

2026

APPSC ANDHRA PRADESH STATE FOREST SERVICE



Module - 2

- | | |
|---|--|
| ☐ Agroforestry | ☐ Soil science |
| ☐ Social forestry | ☐ Silviculture system |
| ☐ JFM | (not in syllabus) |
| ☐ Watershed management | |

Congratulations

To all our successful candidates in

MPPSC STATE FOREST SERVICE



Rank – 1

Shashank Jain

Comprehensive Forestry
Course + CIGP



Rank – 3

Jyoti Thakur

Comprehensive Forestry
Course + CIGP



Rank – 4

Shivam Gautam

Comprehensive Interview
Guidance Programme



Rank – 5

Nitin Patel

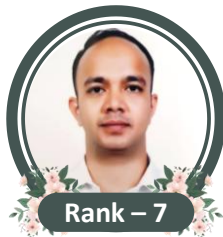
Comprehensive Forestry
Course + CIGP



Rank – 6

Ravi Kumar

Comprehensive Interview
Guidance Programme + Test Series



Rank – 7

Ankur Gupta

Comprehensive Forestry
Course



Rank – 8

Deependra Lodhi

Comprehensive Interview
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Rank – 9

Kapil Chauhan

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Rank – 10

Alok Kumar Jhariya

Comprehensive Forestry
Course + CIGP



Rank – 11

Tarun Chouhan

Comprehensive Interview
Guidance Programme + Test Series



Rank – 12

Raghvendra Thakur

Comprehensive Forestry
Course + CIGP

11 Out of **12** Total
Selections in

Assistant Conservator of Forest (ACF) – 2023

GENERAL FORESTRY

MODULE – 2



EDITION : 2026

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Module - 2

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PAPER ANALYSIS

SYLLABUS

GF-I | UNIT – IV : SOIL SCIENCE & GEOLOGY

◆ **Geological formation** of the rocks and minerals of India. ◆ **Earth and its layers**-domains of earth Types – of rocks and their formation. weathering process of rocks- factors affecting soil formation-physical, chemical and biological properties of soil; minerals, their types and their conservation. ◆ **Soil conservation** - definition, causes for erosion, types - wind and water erosion; conservation and management of eroded soils/areas, windbreaks, shelter belts; sand dunes; reclamation of saline and alkaline soils, waterlogged and other wastelands. Role of forests in conserving soils. ◆ Maintenance and build-up of **soil organic matter**; forest leaf litter and composting; Role of microorganisms in ameliorating soils; N and C cycles.

GF-I | UNIT – VI : AGROFORESTRY

◆ Scope and necessity; role in the life of people and domestic animals and in integrated land use, planning especially related to soil and water conservation, water recharge, nutrient availability to crops, nature and eco-system preservation including ecological balances through pest-predator relationships and providing opportunities for enhancing biodiversity, medicinal and other flora and fauna. ◆ Agroforestry systems under different agroecological zones, selection of species and role of multipurpose trees and NTFPs, techniques, food, fodder and fuel security. ◆ Objectives, scope and necessity of social forestry.

GF-I | UNIT – V : WATERSHED MANAGEMENT

◆ Basics of surface and subsurface water resources, pollution of water and water resource management. ◆ **Concepts of watershed**; Role of mini-forests and forest trees in overall resource management, forest hydrology, watershed development. ◆ **Water-harvesting and conservation**; groundwater recharge and watershed management; the role of integrating forest trees, horticultural crops, field crops, grass and fodders

GF-I | UNIT – VI : JOINT FOREST MANAGEMENT

◆ Genesis, principles, objectives and methodology of **Community Forest Management** in Andhra Pradesh.

PYQs ANALYSIS

Topic	FRO 2018	FSO 2019	ACF 2022	RFO 2022	FRO 2025 Pre	FRO 2025 Mains	FSO 2025 Pre	FSO 2025 Mains	Total
Agroforestry + Social Forestry	10	8	26	16	2	8	1	4	75
Watershed Management	5	1	4	15	9	11	2	15	62
Joint Forest Management	2	1	1	6	–	1	–	3	14
Soil Science & Geology	17	12	15	8	13	31	6	14	116
Silvicultural System	–	–	3	–	–	5	–	7	15
Total	34	22	49	45	24	56	9	43	282

1. AGROFORESTRY + SOCIAL FORESTRY

► AGROFORESTRY

1. World Agroforestry Centre is located in [APPSC (ACF) 2022]
 - (a) Kenya
 - (b) South Africa
 - (c) Ethiopia
 - (d) Zimbabwe
2. Which of the following are the basic attributes of all agroforestry systems that form the basis for evaluation of various agroforestry systems? [APPSC (ACF) 2022]
 - (a) Potentiality, Productivity and Adaptability
 - (b) Sustainability, Profitability and Productivity
 - (c) Productivity, Sustainability and Adaptability
 - (d) Productivity, Suitability and Adoptability
3. 'Seasonal grazing of cattle in pastures under trees' is what type of temporal arrangement in agroforestry systems? [APPSC (ACF) 2022]
 - (a) Interpolated
 - (b) Concomitant
 - (c) Coincident
 - (d) Intermittent
4. Shifting cultivation is locally called _____ in Malaysia [APPSC (ACF) 2022]
 - (a) Hanumo
 - (b) Ladang
 - (c) Karen
 - (d) Milpa
5. Which secondary metabolite present in *Leucaena* spp. Is responsible for its allelopathic effect? [APPSC (ACF) 2022]
 - (a) Mimosine
 - (b) Cyanogenic glycoside
 - (c) Anthraquinone
 - (d) Coumarin
6. Which of the following is **NOT** true with regard to the selection criteria for good alley cropping trees? [APPSC

- (ACF) 2022]
- (a) It should be nitrogen-fixing in nature.
 - (b) It should be able to resprout quickly after pruning, coppicing or pollarding.
 - (c) It should have a shallow tap root system.
 - (d) It should have a light, open crown that allows sunlight to pass through.
7. The Zabo farming system is practised by tribal farmers of which state in India? [APPSC (ACF) 2022]
 - (a) Arunachal Pradesh
 - (b) Nagaland
 - (c) Sikkim
 - (d) Orissa
 8. Which of the following factors is multiplied by total nitrogen content to determine the crude protein in fodder? [APPSC (ACF) 2022]
 - (a) 2.5
 - (b) 4.2
 - (c) 6.25
 - (d) 8.15
 9. Is the major cash crop of Chagga home gardens [APPSC (ACF) 2022]
 - (a) Tobacco
 - (b) Cashew nuts
 - (c) Coffee arabica
 - (d) Cloves
 10. Taungya is a ____ Word [APPSC (ACF) 2022]
 - (a) Burmese
 - (b) Latin
 - (c) Greek
 - (d) French
 11. Who among the following directed the development of a diagnosis and design (D&D) survey in agroforestry at ICRAF for the first time? [APPSC (ACF) 2022]
 - (a) GHS Nair
 - (b) JB Raintree
 - (c) PKR Nair
 - (d) J J Tulman
 12. Fan design and parallel row layouts,

- which are experimental designs in agroforestry, are examples of [APPSC (ACF) 2022]
- (a) Y-designs
 - (b) Incomplete block designs
 - (c) Systematic designs
 - (d) Randomised complete block designs
13. Which of the following species is **NOT** recommended to create shelterbelts? [APPSC (ACF) 2022]
 - (a) *Quercus leucotrichophora*
 - (b) *Azadirachta indica*
 - (c) *Lannea coromandelica*
 - (d) *Prosopis juliflora*
 14. Which of the following statements about home gardens is FALSE? [APPSC (ACF) 2022]
 - (a) They consist of an assemblage of plants, which may include trees, shrubs, vines and herbaceous plants, growing in or adjacent to a home compound.
 - (b) They have low species diversity.
 - (c) They exhibit diverse practices from growing vegetables behind houses to complex multistoreyed systems.
 - (d) The entire crop-tree-animal unit is managed by family labour.
 15. In which Five-Year Plan period was National Research Centre for Agroforestry (NRCAF) established in Jhansi? [APPSC (ACF) 2022]
 - (a) Seventh
 - (b) Sixth
 - (c) Fifth
 - (d) Eighth
 16. When two components— woody or non-woody— stay together for some part of life in an agroforestry system, the temporal arrangement of components is called [APPSC (ACF) 2022]
 - (a) Intermittent
 - (b) Interpolated
 - (c) Coincident
 - (d) Concomitant

17. As per the FAO classification of agroforestry systems, when all the three components, namely trees, animals and crops, are integrated into a system, then it represents _____ system [APPSC (ACF) 2022]
- Agrisilviculture
 - Agrosilvopastoral
 - Silvopastoral
 - Hortipastoral
18. Hedge row inter-cropping and improved fallow are examples of _____ [APPSC (ACF) 2022]
- Hortipasture
 - Silvipasture
 - Agrisilviculture
 - Agrihorticulture
19. In northern states of India like Haryana, Punjab and Uttar Pradesh, which tree crop combination does the most common agroforestry system have? [APPSC (ACF) 2022]
- Poplar and rice
 - Teak and rice
 - Grewia and wheat
 - Poplar and wheat
20. International Council for Research in Agroforestry (ICRAF) or 'World Agroforestry' is located in _____ [APPSC (ACF) 2022]
- Gland, Switzerland
 - Nairobi, Kenya
 - Rome, Italy
 - Vienna, Austria
21. The arrangement of components in an agroforestry system is done on a functional basis. Which of the following is the 'production function' role of an agroforestry system? [APPSC (ACF) 2022]
- Food
 - Soil improvement
 - Moisture conservation
 - Shade
22. Taungya cultivation originated in _____ [APPSC (RFO) 2022]
- America
 - India
 - Burma

- (d) Africa
23. Which of the following is NOT the basis of classification of agroforestry systems as given by Nair (1987)? [APPSC (RFO) 2022]
- History of the system (land use in the past)
 - The structure of the system (composition and arrangement of components)
 - Function of the system (role and output of components)
 - Ecological spread (ecological zone where system exists)
24. Alley cropping is also called _____ [APPSC (RFO) 2022]
- tree-grain cropping
 - hedge-row intercropping
 - relay cropping
 - shifting cultivation
25. Match the following basis of classification with their respective principles [APPSC (RFO) 2022]

Basis of classification	Principle
A) Structure	1) Level of input management (high or low inputs), commercial goals and, intensity and scale of management (Subsistence, commercial etc.)
B) Physiognomic	2) Land use pattern in the course of adoption of agroforestry
C) Land use	3) Composition and arrangement of components
D) Socio-economic	4) Character of vegetation, e.g., Xeromorphic, etc.

- A-1, B-2, C-3, D-4
- A-4, B-3, C-2, D-1
- A-3, B-2, C-4, D-1

- (d) A-3, B-4, C-2, D-1

26. Match the following types of agroforestry systems with their respective time and temporal sequence of crops [APPSC (RFO) 2022]

Type of Agroforestry system	Crop's temporal and time sequence
A) Concomitant	1) When different crops grow on land together at one time, like pastures and trees
B) Interpolated	2) When different components stay together for some period, like Taungya
C) Coincident	3) When annual crops are grown under perennials, like wheat under populus.
D) Intermittent	4) When different components occupy the space in different time, like home gardens.

- A-2, B-4, C-1, D-3
- A-3, B-1, C-4, D-2
- A-1, B-2, C-3, D-4
- A-4, B-3, C-2, D-1

27. Match the following based on the functional classification of agroforestry systems [APPSC (RFO) 2022]

Agroforestry system	Examples
A) Productive	1) Soil Conservation
B) Protective	2) Hedge-row cropping
C) Multipurpose	3) Rearing of animals and fishes along with trees

- A-1, B-2, C-3
- A-3, B-2, C-1
- A-1, B-3, C-2

(d) A-3, B-1, C-2

28. In an agroforestry system, soil productivity is enhanced due to [\[APPSC \(RFO\) 2022\]](#)

- A) Decreased soil organic matter
- B) Addition of Nitrogen in the soil if leguminous plants are grown
- C) Maintain soil organic matter
- D) Promote more open nutrient cycling.

Options

- (a) A and B
- (b) A and C
- (c) B and D
- (d) B and C

29. In an agroforestry system, soil health is maintained by which of the following? [\[APPSC \(RFO\) 2022\]](#)

- A) Decreasing biological components of soil
- B) Increasing or stabilising physical components of soil
- C) Improve chemical components in the soil in favour of plants

Options

- (a) Only A
- (b) Only B and C
- (c) Only B
- (d) Only A and C

30. Which of the following benefit soil health in agroforestry practices? [\[APPSC \(RFO\) 2022\]](#)

- A) Improved soil nutrient availability and soil fertility due to the presence of trees in the system
- B) Suppressed soil microbial dynamics
- C) Incorporation of trees in agroforestry to enhance soil organic carbon

Options

- (a) A and C
- (b) A, B and C
- (c) B and C
- (d) A and B

31. Match the following ecozones with

agroforestry systems that are primarily used to improve the habitat [\[APPSC \(RFO\) 2022\]](#)

A) Tropical Soil productivity	1) Agrisilvi, silvihorti and silvipasture
B) Arid lands soil productivity	2) Multistorey cropping agrisilvisulture
C) Hill region soil productivity	3) Shelter belts
D) Wetlands	4) Alley cropping

- (a) A-2, B-4, C-3 D-1
- (b) A-1, B-3, C-4, D-2
- (c) A-4, B-1, C-2, D-3
- (d) A-3, B-2, C-1, D-4

32. Which of the following agroforestry trees is NOT known to cause allelopathy or toxicity in the soil? [\[APPSC \(RFO\) 2022\]](#)

- (a) Eucalyptus
- (b) Leucaena
- (c) Gmelina
- (d) Populus

33. Among the crops grown in the homestead is the most dominant and important tree known as 'Tree of Hundred uses' [\[APPSC FSO 2019\]](#)

- (a) Palmyra
- (b) Coconut
- (c) Arecanut
- (d) Tapioca

34. Home Gardens is the most prevalent agro-forestry system being adopted in [\[APPSC FSO 2019\]](#)

- (a) High land
- (b) Semi arid region
- (c) Humid tropical region
- (d) Arid region

35. The sustainable land use systems

involving trees combined with crops and I or animals on the same unit of land is termed as..... [\[APPSC FSO 2019\]](#)

- (a) Sustainable forest management
- (b) Social Forestry
- (c) Agroforestry
- (d) Farm Forestry

36. cultivation is also known as 'slash and burn' or Swidden cultivation'. [\[APPSC FSO 2019\]](#)

- (a) Shifting
- (b) Taungya
- (c) Silviculture
- (d) Horticulture

37. Of succulent feeds, is the most convenient and economic method for maintaining larger livestock [\[APPSC FSO 2019\]](#)

- (a) pasture
- (b) Cultivated fodder tree
- (c) Cultivated fodder crops
- (d) Silage

38. Which type of farming is used to restore soil fertility in India's dry lands? [\[APPSC FSO 2019\]](#)

- (a) Co-operative farming
- (b) Irrigation farming
- (c) Ley farming
- (d) Plantation farming

39. The homegardens are cited as an excellent example to show diversity and complexity of the structure and function of tropical homegardens. [\[APPSC FSO 2019\]](#)

- (a) Kandyana
- (b) Javanese
- (c) Kerala
- (d) Fuyo

40. How many agro - climatic zones are there in India? [\[APPSC FRO 2018\]](#)

- (a) 10
- (b) 13
- (c) 15
- (d) 20

41. How many biogeographic zones are there in India? [\[APPSC FRO 2018\]](#)

- (a) 10

- (b) 11
(c) 9
(d) 12
- 42.** Agrosilvopastoral systems consist of which of these elements [APPSC FRO 2018]
 (a) Animals, tress and crops
 (b) Only trees and crops
 (c) Only animals and crops
 (d) Only animals and trees
- 43.** The first taungya plantations were raised in North Bengal in the year [APPSC FRO 2018]
 (a) 1896
 (b) 1897
 (c) 1899
 (d) 1898
- 44.** Diversity of plant material in polycultural systems often leads to [APPSC FRO 2018]
 (a) Higher pest intensities
 (b) No pest intensities
 (c) Lower pest intensities
 (d) Very high pest intensities
- 45.** In which year was the national agroforestry policy launched in india? [APPSC FRO 2018]
 (a) 2013
 (b) 2014
 (c) 2017
 (d) 2018
- 46.** Where is the headquarters of the international centre for research in agroforestry (icraf) located? [APPSC FRO 2018]
 (a) Kathmandu
 (b) New Delhi
 (c) Dhaka
 (d) Nairobi
- 47.** What percentage of India's total geographical area is currently under agroforestry practices, according to the GROW report by NITI Aayog? [APPSC FRO (Pre) 2025]
 (a) 10.45%
 (b) 12.67%
 (c) 8.65%
 (d) 9.25%
- 48.** How much additional carbon sink is India targeting through forest and tree cover expansion by 2030 as per the Nationally Determined Contribution (NDC)? [APPSC FRO (Pre) 2025]
 (a) 4.0 to 5.0 billion tonnes of CO₂ equivalent
 (b) 2.5 to 3.0 billion tonnes of CO₂ equivalent
 (c) 1.5 to 2.0 billion tonnes of CO₂ equivalent
 (d) 5.5 to 8.0 billion tonnes of CO₂ equivalent
- 49.** Which method is commonly used to preserve green fodder for off season feeding ? [APPSC FSO (Main) 2025]
 (a) Composting
 (b) Fermentation
 (c) Silage making
 (d) Drip irrigation
- 50.** Which Agroforestry system involves combining agricultural crops with tree crops ? [APPSC FRO 2025]
 (a) Silvopastoral System
 (b) Agrosilvopastoral System
 (c) Agrisilvicultural System
 (d) Mixed Wood Lots
- 51.** What is the main purpose of Apiculture with Trees in Agroforestry? [APPSC FRO 2025]
 (a) To grow trees that provide fruits for local communities
 (b) To increase honey production by planting nectar-rich trees
 (c) To plant trees that prevent soil erosion
 (d) To grow trees that act as windbreaks
- 52.** Which agroforestry system in the Himalayan region integrates tree cultivation with agricultural crops, allowing farmers to grow crops alongside young trees? [APPSC FRO 2025]
 (a) Silvopastoral System
 (b) Taungya System
 (c) Alley Cropping
 (d) Windbreaks
- 53.** Slash and burn agriculture is called [APPSC FSO (Pre) 2025]
 (a) Industrial forestry
 (b) Conservation forestry
 (c) Tree cultivation
 (d) Shifting cultivation
- 54.** Allelopathy refers to [APPSC FRO 2025]
 (a) The symbiotic relationship between plants
 (b) The absorption of nutrients by plant roots
 (c) The process of pollination in flowering plants
 (d) The effect of chemicals released by one plant on the growth of another
- 55.** In which agro-ecological zone of India is the practice of Jhum cultivation (shifting cultivation) predominantly observed ? [APPSC FRO 2025]
 (a) Indo-Gangetic Plains
 (b) Western Ghats
 (c) Eastern Himalayan Region
 (d) Deccan Plateau
- **MULTIPURPOSE TREE SPECIES (MPTS)**
- 56.** Is a multipurpose tree species which is native to Australia [APPSC (ACF) 2022]
 (a) Robinia pseudoacacia
 (b) Prosopis juliflora
 (c) Leucaena leucocephala
 (d) Casuarina equisetifolia
- 57.** Which of the following statements about selection of good agroforestry trees is INCORRECT? [APPSC (ACF) 2022]
 (a) The trees should have light open crown that allows enough light penetration.
 (b) The trees should have good re-sprouting ability after pruning or pollarding.
 (c) The trees should have thick shallow roots.
 (d) The trees should have good productive capacity for food,

fibre, wood, etc.

58. Which of the following is NOT a tropical/subtropical multipurpose tree in India? [APPSC (RFO) 2022]
- Grewia optiva*
 - Betula utilis*
 - Bauhinia variegata*
 - Leucaena leucocephala*
59. *Ailanthus excelsa* is a fast-growing fodder tree that could be propagated in association with forage and food crops widely grown in the Indian Peninsula. What is its common name? [APPSC (RFO) 2022]
- Kadamb, Cadamba
 - Whistling tree, Junglisaru
 - Kapok tree, Silk-cotton tree
 - Tree of Heaven, Ardu
60. Which of the following trees are NOT temperate agroforestry trees in India? [APPSC (RFO) 2022]
- Abies pindrow*
 - Juglans regia*
 - Robinia pseudocassia*
 - Picea smithiana*
- Options**
- B and C
 - A and B
 - B and D
 - D and A
61. Which of the following trees does NOT enhance nitrogen in soil, and thus soil productivity being a non-nitrogen fixing species? [APPSC (RFO) 2022]
- Caragana
 - Luecaena
 - Populus
 - Faidherbia
62. species is an important fodder tree for dry region of the country. [APPSC FSO 2019]
- Agropyrum caninum*
 - Acacia nilotica*
 - Salix spp.*
 - Populus alba*
63. *Casuarina equisetifolia* improves soil fertility through [APPSC FRO 2025]

- Nitrogen fixation in symbiosis with Frankia bacteria
 - Mycorrhizal association with fungi
 - Accumulating organic matter from fallen leaves
 - Absorbing minerals from deep soil layers
64. *Casuarina equisetifolia* is commonly used for which of the following purposes? [APPSC FRO 2025]
- Fruit production
 - Windbreaks and coastal protection
 - Timber production
 - Ornamental gardening
- **SOCIAL FORESTRY**
65. The term 'social forestry' was coined by [APPSC (ACF) 2022]
- BT Kang
 - JC Westoby
 - Dietrich Brandis
 - JB Raintree
66. The practice of forestry in all its aspects on farm and village lands, generally more or less integrated with other farm operations, is called [APPSC (ACF) 2022]
- Village forestry
 - Community forestry
 - Farm forestry
 - Social forestry
67. Which of the following statements about social forestry is INCORRECT? [APPSC (ACF) 2022]
- Social forestry is the practice of forestry on lands outside the conventional forest area for the benefit of the rural and urban communities.
 - Social forestry includes in it farm forestry, extension forestry, community woodlots, rehabilitation of degraded forests and recreation forestry.
 - It was first recognised as an important component of forestry for meeting rural needs

- in the interim report of the National Commission on Agriculture in 1976.
- (d) The term 'Social forestry' was coined by Indian National Congress in 1976.
68. Social Forestry programme was launched in [APPSC (RFO) 2022]
- Seventh five year plan
 - Sixth five year plan
 - Fifth five-year plan
 - Eighth five-year plan
69. The term social forestry was first used in 1976 in India by [APPSC FRO 2018]
- The National Commission on Agriculture
 - The National Commission on Horticulture
 - The National Commission on Forestry
 - The National Commission on Silviculture
70. The scope of social forestry does not include which type of forestry [APPSC FRO 2018]
- Farm forestry
 - Community woodlots
 - Community reserve
 - Extension forestry
71. The term 'social forestry' was coined by [APPSC FRO 2018]
- Gifford Pinchot
 - Dietrich Brandis
 - JC Westoby
 - John Evelyn
72. Which government scheme promotes afforestation under Social Forestry? [APPSC FRO 2025]
- PM-KISAN
 - CAMPA
 - Swachh Bharat Abhiyan
 - MGNREGA
73. Forestry aimed at producing flow of protection and recreation benefits to the community [APPSC FSO (Main) 2025]
- Agro forestry

- (b) Urban forestry
- (c) Social forestry
- (d) Environmental forestry

- 74.** The word Social Forestry was first pronounced by [APPSC FSO (Main) 2025]
- (a) Swaminathan
 - (b) Jadhav Payeng
 - (c) Westoby
 - (d) Brandis
- 75.** Which of the following is not a type of social forestry? [APPSC FSO (Main) 2025]
- (a) Farm forestry
 - (b) Community forestry
 - (c) Urban forestry
 - (d) Industrial forestry

2. WATERSHED MANAGEMENT

- 76.** How many Land Capability Classes are there? [APPSC (ACF) 2022]
- (a) Six
 - (b) Four
 - (c) Five
 - (d) Eight
- 77.** Which of the following species is the most suitable for the reclamation of saline and alkaline soils? [APPSC (ACF) 2022]
- (a) Tamarindus indica
 - (b) Dalbergia sissoo
 - (c) Populus deltoides
 - (d) Prosopis juliflora
- 78.** is a watershed development project sponsored by the Central Government that aims at enabling the rural population to conserve water for drinking, irrigation, fisheries and afforestation [APPSC (ACF) 2022]
- (a) Atal Bhujal Yojana
 - (b) Arvary Pani Sansad
 - (c) Haryali
 - (d) Neeru-Meeru
- 79.** The Central Ground Water Authority was constituted under Section _____ of the Environment

(Protection) Act, 1986 [APPSC (ACF) 2022]

- (a) 3 (3)
 - (b) 5 (3)
 - (c) 2 (1)
 - (d) 6 (2)
- 80.** Understanding of relationships between hydrological and biological processes at different scales to improve water security, enhance biodiversity and further opportunities for sustainable development by lessening ecological threats and maximising greater harmony within catchment processes, is called [APPSC (RFO) 2022]
- (a) Ground water hydrology
 - (b) Hydroinformatics
 - (c) Hydrogeology
 - (d) Ecohydrology
- 81.** Match the following hydrological events and their measurement method/ the factors they depend on [APPSC (RFO) 2022]

Hydrological event	Measurement and/or dependent upon
A) Inconsistency of rainfall data	1) Topography
B) Runoff	2) Temperature
C) Evaporation	3) Double mass curve technique

- (a) A-1, B-2, C-3
 - (b) A-3, B-1, C-2
 - (c) A-3, B-2, C-1
 - (d) A-2, B-3, C-1
- 82.** Match the following hydrological events and their respective measurement methods [APPSC (RFO) 2022]

Hydrological event	Measurement
A) Hydrological cycle	1) Kirpich formula
B)	2) Blaney

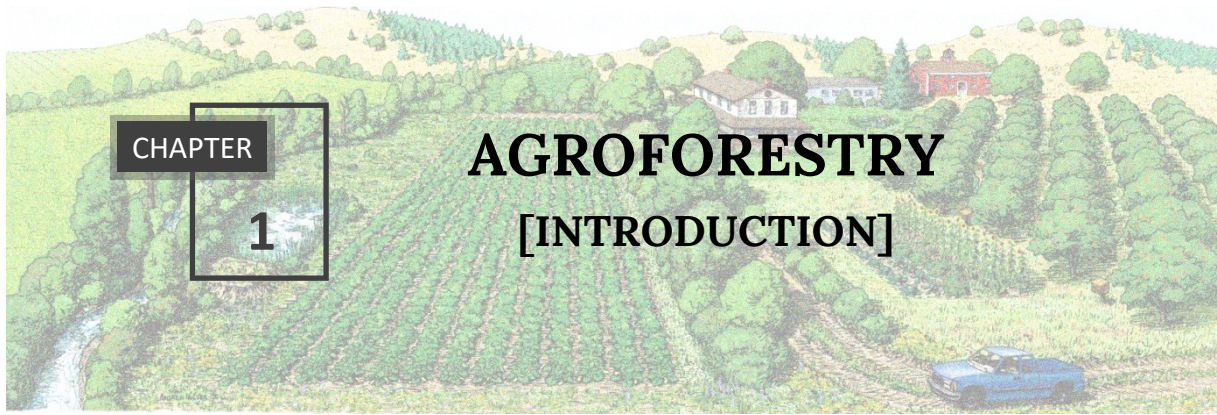
Evapotranspiration	Criddle method
C) Time of concentration	3) Water budget equation

- (a) A-3, B-1, C-2
 - (b) A-2, B-3, C-1
 - (c) A-1, B-2, C-3
 - (d) A-3, B-2, C-1
- 83.** Match the following stream hierarchy and their number [APPSC (RFO) 2022]

Stream hierarchy	Number
A) Water resources region	1) 35
B) Basins	2) 112
C) Catchments	3) 3257
D) Watersheds	4) 6

- (a) A-1, B-2, C-3, D-4
 - (b) A-4, B-3, C-2, D-1
 - (c) A-4, B-1, C-2, D-3
 - (d) A-4, B-2, C-3, D-1
- 84.** 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]
- (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
- 85.** The number assigned to Water Resource Region in which all drainage flow into the Arabian Sea except Indus drainage, as suggested

- by Dr. AN Khosla in 1949, is _____ [APPSC (RFO) 2022]
- (a) 2
(b) 4
(c) 5
(d) 6
- 86.** The initial stage of water erosion in any watershed is _____ [APPSC (RFO) 2022]
- (a) rill erosion
(b) gully erosion
(c) sheet erosion
(d) splash erosion
- 87.** Which of the following statements is/are correct? [APPSC (RFO) 2022]
- A) The mass rainfall curve is a plot between the accumulated rainfall at a station as ordinate and time as abscissa, plotted in chronological order.
B) The hyetograph is the graphical representation of rainfall versus time.
- Options**
- (a) Only statement B is correct
(b) Both statements A and B are incorrect
(c) Only statement A is correct
(d) Both statements A and B are correct
- 88.** Which of the following statements are correct? [APPSC (RFO) 2022]
- A) Runoff coefficient is the ratio of runoff to rainfall intensity
B) It is a larger value for areas with high infiltration and low runoff, and higher for permeable, well vegetated areas.
C) Runoff coefficient is regulated by vegetation composition, surface coverage, slope and soil type.
D) It is used in the rational method to calculate the quantity of water that the drainage system needs to handle.
- Options**
- (a) Only statements C and D are correct
(b) Only statements A, B and C are correct
(c) Only statements A and B are correct
(d) Only statements B, C and D are correct
- 89.** The range and average size (in hectare) of a micro-watershed in India is _____ and _____, respectively [APPSC (RFO) 2022]
- (a) 500–1500; 1000
(b) 1000–2000; 1500
(c) 1000–1500; 750
(d) 2000–3000; 2500
- 90.** The time taken for the runoff to reach from the remotest point of the watershed to the outlet is called [APPSC (RFO) 2022]
- (a) Run off lag coefficient
(b) Runoff coefficient time
(c) Time of concentration
(d) Time lag coefficient
- 91.** _____ is a set of characteristics curve that describe the rainfall characteristics specific to the region [APPSC (RFO) 2022]
- (a) Peak-Flow
(b) Intensity-Duration-Frequency
(c) Peak-Erodibility
(d) Peak-Intensity-Flow
- 92.** Permanent gully control structures are designed for a period of _____ years [APPSC (RFO) 2022]
- (a) 5 to 10
(b) 10 to 20
(c) 20 to 25
(d) 25 to 50
- 93.** _____ is a series of broad channel or embankments constructed at suitable spacing along the graded gentle slopes [APPSC (RFO) 2022]
- (a) Continuous trench
(b) In-line trench
(c) Contour trench
(d) Staggered trench
- 94.** _____ is/are widely used to estimate runoff from small-to medium-sized watersheds [APPSC (RFO) 2022]
- (a) Soil-vegetation land use
(b) Antecedent moisture conditions
(c) SCS curve-number
(d) Soil antecedent moisture
- 95.** _____ refers to a technique of lowering groundwater in waterlogged areas by raising tree plantations. [APPSC FSO 2019]
- (a) Bio-exhaustion
(b) Bio-drainage
(c) Bio-depletion
(d) None of the given options
- 96.** The Chauka system is a method for harvesting rainwater practiced in which Indian state? [APPSC FRO 2018]
- (a) Rajasthan
(b) Gujrat
(c) Madhya Pradesh
(d) Bihar
- 97.** Who is popularly known as the waterman of India? [APPSC FRO 2018]
- (a) Shirish Apte
(b) Ayyappa Masagi
(c) Rajendra singh
(d) Aabid Surti
- 98.** What is the size of the milli watershed? [APPSC FRO 2018]
- (a) 10,000 to 50,000 ha
(b) 1,000 to 10,000 ha
(c) 100 to 1,000 ha
(d) 1 to 100 ha
- 99.** Who developed the universal soil loss equation (ULSE) [APPSC FRO 2018]
- (a) Lorenzo A Richards
(b) Justus von Liebig
(c) George Nelson Coffey
(d) W Wischmeier and D Smith
- 100.** Subsurface water that is found in a fully saturated zone is known as [APPSC FRO 2018]
- (a) Vadose water
(b) Capillary water
(c) Groundwater
(d) Soil water



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 CO₂-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

- **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.

In one line

Agroforestry = Crop + Tree ± Livestock.

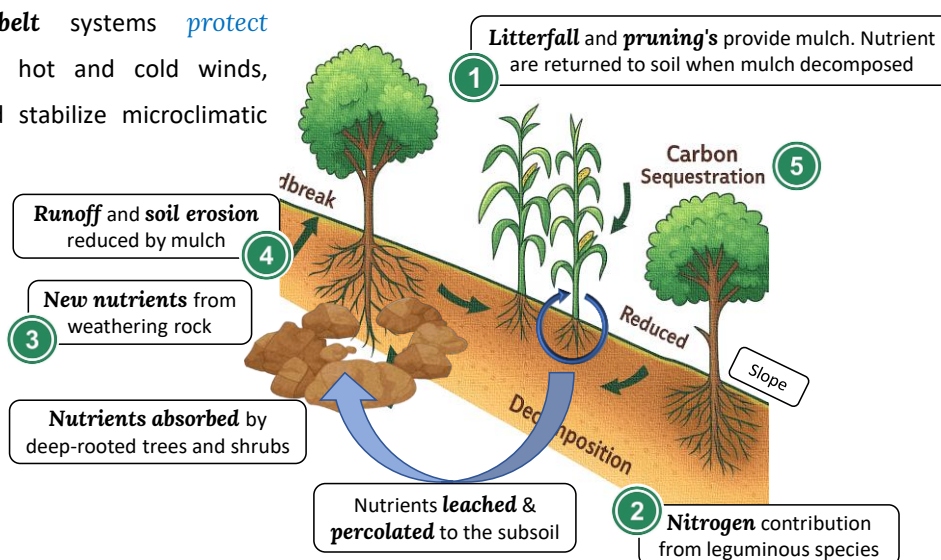
The first two components are essential; **livestock is optional**.

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.





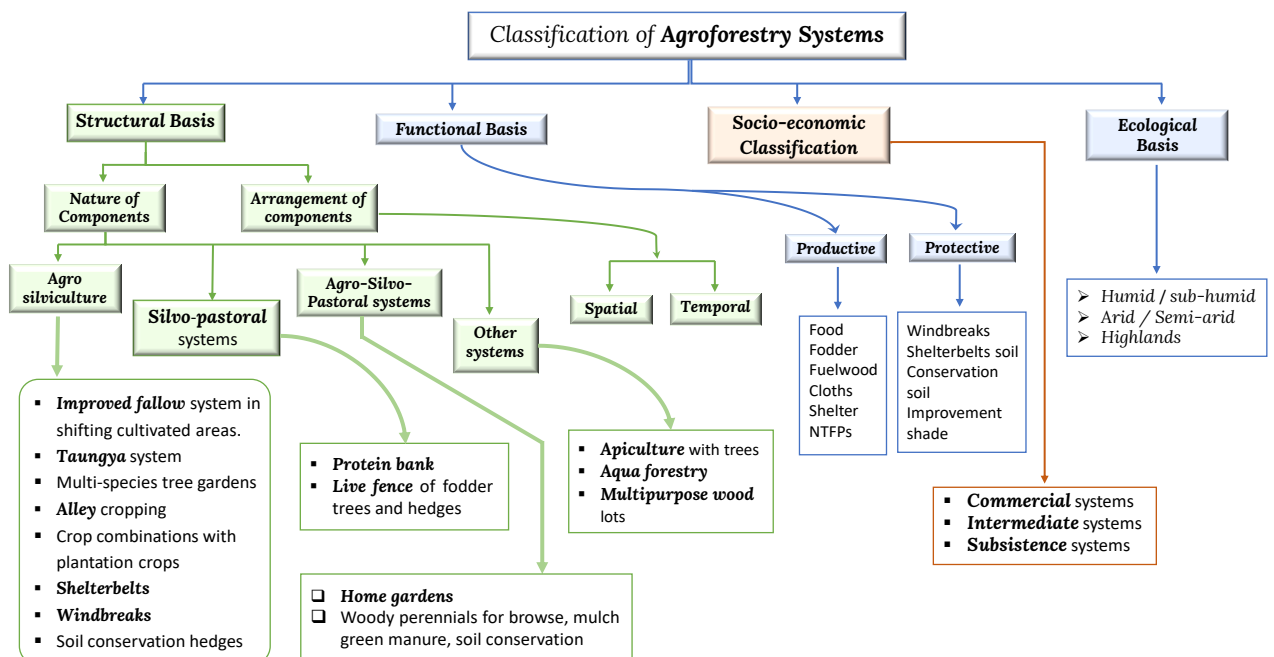
Agroforestry systems can be classified based on **Structure**, **Functions**, **Socio-Economic** settings, **Ecological** conditions, and **Vegetation** appearance. Two major scientists proposed widely accepted classification systems :

➤ **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**.



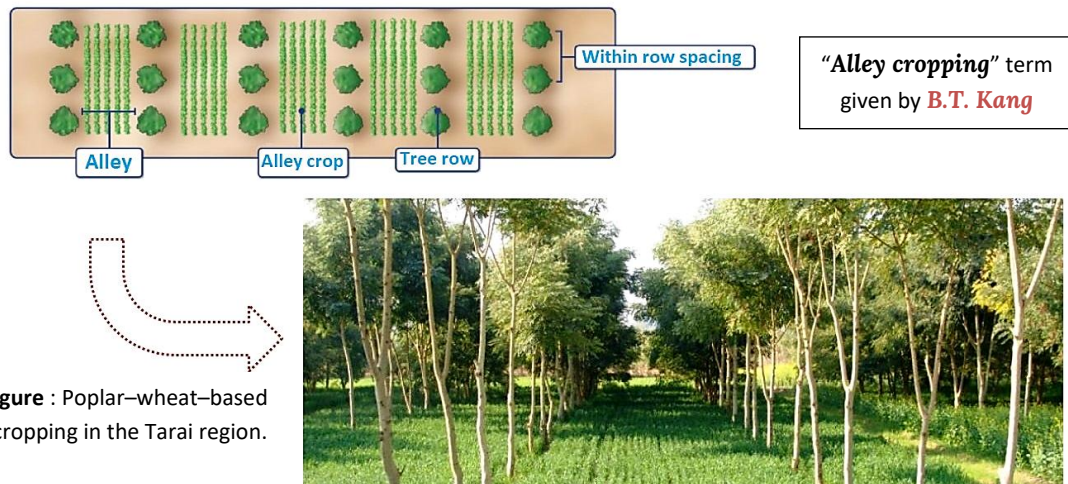
➤ **Physiognomic Classification** : Based on **appearance** and **ecological adaptations** of vegetation – Xeromorphic, Mesomorphic, Hydromorphic, etc.

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** – Silviculture, Aqua-forestry, etc.

- On **sloping land**, hedgerows are always established **along the contour** to control runoff and soil erosion.
- Maintenance operation includes regular **pruning***, **trenching*** (Root pruning), **gap filling** (to maintain continuous hedgerow), **pollarding*/coppicing** (where applicable), **Singling**, **Weeding*** & **Mulching** around the tree base, **Manuring** (where needed) and **Pest management**.



Examples

Populus deltoides, an exotic species native to North America, has been widely introduced in the **Tarai region** of India for the pulp, paper, matchwood, and plywood industries. It is primarily grown under **poplar–soybean** and **poplar–wheat** intercropping systems. **Eucalyptus–wheat** based alley cropping is common in **Punjab**. **Leucaena leucocephala** is grown as an alley crop in **Rajasthan & Maharashtra**, while **Gliricidia sepium** is primarily grown in alley systems in the **North-East region**. **Ailanthus excelsa** is widely grown around **Nagpur**, meeting the regional demand for timber, matchwood, and plywood.

- ✎ **Populus ciliata** is an **Indian native poplar species**, naturally found in the **Western Himalaya**, especially in cold desert and high-altitude regions of Jammu & Kashmir, Himachal Pradesh, and Uttarakhand. Whereas, **Populus deltoides** is an exotic species native to **North America**, widely introduced in the **Tarai region** of India for **Pulp, Paper, Matchwood**, and **Plywood** industries.

IMPORTANCE OF TREE COMPONENT IN ALLEY CROPPING

The tree component plays several critical ecological and economic roles.

- Microclimate regulation** : Hedgerows reduce evaporation losses from the soil surface, moderate temperature extremes, and diminish the frost–heat shock effect on food crops. They also act as partial windbreaks, improving lodging resistance in cereals.
- Soil fertility enhancement** : Leguminous hedgerow species fix atmospheric nitrogen through *Rhizobium* symbiosis, thereby reducing dependence on synthetic fertilizers such as urea. Their leaf litter, pruning, and deep root systems contribute to nutrient recycling, enrich soil organic matter, and bring minerals from deeper soil layers to the surface horizon.
- Production diversification and risk reduction** : Trees provide fuelwood, fodder, green manure, small timber, and poles, thereby supplementing farm income and reducing the risk of crop or income failure.
- Weed suppression and erosion control** : Regular mulch deposition suppresses weed growth, while hedgerows laid along contours help slow surface runoff and reduce soil erosion on sloping lands.

► LIVE FENCE OF FODDER TREES & HEDGES

A **Live Fence** (also called *Living Fence*) is a protective boundary made by planting **Dense, Thorny** or **woody shrubs/trees**, around farmlands. These plants grow into a **thick, impenetrable barrier** that prevent entry of stray animals, protect crops, and simultaneously provide fodder, fuelwood, small timber, and ecological benefits.

Suitable Species

- Thorny Shrubs (Highly Effective) : *Prosopis juliflora* (Vilayati babool), *Carissa carandas* (Karonda), *Ziziphus jujuba*, *Agave americana* (Sisal) — excellent barrier, *Opuntia* spp. (Cactus) — good for arid areas, *Jatropha curcas*, etc.
- Woody Trees for Structural Strength : *Gliricidia sepium* (good coppicing ability), *Leucaena leucocephala*, *Erythrina indica*, Neem, Babul, etc.



C | AGRI-SILVO-PASTURE System

In an **agri-silvo-pasture system**, **woody perennials (trees and shrubs)** are combined with **seasonal agricultural crops** and **grasses/legumes for grazing** or **cut-and-carry fodder**. Thus, **Trees + Crops + Pasture** are managed together on the same unit of land.

► HOME GARDENS (MULTI-TIER SYSTEM)

Home gardens are **traditional, highly intensive multi-tier agroforestry systems** located **around the house (homestead)**. They are very common in **high-rainfall, humid tropical regions** of South and Southeast Asia. In India, **Kerala** and **Tamil Nadu** are well-known for **coconut-based** home gardens.

A major feature is their **multi-tier structure*****, which usually has **3-4 vertical canopy layers*****

- **Upper tree layer** – tall trees like *Cocos nucifera* (Coconut – a tree of Hundred uses), *Artocarpus heterophyllus* (Jackfruit), *Mangifera indica* (Mango), *Azadirachta indica* (Neem), etc.
- **Middle layer** – smaller fruit trees, banana, papaya, shrubs, etc.
- **Lower layer** – shade-tolerant vegetables, spices and medicinal plants.
- **Herbaceous layer near the ground** – grasses, legumes, leafy vegetables and small herbs.

Plants are arranged in **different height levels (multi-tier)** and not in a strict geometric pattern. This gives the garden a **forest-like structure**.

Most home gardens also keep domestic animals like cows, goats and poultry. Plants supply food, fodder and fuelwood, while animals provide milk, meat, eggs and manure.



✂ In **Indonesia**, home gardens are known as **Pekarangan*****. (–karang = 'yard').

In Tanzania = **Chagga homegarden**

► WOODY HEDGEROWS

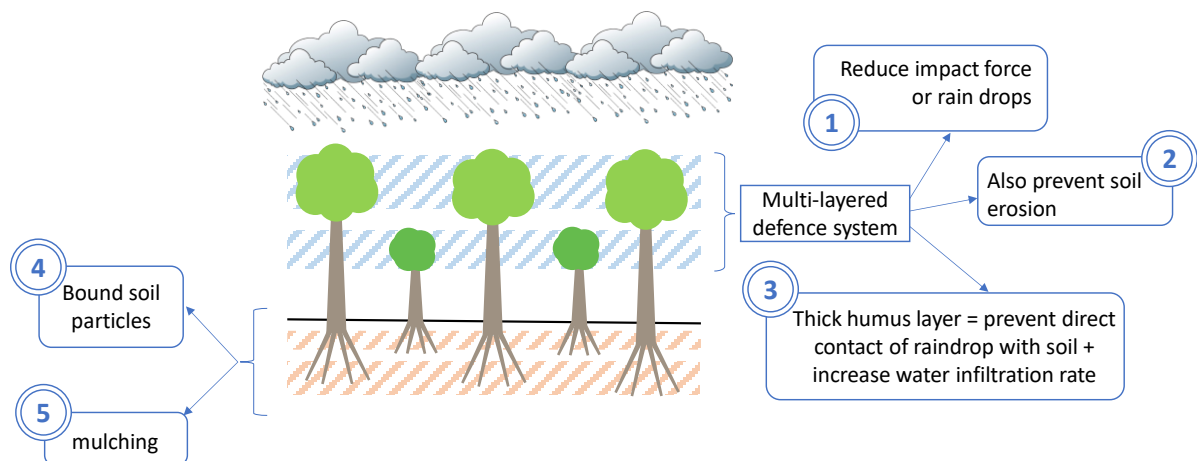
Woody hedgerows are **rows of fast-growing**, usually **coppicing shrubs** or **trees** planted close together, often along **contours** or **field boundaries**.



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 TREES IN NUTRIENT RECYCLING / PRODUCTIVITY

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

- **Humidity Enhancement** : Reduced radiation + $\uparrow$ transpiration beneath tree cover increase relative humidity, which improves the energy balance of the crop ecosystem and enhances crop performance.
- **Yield Stabilization** : In cereals, high temperature during the grain-filling (reproductive) stage leads to reduced productivity; integrating trees can mitigate heat-induced yield losses, especially under climate change scenarios.
- **Wind Speed Reduction** : Trees act as **windbreaks**, decreasing wind velocity across the leeward side and thereby protecting soil and vegetation.

Agroforestry systems create a micro-climatic niche that enhances resource use efficiency, improves crop resilience to climate variability, and contributes to sustainable agricultural productivity.

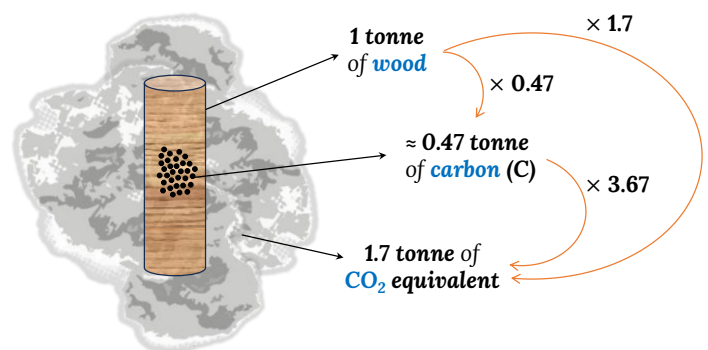
► ROLE IN CARBON SEQUESTRATION / AIR QUALITY IMPROVEMENT / ENVIRONMENTAL CONSERVATION.

Agroforestry helps maintain the **CO₂-O₂ balance** through continuous **photosynthesis** & **biomass accumulation**. Long-lived woody perennials act as **permanent carbon sinks** by storing carbon in **above-ground biomass (stem, branches, leaves)** and **below-ground biomass (roots, soil organic carbon)**.

- Tree-based intercropping systems can sequester up to **50% more carbon** compared to conventional monoculture systems, contributing significantly to climate change mitigation.
- In India, smallholder agroforestry systems sequester approximately **1.5–3.5 Mg C ha⁻¹ yr⁻¹ ($\approx$ 5.5–13 t CO₂e ha⁻¹ yr⁻¹)**, depending on species composition, site conditions, and management practices.

✎ **Mg C ha⁻¹ yr⁻¹** = Megagrams (= 1000 kg = 1 Metric ton) of carbon per hectare per year.

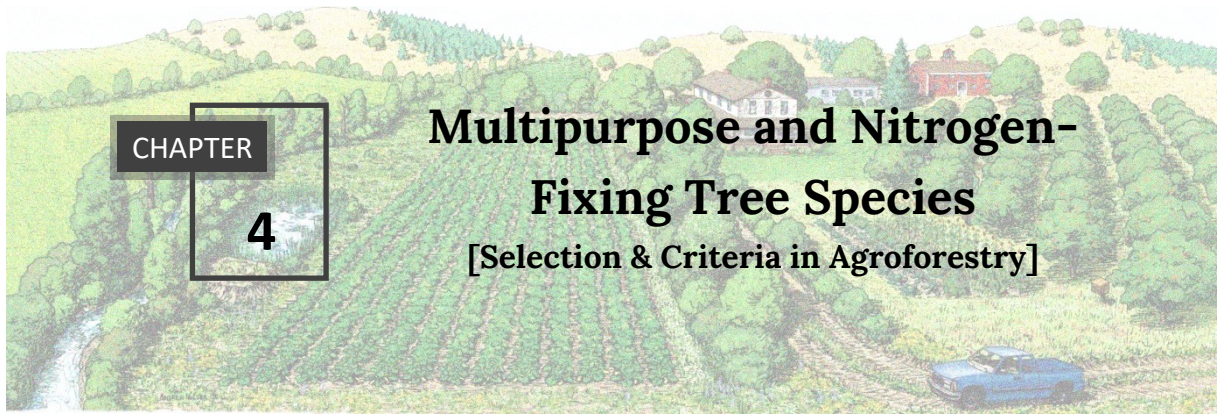
- Trees absorb atmospheric pollutants such as **CO₂, SO₂, NO_x, ozone**, and particulate matter (**PM_{2.5}/PM₁₀**), thereby improving local and regional air quality.
- Agroforestry systems produce **sulphur-free fuelwood**, reducing dependence on fossil fuels and minimizing indoor air pollution.
- Vegetative buffer strips intercept and **bio-filter agrochemical residues, pesticides, fertilizers**, and sediments before they reach surface water bodies, thus protecting water quality.



► AESTHETIC SERVICES

Agroforestry systems significantly enhance the **visual appeal & scenic beauty** of rural and peri-urban landscapes by **enriching landscapes, supporting traditions**, and **strengthening human-nature relationships**. These services are often **vital for community identity**, well-being, and environmental stewardship.

- Practices such as **alley cropping, silvopasture, shelterbelts, and windbreaks create natural boundaries, green corridors, scenic beauty, and visually appealing landscapes (biophilic)**.
- Agroforestry attracts birds, pollinators, and small fauna, enriching opportunities for **birdwatching, nature photography, and ecotourism**.
- **Forest bathing^{***}** : Visually green and biodiverse spaces contribute to **mental well-being, aesthetic satisfaction, and cultural attachment**.



4.1 | CHOICE OF SPECIES / SELECTION CRITERIA

The success of an agroforestry system largely depends on the appropriate selection of tree species. Ideal tree species must possess desirable biological, ecological, and socio-economic characteristics to ensure **productivity, compatibility, and sustainability**.

Key Characteristics –

▷ Growth Behaviour and Establishment

- **Fast growing*** : Species should establish quickly, grow rapidly, attain harvestable size early, and require minimal maintenance—supporting short rotation cycles.
- **Short juvenile period (Early Maturity)** : Reduces gestation lag and improves farmer adoption and profitability.
- **Ease of propagation and regeneration** : Species capable of reproducing through seeds, vegetative propagation, or root suckers and showing high survival rates are desirable.

▷ Production Compatibility

- **Low competition with food crops** (Complementarity) : Selected species should not compete with associated food crops for *light, water, nutrients, or space*.
- **Compatible root architecture** : **Deep taproots*** system or **sparse lateral*** roots system minimize underground competition and allow crops to utilize topsoil resources efficiently.
- **Complementary Canopy architecture*** : A small and straight crown with light-filtered (dappled) shade or a deciduous habit (seasonal leaf fall) is preferred, especially for intercropping systems.

▷ Soil Health and Ecosystem Services

- **Nitrogen-fixing*** capability : Preference should be given to leguminous species (NFTs) to enhance soil fertility and nutrient cycling = Adaptable to grow on difficult sites.
- **Non-toxic & non-allelopathic*** : Species should not release harmful compounds (e.g., Mimosine) or allergens detrimental to crops, livestock, or human health (e.g., poplar-related allergy cases in J&K).
- **High litter quality & biomass return (Nutrient Cycling Potential)** : Leaf litter should be nutrient-rich, fast degrading, and capable of improving soil structure and organic matter.

▷ Management Suitability

- **High coppicing*** ability : Tree species should regenerate vigorously post-harvesting and support multiple cutting cycles [Ensuring continuous biomass supply].
- **Amenability to pruning and pollarding (Silvicultural Responsiveness)** : Allows canopy manipulation to maintain crop–tree balance and enhance biomass production.
- **Thornless*** habit : Safer for farm operations and livestock handling.



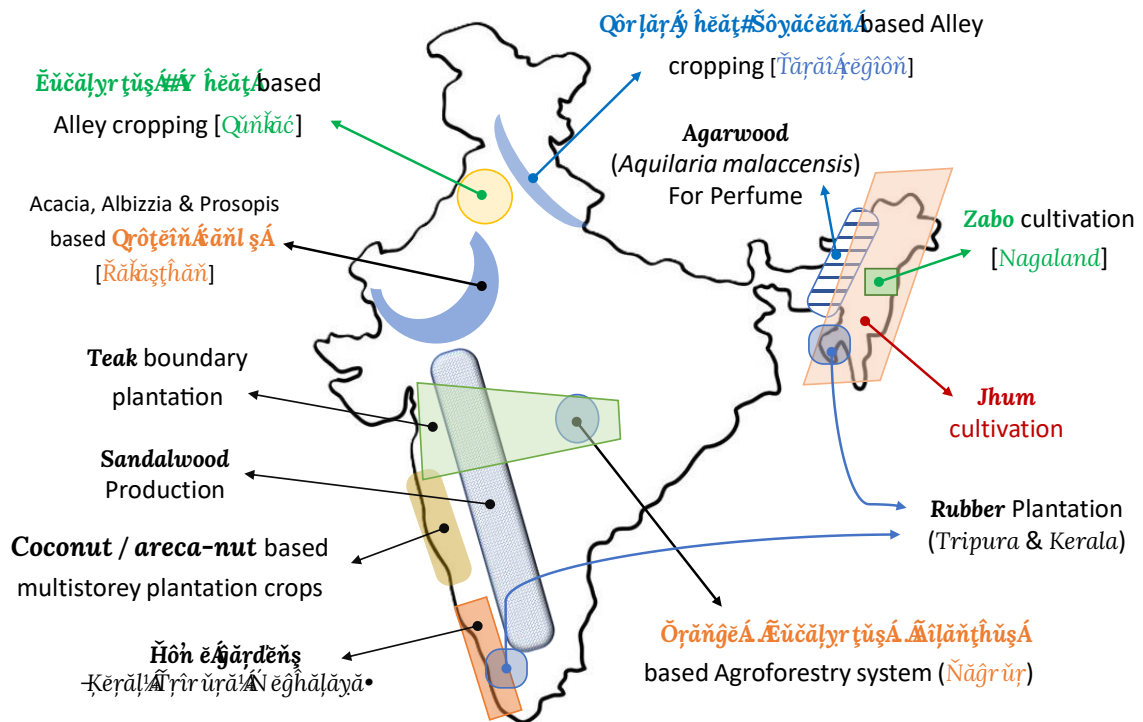
CHAPTER

5

COMMERCIAL AGROFORESTRY SYSTEMS

5.1 | COMMERCIAL 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	<i>Populus deltoides</i> (Poplar), <i>E. tereticornis</i> (Eucalyptus), <i>Melia dubia</i> , 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 (<i>Leucaena</i>), Gamhar (<i>Gmelina arborea</i>)	Furniture, construction timber, paper & pulp
Maharashtra	<i>Melia dubia</i> , Sandalwood (<i>Santalum album</i>), Bamboo, etc.	Medical, perfumes, plywood & pulp

DIAGNOSIS & DESIGN

Diagnosis and Design (D & D) *** is a systematic framework developed by the **International Centre for Research in Agroforestry (ICRAF)**, now known as **World Agroforestry (CIFOR-ICRAF)**. It was conceptualized by **J.B. Raintree** *** in the 1980s to help researchers and field workers identify land management problems and design suitable **agroforestry-based solutions**.

D & D forms the foundation of **Agroforestry Systems Research**, combining biophysical, economic, and socio-cultural analyses to create sustainable land-use systems that balance productivity with conservation.

In one line

“D & D is both a **diagnostic tool** and a **design process** — it identifies what is wrong with the existing land-use system and prescribes feasible agroforestry interventions to improve it”

6.1 OBJECTIVES / PURPOSE

- **Describe and analyze** existing land-use systems in a given area.
- **Identify major constraints** affecting productivity, sustainability, and resource use.
- **Design appropriate agroforestry technologies** to address these problems.
- **Formulate research and development activities**, such as field trials, surveys, and participatory evaluations.
- **Develop linkages** between research institutions, extension agencies, and local communities for effective technology transfer.

6.2 THE KEY FEATURES OF D & D

- **Flexibility** : The methodology is adaptable and *can be modified according to local conditions*, available resources, and the needs of users.
 - It can be applied at any spatial scale — from a small farm to an entire ecological region.

- **Rapidity (Speed)** : D & D serves as a *rapid appraisal tool* during the planning stage, providing quick insights into problems and potential interventions. Later, it allows detailed and in-depth studies during project implementation.
- **Repetition (Iterative Learning)** : D & D is an *open-ended learning process*. Initial designs are treated as provisional and refined through continuous feedback, monitoring, and evaluation.
 - The process continues until further improvements are no longer necessary.

6.3 CRITERIA OF A GOOD AGROFORESTRY DESIGN

A good agroforestry design developed through the D & D approach must fulfil three essential conditions —

- **Productivity** : The system should increase overall output per unit area — including crops, trees, and livestock — while optimizing labour, diversify the income, reducing input costs, and ensuring ecological stability.
- **Sustainability** : It must maintain long-term soil fertility, hydrological balance, and biodiversity, ensuring that future generations can continue to benefit from the land.
- **Adoptability (Social Compatibility)** : The proposed technology must suit local social, economic, and cultural conditions.
 - A technically perfect design is useless unless local farmers are willing and able to adopt it.

6.4 WHO CAN USE THE D & D METHODOLOGY

The D & D framework is applicable to multiple stakeholders:

- **Researchers** in forestry, agriculture, ecology, and land-use planning.
- **Extension officers** and government field workers engaged in technology dissemination.

AGROFORESTRY POLICY

Agroforestry—an integrated approach **combining trees, crops, and livestock**—plays a vital role in meeting India's growing demand for timber, fodder, fuelwood, and environmental services. However, until 2014, India lacked a dedicated national policy to coordinate the diverse programs under agriculture, forestry, and rural development.

Recognizing this gap, the Government of India formulated the **National Agroforestry Policy (NAP) 2014**, the first of its kind in the world, to promote tree-based farming in a systematic, farmer-friendly, and environmentally sustainable manner.

In one line

During the **3rd World Congress on Agroforestry^{***}** held from **10–14^{***} February 2014^{***}** in **New Delhi^{***}**, the then President of India, Shri **Pranab Mukherjee^{***}**, announced India's National Agroforestry Policy 2014 — which was also the **1^{st^{***}} such policy in the world.**

Later, **Nepal^{***}** became the **2nd country** to launch a national agroforestry policy.

Need for a National Agroforestry Policy

Earlier agroforestry and social-forestry efforts achieved limited success because of several inter-related constraints :

- **Absence of Dedicated Policy and Institutional Mechanism** : No unified framework existed to coordinate different schemes and ensure inter-sectoral convergence.
- **Weak Integration of Farming Systems** : Past programs often emphasized **exotic species** and neglected integration with crops and livestock.
- **Restrictive Regulations** : Complicated permissions under **forest laws and court orders** (e.g., Supreme Court, NGT) discouraged felling and marketing of trees grown on private lands.
- **Inadequate Research and Extension** : **Limited R & D, poor dissemination of technologies**, and weak capacity-building among farmers and field officers.

- **Lack of Finance and Insurance** : Farmers had little access to **institutional credit or risk coverage** for tree-based systems.
- **Poor Market Access and Industry Linkages** : Absence of efficient **value chains** kept industry operations at sub-optimal levels.
- Integration of our forest **policy targets and goals** through agroforestry practices for enhancing productivity and ecological stability.

MAJOR POLICY GOALS

The policy seeks to **mainstream agroforestry** into the national rural-development and environmental agenda through the following broad goals:

- Setting up a **National Agroforestry Mission** and an **Agroforestry Board** to implement the National Policy by bring coordination and synergy among diverse programs under agriculture, forestry, environment, and rural sectors.
- Improving the **Productivity, Employment, Income, and Livelihood Opportunities** – Particularly for small and marginal farmers through agroforestry systems.
- **Meeting the Ever-Increasing Demand** for timber, food, fuel, fodder, fertilizer, fibre, and other agroforestry products.
- **Conserve Natural Resources and Protect the Environment** – Enhance ecological stability, mitigate climate change, and increase tree / forest cover outside recorded forests.

Which is not the **major goal** of the National Agroforestry Policy, 2014? [MPPSC Forest (Main) 2022]

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

- Examples : Buddha Jayanti Park (Delhi), Eco-tourism parks of Kerala and Uttarakhand.
- Common Species : *Delonix regia*, *Saraca indica*, *Cassia siamiae*, etc.
- Challenges : Limited land availability in high-cost urban zones, Legal and administrative constraints, Ecological concerns (e.g., ban on *Canocarpus* in Gujarat).

► **EXTENSION FORESTRY** is the practice of growing trees and shrubs outside forest areas, or away from conventional forest regions, to increase the total area under tree cover.

- **Linear Strip plantations** – Planting fast-growing species along roadsides, canals, railway tracks, and stream banks (riparian buffers), etc.
- **Mixed forestry**^{***} : A method of cultivating a combination of **fodder grasses**, **scattered fodder trees**, **fruit trees**, and **fuelwood** species on **wastelands**, **village commons**, and **panchayat lands** to maximize land productivity and support local livelihoods. (Under Panchvan scheme (1976-77), afforestation done is done on denuded village wasteland and degraded government forest)

Objectives : Increase the area under tree cover, Protect the environment (soil and water conservation), Provide social benefits such as fuel, fodder, timber, and minor forest products, etc.

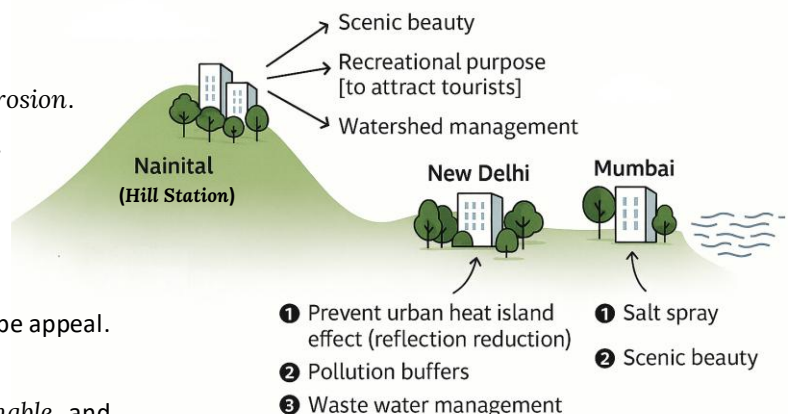
Key Locations : Roadside, canal banks, railway lines, tank beds, school/institutions, embankments.

Difficulties : High initial investment cost, Requirement of skilled labour, etc.

► **URBAN FORESTRY** : a branch of social forestry involving the plantation and management of trees in urban and peri-urban areas to improve the environment, landscape quality, and the overall well-being of urban populations. It primarily focuses on planting **flowering** and **ornamental** trees and **shrubs** using forestry principles and technologies for the benefit of city residents.

Objectives of Urban Forestry

- Reduction of **greenhouse effects**.
- Prevention of **urban runoff** and **soil erosion**.
- Abatement of **air and noise pollution**.
- Support for **groundwater recharge**.
- Provides **fuel, food, shade**, and other ecosystem services.
- Enhances **aesthetic value** and **landscape appeal**.
- Supports **urban wildlife habitat**.
- Essential for creating **healthy, sustainable, and climate-resilient cities**.



Scope

- Control of urban air pollution (e.g., New Delhi).
- Shelter for urban wildlife.
- Recharge of local watersheds (e.g., Okhla Bird Sanctuary region, New Delhi).
- Recreation and aesthetic development.

Suitable Species : Mango (*Mangifera indica*), Jamun (*Syzygium cumini*), Neem (*Azadirachta indica*), Khejri (*Prosopis cineraria*), etc.

Challenges / Limiting Factors

WATERSHED MANAGEMENT

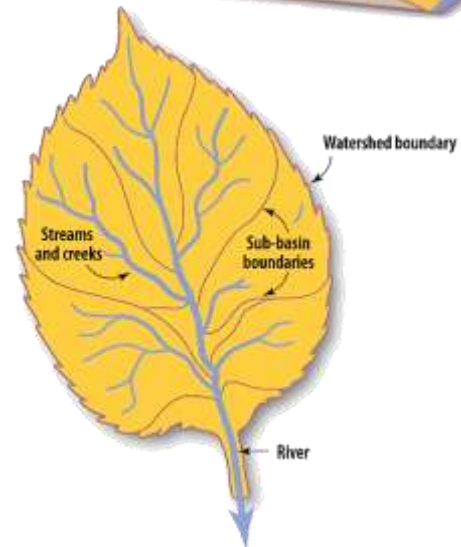
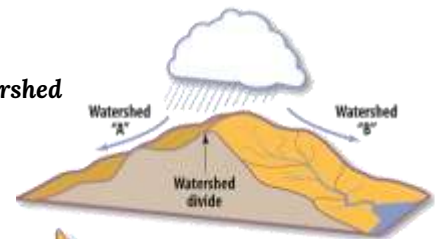
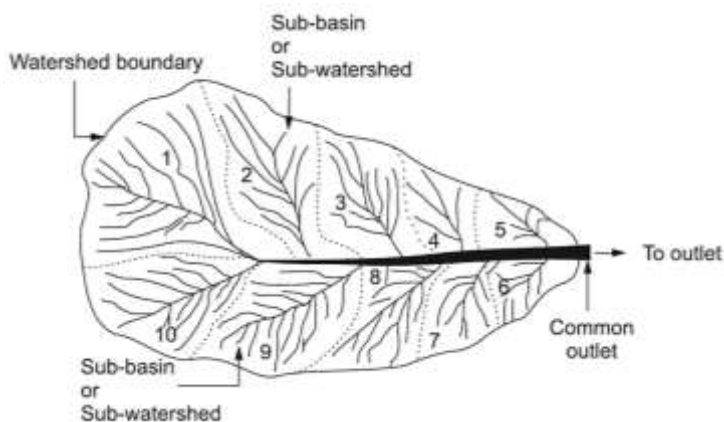
9.1 | WHAT IS WATERSHED ?

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

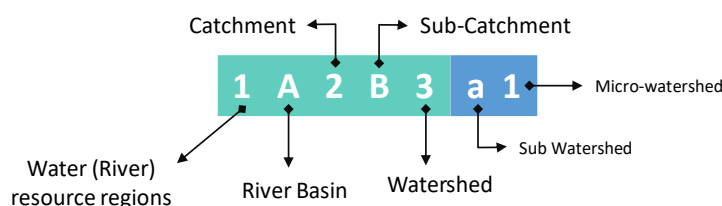


WATERSHED MANAGEMENT

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]

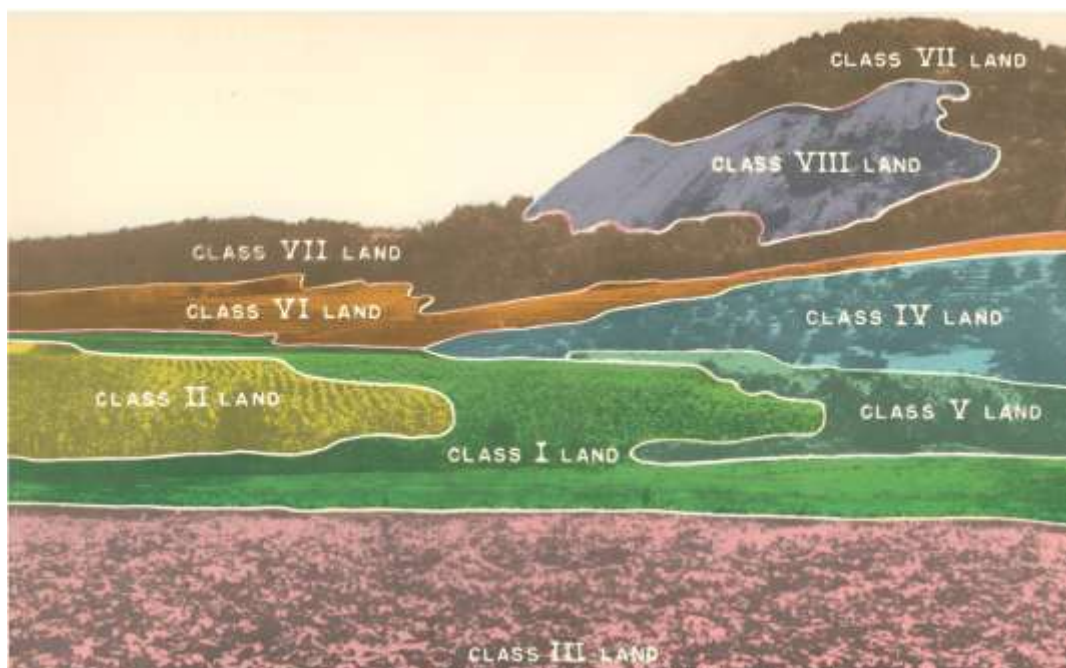
List-I (Drainage Unit)	List-II (Watershed code)
(a) Watershed	(i) 4B2A3a1b
(b) Catchment	(ii) 4B2
(c) Basin	(iii) 4B
(d) Micro watershed Gr-1	(iv) 4B2A3

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. <i>Special management practices are not required</i>	<i>Required good soil management practices only = Suitable for the most of crops.</i>
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 <i>perennial vegetable</i> only.
Land Unsuitable for cultivation but suitable for permanent vegetative cover (for grazing)			
V	Dark grey	The land is <u>not suitable for arable farming</u> . Have No <u>limitations for use</u> .	Very suitable for Grazing or Forestry
VI	Orange	Non-arable land. Have <u>moderate limitations</u> in use, e.g., steep slopes.	Suitable for grazing or Forestry
VII	Red	Non-arable land. Have <u>severe limitations</u> 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 <u>very severe limitations</u>	Suitable only for <u>wildlife or recreation purposes</u> .

- **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).

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 m² at the surface and extends to the bottom bedrocks of the soil.

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

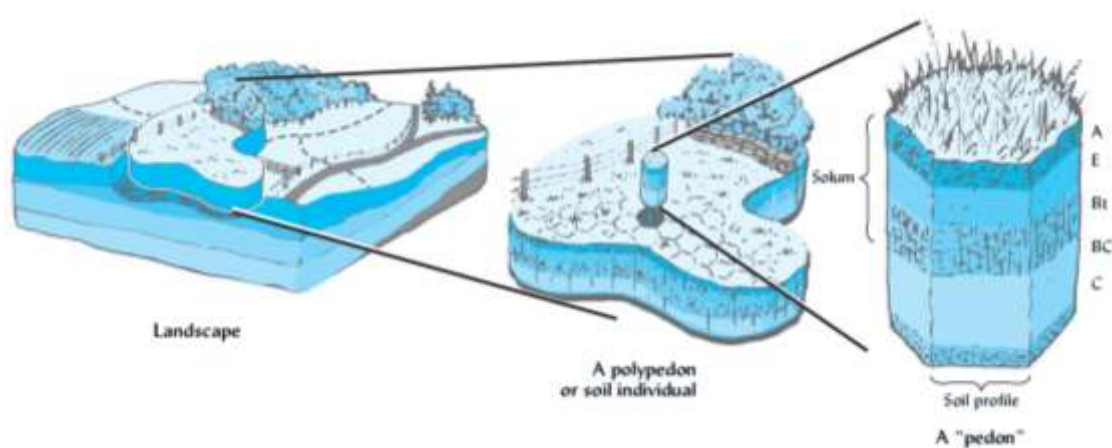


Figure 1.1 : Pedon is a natural body of soil that is large enough to allow classification of the soil.

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.

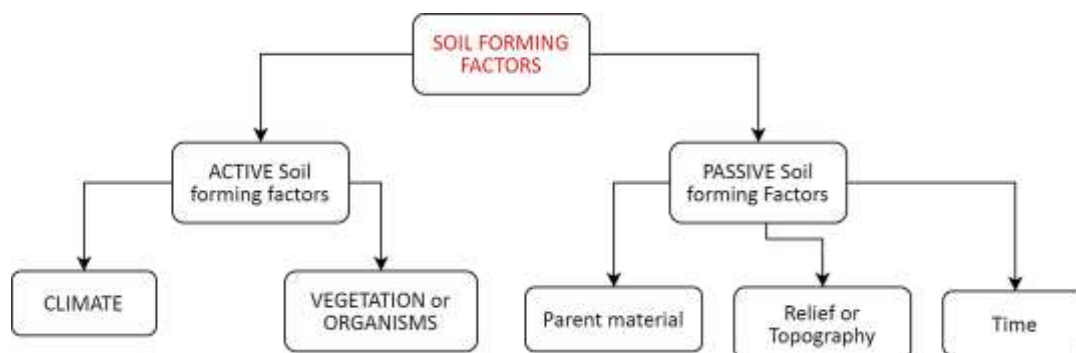
- Soil genesis : the mode of origin of soil with particular reference to the processes and soil-forming factors responsible for the development of solum or true soil.
- Soil survey : consists of morphological examination, description, classification, and mapping of soils in their natural environment.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

SOIL FORMATION

4.1 SOIL FORMATION ?

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

SOIL FORMING FACTORS



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

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

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

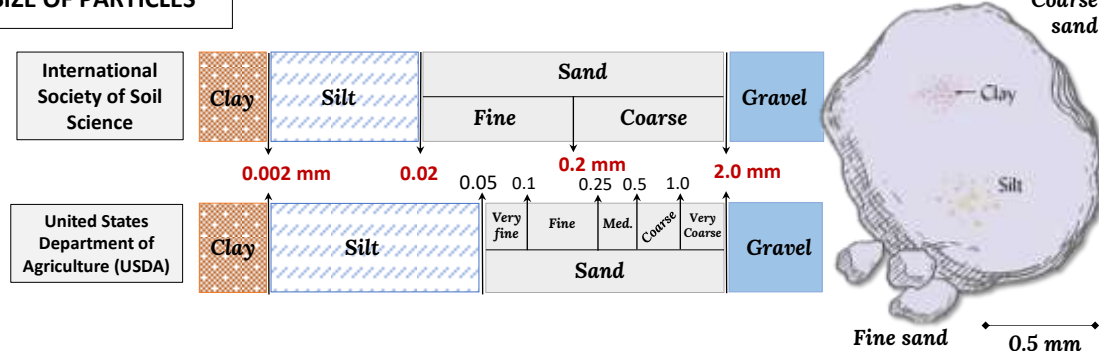
- **Time**
- **Relief or Topography** : topography refers to the differences in the elevation of the land surface. As per FAO guidelines –

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*.

SIZE OF PARTICLES



- ✍ 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)

CHEMICAL PROPERTIES

7.1 SOIL pH

The term pH is from the French “*Pouvoir Hydrogen*” or hydrogen power. Soil pH or soil reaction is an indication of the acidity or alkalinity of soil. The excess hydrogen ion concentration causes soil acidity, whereas soil alkalinity is produced by hydroxyl ion concentration.

pH is the negative log of hydrogen ion (H⁺) activity in an aqueous solution in moles/ L

$$\text{pH} = -\log_{10} (\text{H}^+)$$

Where : (H⁺) is the activity of hydrogen ions in moles/lit.

- ✿ pH concept given by **Sorensen**^{***}
- ✿ **pH scale : 0 to 14**^{***} with **pH 7** as the **neutral** point | **Below 7 = Acidic** | **Above 7 = Basic/Alkaline**
- ✿ A *decrease in pH by one unit* represents a *10-fold increase in H⁺ ion concentration*.
- ✿ Forest soil = High organic matter = **Acidic**^{***}
- ✿ The optimum pH for a good nursery = **5 – 6**^{***}
- ✿ Most of nutrient available at pH = **5.5 – 6.5**^{***}
- ✿ Peat soil pH : **< 3**^{***}
- ✿ Buffering capacity of soil = Ability of a soil to resist changes in pH [**Humus**^{**} has high buffering capacity]

IMPORTANCE OF SOIL PH

The pH of the soil is an important physicochemical characteristic because it influences

- Suitability of soil for crop production
- Availability of soil nutrients to plants
- Microbial activity in the soil
- Physical properties of soil like structure, permeability etc.

NUTRIENT AVAILABILITY

17 Essential elements : **C, H, O, N, P, K, Ca, Mg**, and **S** are called **Macro-elements** or **Macro-Nutrients**, and they generally present in plant tissues in large amounts (over 10 million moles per Kg of dry matter). Carbon, hydrogen, and oxygen are mainly obtained from CO₂ and H₂O, while they absorb the others from the soil as mineral nutrition. The other remaining elements that are required in tiny amounts (*less than 10 m. mole Kg⁻¹ of dry matter*) are called - **Micronutrients** or **trace elements**. These include **Iron (Fe)**,

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.

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*

2.2 SPECIFICATIONS

- **Removal / felling of the mature crop** : The *coupe is felled and removed in one operation*. However, some mature trees may be retained for frost protection, as a *nurse crop* for frost-tender species, or as insurance against regeneration failure, but their number should be kept minimal.

- **Mode of regeneration** : *Mostly artificial, sometimes natural*.

Why is artificial regeneration preferred in most cases?

- Quickest & surest method of regeneration.
- Strict control over crop composition : enables the introduction of fast-growing exotics (*Eucalyptus*, *Acacia mearnsii*, *Casuarina equisetifolia*).
- Earlier opening for grazing : important for villages dependent on forest grazing.

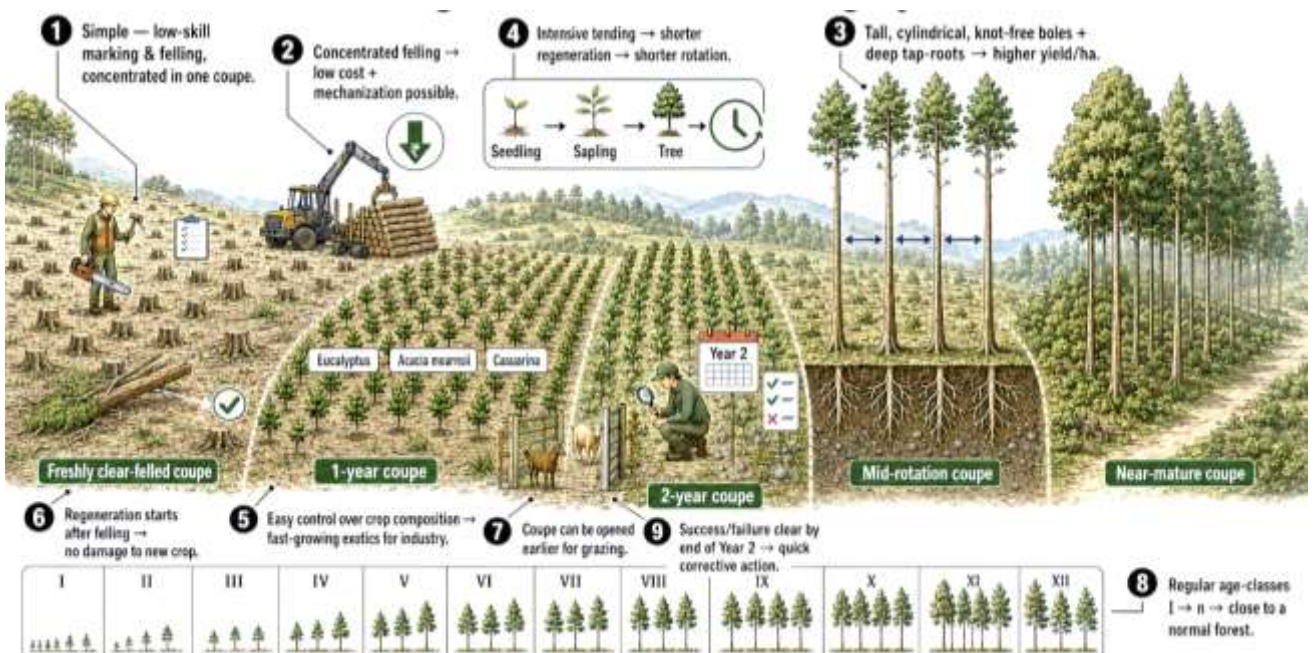
⇒ The clear-felling system was introduced for the first time by **Heinrich Von Cotta** in Saxony (Germany).

Occasionally, regeneration occurs naturally from seeds stored in the soil of the felled area or received from trees standing on the sides (adjoining coupes).

- **Characteristics of the new crop** : *Absolutely Even-Aged* (If no failure or fire). A *normal series of age-gradations* from 1 to n year develops.

2.3 ADVANTAGES

- One of the *simplest silviculture systems*. Marking and cutting of trees does *not need high skill* + everything is removed in one operation + all work is concentrated in a single annual coupe. So, *easy to practice* and *supervise* various silvicultural activities.
- **Cost of production** : Since all felling work is concentrated in one coupe, felling and extraction costs are low + the system also supports *mechanization* of conversion and extraction work.
- Trees grown under this system are *taller*, with *more cylindrical*, *cleaner* and *knot-free boles*, *lower tapering rates*, and well-developed *deep tap-roots*, because of *intense horizontal competition* for light, water and rooting space = *higher timber yield per unit area*.
- Quick early establishment (due to intensive tending) → shorter regeneration period → *shorter rotation* possible.



SINGLE-TREE v/s GROUP SELECTION

Parameter	Single-Tree Selection	Group Selection
Unit of removal	Individual scattered trees	Small patches / groups (0.05-0.5 ha)
Suitable for	Shade demander spp. i.e., Deodar, Fir, Spruce, etc.	Light-demanders & moderate shade tolerant spp. i.e., Sal, mixed deciduous forest.
Crop produced	All-aged on every unit of area	Groups of similar-aged trees scattered over area
Marking demand	Highest → Every tree judged individually	Lower → group boundaries decided
Logging cost	Highest — diffused	Lower — concentrated within groups



Figure : 4.2 Group selection system

► ADVANTAGES

- Trees of all ages are mixed together on each unit area.
- Continuous multilayer Canopy both horizontally and vertically + Multilayered Root Systems = More effective utilization of site factors.
- Multi-aged, multi-species forest = most resistant to damage from insect pests, wind, snow, fire, and weed/grass invasion.
- Natural regeneration comes up without difficulty due to the abundance of seed bearers.
- Trees of all age classes grow below the older trees = Natural pruning = well-developed crowns and long, clean, cylindrical boles.
- It is biologically richer, supports more biodiversity, and is superior in aesthetic and scenic values to monoculture plantations.
- About the same volume removed every felling cycle (Sustained yield) — unlike concentrated systems where 50–70% of yield comes in a few years of regeneration fellings.

► DISADVANTAGES

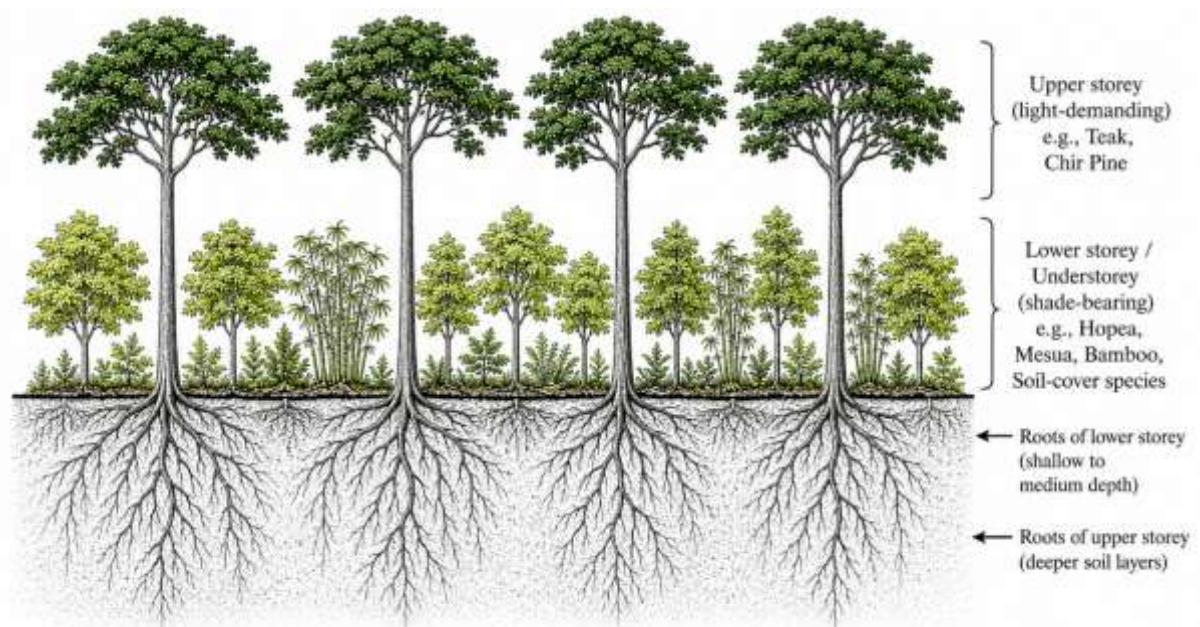
- This system requires a high degree of technical skill in marking and felling so that natural

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.

CONVERSION

Sometimes, we required to change from one silvicultural system to another as per necessitated by market demand, soil and climatic condition. This is usually referred to as conversion.

► **Definition** : *A change from one silvicultural system or one set of species to another.*

7.1 KINDS OF CONVERSION

- **Change in crop composition (Species)** : Replacing an indigenous mix with a fast-growing / valuable / climate-adapted species.
Example : *Tropical pines* and teak in Bastar (CG); *Cryptomeria japonica* in Darjeeling hills (WB); *Eucalyptus hybrid* and *Populus deltoides* in UP, Punjab, Haryana.
- **Change in silvicultural system** : Driven by failure of the existing system, advance of regeneration knowledge, market shift or policy.
Example : Selection-cum-Improvement → Uniform → Indian Irregular Shelterwood for Sal.

7.2 NEEDS = YIE

- **Increasing yield from forests** : To meet rising demand of fuelwood, fodder and timber = Forces restocking with valuable, fast-growing species.
- **Industrial demand** : Pulp-paper, plywood, match, particle-board, biomass-energy and rayon industries demand specific species → conversion to Eucalyptus, Casuarina, Populus, Subabul, Acacia mearnsii plantations on captive/farm forests.
- **Advantages of a particular system** : When a system offers higher yield, simpler working, concentration of work and easier improvement of growing stock, it is adopted.
- **Failure/Loss of the Existing system** : When the prescribed system fails to regenerate the crop, it must be abandoned. Examples : Uniform System for sal in Haldwani / Ramnagar (UP) — abandoned for Indian Irregular Shelterwood System.
- **Advancement in Silvicultural knowledge with time** : Where regeneration of a species (natural or artificial) has been perfected, more intensive systems become feasible — driving conversions to Uniform / clear-felling-with-taungya / clear-felling-with-artificial regeneration.
- **Development of communication system and market demand** : Improved roads + assured demand for smaller-dimension timber make concentrated-regeneration systems economically viable, driving the shift from selection-based working to Uniform / Coppice systems.

7.3 IS CONVERSION A SILVICULTURAL SYSTEM? THE GREAT DEBATE

► **YES, it is (as per some believers)**

- Trevor (1925) : Coined the term *Conversion System* & formally recognised these methods as a class of silvicultural treatment in their own right.
- British Commonwealth Forest Terminology (BCFT) has accepted the term *Conversion System* and has defined it as a method of silvicultural procedure designed to change forest crops from one

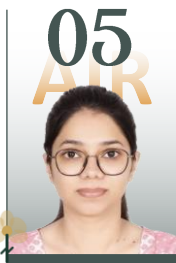


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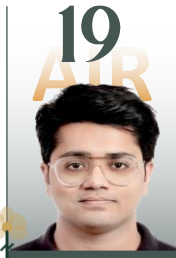
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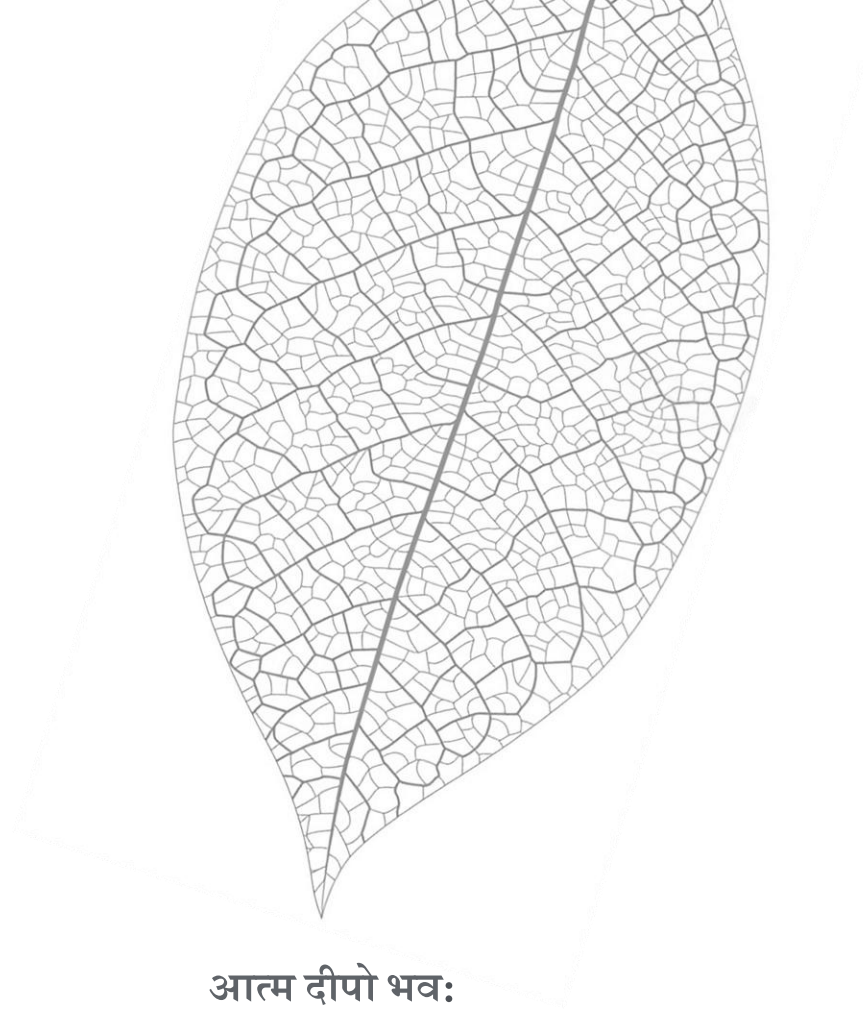


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आत्म दीपो भवः

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.