin (Dhora)*** : An ingenious traditional system used in the arid regions of ***Jaisalmer***, Rajasthan to harvest surface runoff for agriculture. It consists of a long earthen embankment (bund) 100–300 m in

CHAPTER 1

FOREST SOIL

[INTRODUCTION]

1.1 WHAT IS SOIL ?

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

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

PEDON ?

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

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

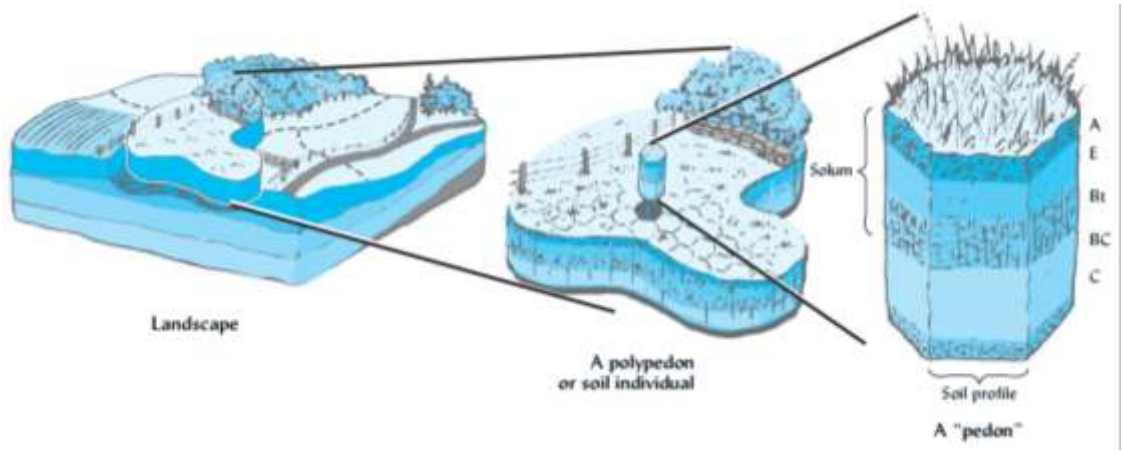


Figure 1.1 : Pedon is a natural body of soil that is large enough to allow classification of the soil.

PEDOLOGY : Pedology = Pedon + Logos = Greek word

↓ ↓

Soil/Earth Study

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

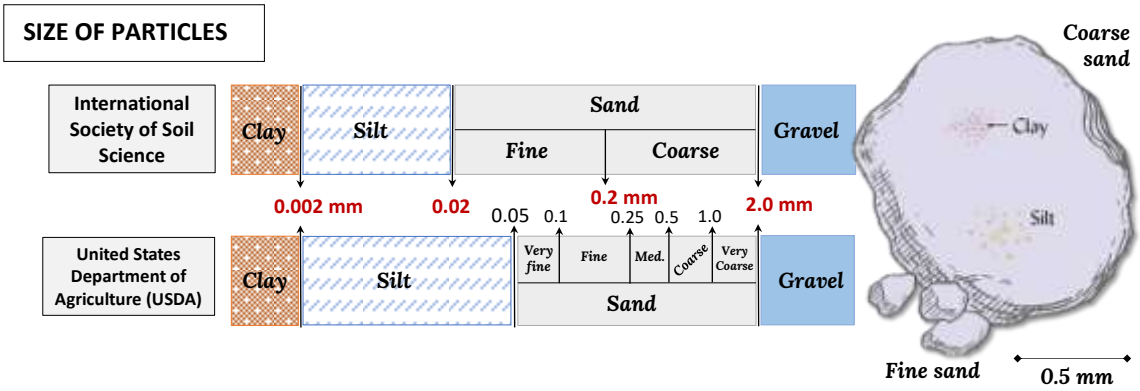
- Soil genesis : the mode of origin of soil with particular reference to the processes and soil-forming factors responsible for the development of solum or true soil.
- Soil survey : consists of morphological examination, description, classification, and mapping of soils in their natural environment.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

CHAPTER 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)

EXERCISE

5. The arrangement of soil particles (sand, silt and clay) within the soil is termed as [BHU M.Sc. (2014) Agroforestry]
(a) Soil structure
(b) Soil colloids
(c) Soil texture
(d) Soil tilth

6. Arrangement of individual soil particles into aggregates is called [BHU (M.Sc.) Agroforestry 2016, 2018]
(a) Soil class
(b) Soil structure
(c) Soil texture
(d) Soil Group

7. Which of the following does not recognize the soil structure [BHU M.Sc. (2019) Agroforestry]
(a) Platy
(b) Prismatic
(c) Blocky
(d) Clay loam

8. Which one of the following soil structures has the highest hydraulic conductivity [ICAR (JRF/PhD) 2020]
(a) Platy
(b) Prismatic
(c) Crumby
(d) Blockey

9. The cation exchange capacity of the soil depends on [TNPSC Forest Apprentice 2018]
(a) Clay content
(b) Sand content
(c) Silt content
(d) Gravel content

Answer-key : 5. (a), 6. (b), 7. (d), 8. (c), 9. (a)

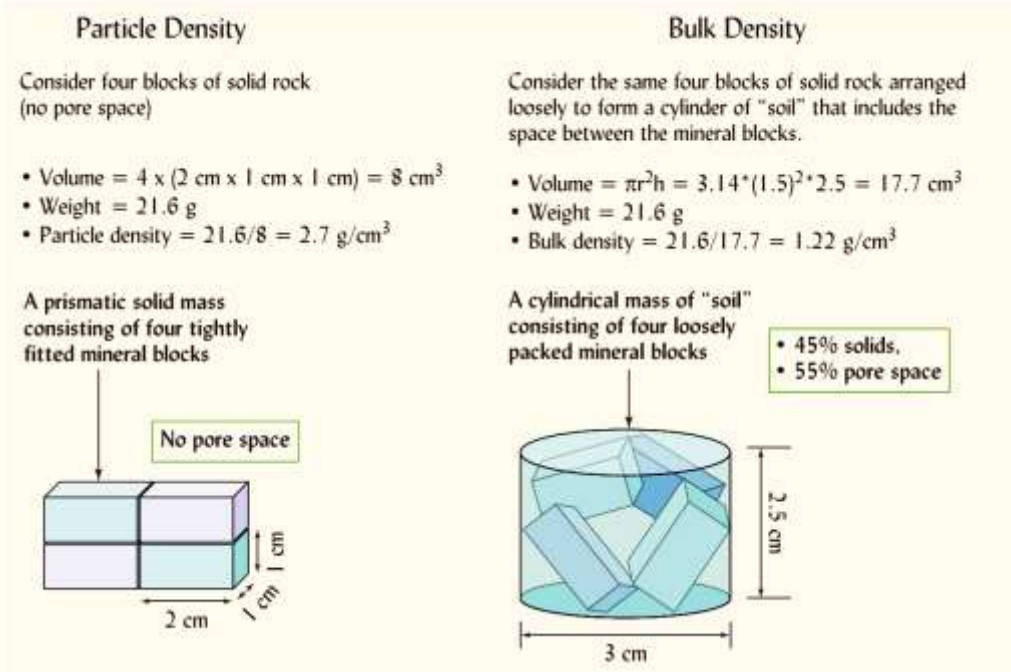
6.3 SOIL DENSITY

Mass per unit volume*** [Unit = **Gram/cm^3**]***

Types

- **Particle density** or *True* **density** : weight per unit volume of the solid portion of the soil.
- **Bulk density** : weight per unit volume of dry soil. It included a *volume of solid & pore space*. It is *always smaller than particle density*.

Example : fine texture soil (clay soil) = Higher pore space = Low Bulk density.



When organic material is added to the soil in root residue, manure, corn stalks, etc., the increased carbon triggers microbial growth. If the amount of N in the added material is inadequate to support the increased growth of microbes, the microbes will absorb N from the soil and immobilize it in their tissues. This will deprive growing plants of the nitrogen they need for immediate growth. As carbon breaks down, larger microbe numbers decrease and N is now released again into the soil. The more stable 10 : 1 C : N ratio can now be established.

- If C: N ratio is higher = Greater competition for Nitrogen
- Low nitrogen, high carbon residues, such as wheat straw, have low nutritional quality for microbes and take longer to decompose.
- C : N ratios also provide clues about the microbial population present, as higher ratios tend to support more fungi present in the soil than bacteria
- A wide C : N ratio leads to a slow decomposition rate, nutrient immobilization may occur, and carbon and energy wastage in large quantities.

TYPES

- **Low C:N ratio (less than 20:1)** : This indicates that there is more nitrogen available than carbon for soil microbes. This can lead to rapid decomposition of organic matter and the release of nitrogen for plant growth. However, if there's too little carbon, microbes may start breaking down existing soil organic matter to meet their energy needs, which can deplete soil health in the long run.
- **Optimal C : N ratio (around 24:1)** : This is considered the ideal range for most soils. It provides enough readily available carbon for microbes to function efficiently while still allowing for some nitrogen release for plants.
- **High C : N ratio (greater than 30:1)** : This indicates that there is more carbon than nitrogen available for microbes. In this case, microbes will compete with plants for available nitrogen, limiting plant growth. The decomposition of organic matter will also slow down.



EXERCISE

10. C : N ratio is a measure of [BHU (M.Sc.) Agroforestry 2016]
(a) Nitrate status in soil
(b) Organic matter
(c) CO_2 in soil
(d) Biomass carbon

11. The C : N ratio of cultivated soils ranges from [APPSC (RFO) 2022 General Forestry – I]
(a) 8 : 1 to 15 : 1
(b) 10 : 1 to 12 : 1
(c) 20 : 1 to 30 : 1
(d) 4 : 1 to 9 : 1

Cultivated soils typically have a C:N ratio in the range of 8:1 to 15:1. This is because they contain a mix of organic matter with varying C:N ratios. Legumes and manure have a higher C:N ratio (20:1 to 30:1), while decomposed organic matter has a lower ratio (around 10:1).

12. If a microorganism has its body C : N ratio 6 : 1 what will be the exact value of the substrate C : N ratio that can be decomposed [BHU (M.Sc.) Agroforestry 2016]
(a) 6 : 1
(b) 12 : 1

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CHAPTER 1

SILVICULTURE SYSTEM

INTRODUCTION

Silviculture

Silviculture is the *art and science of cultivating forest crops*. It deals with the natural laws governing the growth and development of trees and forests, the influence of *environmental factors* upon them, and the techniques of *regenerating them — naturally or artificially* — and *tending* them through their life.

Silvicultural System ?

Forests in India are not all the same. They differ in the *kinds of trees* they have, the *climate*, the *soil*, the *terrain*, and the *biotic pressure*. Because of these differences, one single method of *growing*, *managing*, *Tending* and *Harvesting* cannot work everywhere. If we use the same method in every forest, the crop may fail.

So, foresters have made different methods to manage different types of forests, based on local conditions. Each such method is called a ***Management System*** or a ***Silvicultural System.***

To study these methods, compare them, and talk about them easily, we need to give them proper names. Like the clear felling system, where we harvest the mature crop in single operation (in one go), or the shelterwood system, where we grow a younger crop under the shelter of the older ones before harvesting them — this protects young seedlings from frost, sun, and soil erosion, especially on sensitive or sloping sites.

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

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, includes a method of regeneration, and continues through tending until the next felling cycle.*

- A silvicultural system is a process of tending, harvesting, and replacing with new crops.

1.2 ESSENTIAL CHARACTERISTICS

Every silvicultural system, whatever its name, embodies four essential characters.

- ***Method of Regeneration*** : It may be obtained by *Seed* (self-sown or sown artificially), by *Coppice*, or by other *Vegetative Methods* (root suckers, layering, pollards). *Mode of regeneration is the primary axis of classification* in the Indian system — it splits all systems into ***High Forest*** (seedling origin) and ***Coppice*** (vegetative origin).
- ***Pattern of felling*** : How the *mature crop is harvested* — by a single clear-fell, by a series of regeneration fellings spread over years, or by selection of individual trees. The pattern depends on the silviculture of the species, intensity of demand, accessibility, and local conditions. Crucially, the *pattern of felling*

CHAPTER 2

Clear Felling System

Humans have been doing agriculture since ancient times. Therefore, when the demand for timber gradually increased in Europe towards the end of the 17th century, people had to think about growing trees on a large scale. At that time, the most familiar method before them was agriculture. People already knew how to grow crops in fields. So, they applied the same idea to tree cultivation also.

The method was very simple,

- First, the land was prepared properly.
- Then seeds were sown directly or seedlings raised in a nursery were planted at proper spacing.
- After planting, the crop was protected and maintained.
- After planting, the crop was protected and maintained.
- Finally, when the trees became mature, the whole crop was harvested in one go, just like what we doing with the wheat crop harvesting.

In this way, when commercial timber production began, people started treating trees almost like agricultural crops. They grew the trees, managed them, and finally harvested the entire crop area in one operation. This method is known as the ***Clear-Felling System***.

But the story doesn't end here. Once the system was popularized, they started adopting it in large patches, about 500-1000 hectares or even larger areas, to scale the production, but in practice, it created several new challenges:

[Challenge 1] *Sudden Bulk Labor Requirement* : At the time of harvesting the old crop and immediately after that, for site preparation and planting of the new crop, a large number of skilled labourers were needed. Arranging such a large workforce suddenly was sometimes impossible. Once this short burst of work was over, there was no further activity for the next several years until the tending operations began. The growers could not afford to "*free mein bitha ke khilana*"—that is, keep the labourers idle on payroll for years together. As a result, the trained workforce would scatter away, and finding skilled labour again at the next harvest became a fresh headache.

[Challenge 2] *Long waiting period for the grower* : The grower had already invested heavily in raising the crop, and now he had to wait for the next 20, 30, or even more years, only speculating whether the final harvest would give good returns or not.

[Challenge 3] *Non-uniform production* : The productivity of land is never uniform across the entire region. Some patches give better growth, and some give poor. Therefore, the timber yield from a single big harvest is also uncertain from area to area.

[Challenge 4] *European economies required a regular timber flow,* it may be fixed, but at least regular to maintain its growth. Irregular supply may destroy local timber market.

The solution they came up with

To overcome all these difficulties together, foresters introduced a very practical arrangement — They divided the entire forest area (under production) into a few number of *equal productive* or *equal-size* (*equi-extensive*) plots, called – *annual coupes*, equal to the number of years of the rotation.

Now every year, harvesting and regeneration work is carried out in one coupe. This single change solved many problems in one go:

— Labourers got continuous work throughout the year, every year, which made it possible to keep them as a permanent and trained workforce.
— The local timber market started getting a regular annual timber supply.
— And most importantly, it secured a steady and reliable annual supply of timber (*Sustained Yield*) = something badly needed for the rapidly expanding European economy of that era.

▶ The ***Clear-felling*** system is *a silvicultural system in which equal or equi-productive areas of a mature crop are successively clear-felled in one operation and regenerated, most frequently artificially but sometimes naturally.*

▶ ***Annual coupe***[***] : Suppose the rotation length is n years. To harvest the forest in a planned way, the total area under the system is divided into n equal parts. Each year, one such part is clear-felled. This area, felled in a single year, is called the *annual coupe*. Annual coupes are usually numbered using Roman numerals — I, II, III, and so on — to show the order in which they will be harvested.

When the site is *uniform* (that is, all parts of the forest grow equally well), the area is divided into coupes of equal size. Such coupes are called *equi-extensive* coupes. When the site is *heterogeneous* (some parts are fertile and some are poor), equal-sized coupes will not give equal yield every year. In such cases, the forest is divided into *equi-productive* coupes — coupes that produce roughly the same quantity of wood each year.

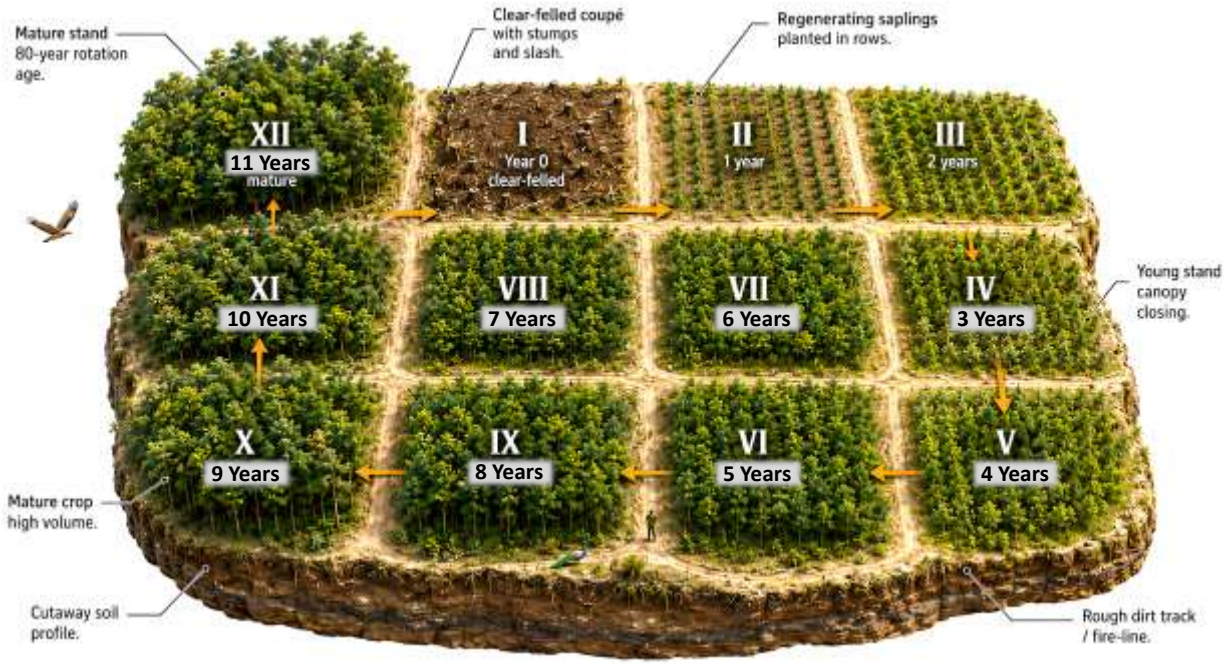


Figure 2.1 : A clear-felling system showing a production area divided into 12 *equi-extensive annual coupes*. ◈ **Coupe I** : Freshly harvested, soil preparation is underway and regeneration activities are about to begin. ◈ **Coupe II** : harvested one year ago, with regeneration carried out at that time; one-year-old seedlings are now visible. ◈ **Coupe III** (adjacent plot) : Two-year-old saplings, ◈ **Coupe XI** : the crop is nearly mature and is scheduled for harvesting next year. *below-ground root competition* and *biodiversity characteristic* at each stage are also illustrated.

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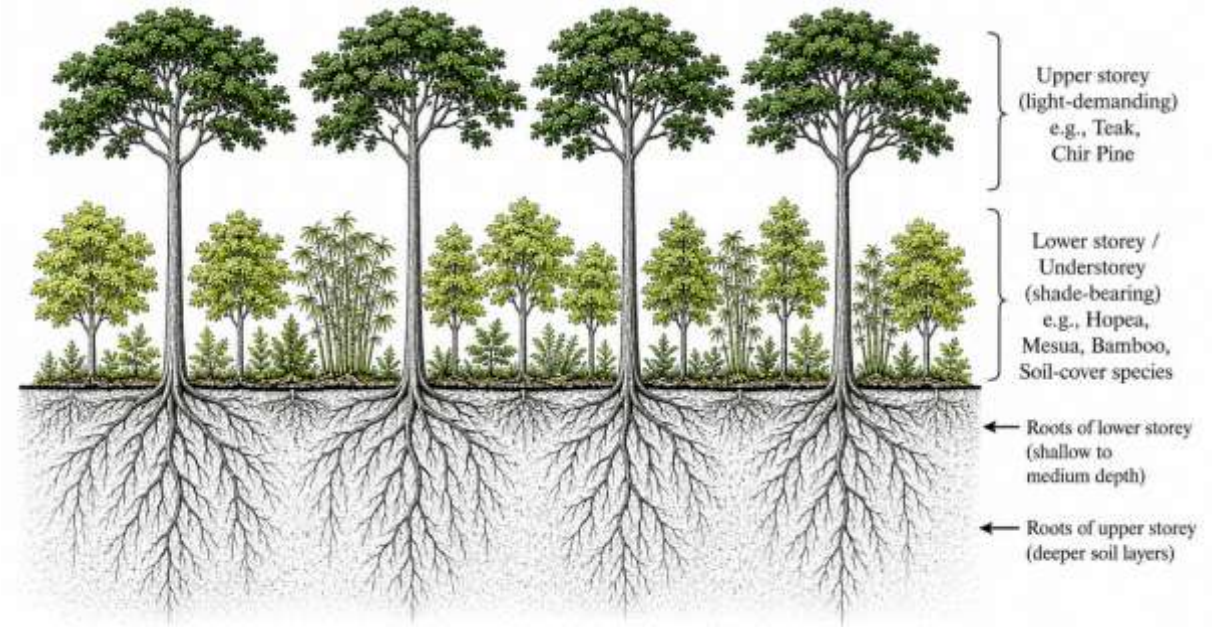
CHAPTER 5

ACCESSORY SYSTEM

Accessory systems are *high forest systems derived from other even-aged systems* by *modifying their silvicultural technique*, thereby resulting in an *irregular* or *two-storeyed high forest*. These include—

5.1 TWO-STOREYED HIGH FOREST SYSTEM

The ***two-storeyed high forest system*** is an accessory silvicultural system that produces a *two-storeyed forest*, in which the canopy is differentiated into *two distinct strata*. Each storey is *approximately even-aged* and is usually of *seedling origin*.



⊳ *Advantages / Objectives*

— Propagation of valuable species which cannot be raised in the open, *i.e.*, Shade-bearing or frost-tender species.
— Growing two crops on the same area = ↑ Total volumetric production = ↑ Income.
— Gradual change of species → transitioning a forest from one dominant species to another over rotations, without a clear-felling pulse.
— Vertical mixture in species composition = ↑ site-factor utilisation + Mimics natural multi-layered forests.
— Early returns : short-rotation lower storey gives intermediate income while upper storey matures.
— Protection of soil : when the upper storey fails to cover.

⊳ *Disadvantages*

— Operationally difficult : under-planting is delicate, painstaking, labour-intensive. Failures common.
— Damage to under-storey : during thinnings or fellings in the upper storey, the lower storey is often crushed or damaged.

EXERCISE – 9.1

1. Which of the following is the felling cycle of bamboo in India? [ICAR (PG) 2017; TNPSC Forest Apprentice 2018; Nagaland PSC CTSE 2021; Assam ASCO 2022]
(a) 3-4 years
(b) 4-5 years
(c) 5-6 years
(d) 5-10 years

2. Bamboo forests are regenerated by adopting a felling cycle of [APPSC (RFO) 2022]
(a) 6 – 9 years
(b) 3 – 4 years
(c) 10 – 12 years
(d) 15 – 16 years

3. The silvicultural system which is adopted for bamboo forest is [ASRB – ARS (NET) 2015; Nagaland PSC CTSE 2016, 2017, 2021]
(a) Group selection system
(b) Culm selection system
(c) Coppice selection system
(d) Accessory system

4. _____ Is the silviculture practice generally applied to manage/maintain *Dendrocalamus strictus* [APPSC (ACF) 2022]
(a) Uniform shelterwood system
(b) Culm selection system
(c) Group shelterwood system
(d) Coppice system

5. Bamboo should be cut at a height of [Nagaland PSC CTSE 2021]
(a) 15 cm
(b) 20 cm
(c) 30 cm
(d) 50 cm

6. The recommended silvicultural system for roadside plantation is [NTA–ICAR (PG) 2020]
(a) Clear felling
(b) Shelter wood system
(c) Simple coppice system
(d) Coppice with reserve system

9.3 CANAL-SIDE PLANTATION

Canal-side plantations are raised on the *strips* owned by the Irrigation Department along both banks of canals — strips originally used for service-roads and earthen borrow-pits for canal repair. UP again pioneered the transfer of these strips to the Forest Department for plantation work.

OBJECTS OF MANAGEMENT

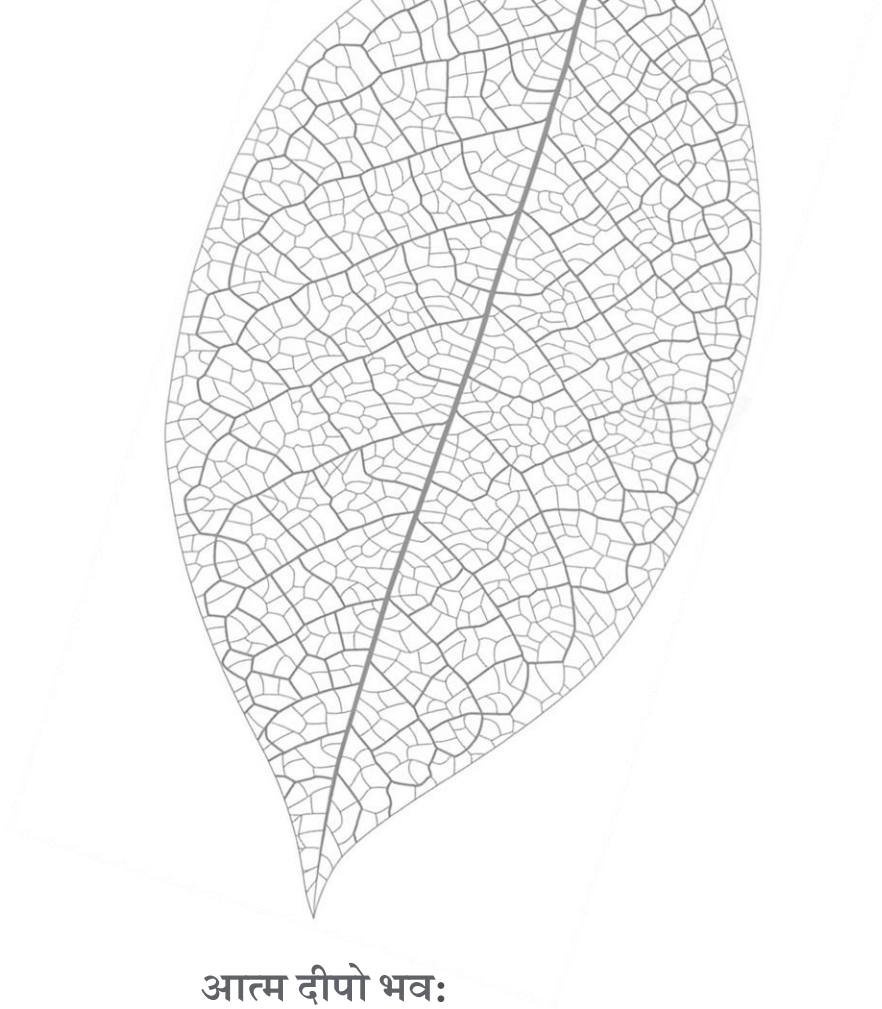
— Stabilisation of canal banks against erosion + reduction of seepage losses through transpiration.
— Provide shade for service roads + canal-management staff.
— Meet local population's small-timber + fodder + MFP needs in linear belts.
— Production of fast-growing fuelwood / pulpwood / poles for industry = Eucalyptus, Sissoo, Casuarina.
— Aesthetic + landscape value along canal corridors.
— Carbon sequestration + state revenue from short-rotation industrial wood.
— Climate-resilience — moderate the adjacent canal command area's micro-climate.

SILVICULTURAL SYSTEM

Clear-felling followed by ***Artificial Regeneration*** through sowing or planting. Short rotation (8-12 yr Eucalyptus / 10-15 Yr Casuarina / 25-30 Yr Sissoo). Strip is divided into Felling Series — usually one canal-segment = one Felling Series — each km / mile = one compartment = one coupe.

PREFERRED SPECIES

— *Western Yamuna Canal* + *Bhakra Canal* + *Sutlej-Yamuna Link* (Haryana, Punjab) : *Eucalyptus* + *Dalbergia sissoo* — among the most productive canal plantations in the country.
— *Indira Gandhi Nahar Project* / *Rajasthan Canal* : *Acacia nilotica* + *Prosopis cineraria* + *Prosopis juliflora* + *Tamarix* = desertification-control objective.
— *Cold desert* = *Salix tetrasperma*.



आत्म दीपो भव:

Single-Source Solution for *Forestry Optional*

This study material not only covers the entire syllabus and previous years' questions in a structured, topic-wise manner but also includes several emerging and important areas that are not explicitly mentioned in the **APPSC RFO/FSO 2025** examination syllabus but from which questions are likely to be asked.