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STATE FOREST SERVICE

2025

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Module - 3

- Forest Management System
- Silvicultural System
- Agroforestry
- Social Forestry
- Tree Improvement And Seed Technology
- Forest Soil
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FOREST RANGER / SOIL SONSERVATION RANGER

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Module - 3

CONTENTS

Module 3

Previous Year Questions

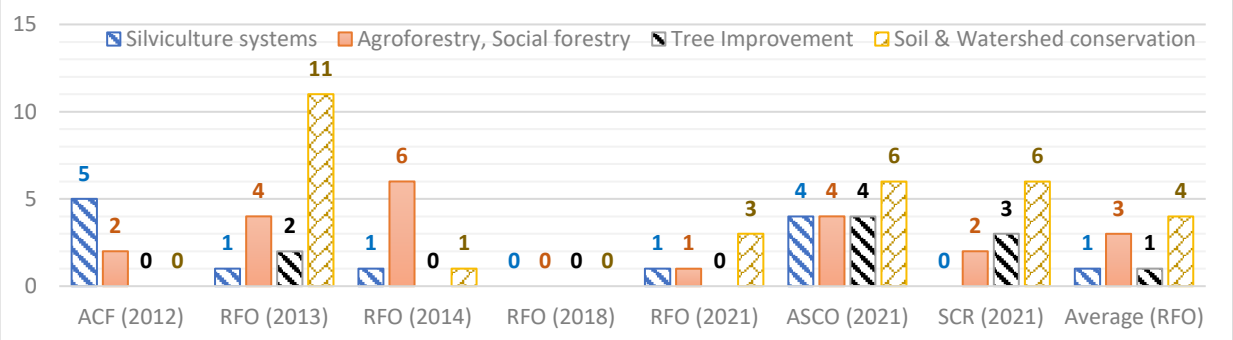
SYLLABUS

- ***Forest Management System*** : ◈ Clear felling system, Uniform shelterwood system, Selection system. Coppice system - Single coppice, Coppice with Standard system, and Coppice with reserve system. ◈ ***Choice of silvicultural system*** – systems of management in important forest types.
- ***Agroforestry*** : ◈ ***Scope and necessity***; role in the life of people and domestic animals and in integrated land use, planning especially related to (i) soil and water conservation; (ii) water recharge; (iii) nutrient availability to crops; (iv) nature and eco-system preservation including ecological balances through pest-predator relationships and (v) Providing opportunities for enhancing biodiversity, medicinal and other flora and fauna. ◈ ***Agroforestry systems*** under different Agro-ecological zones; Selection of species and role of multipurpose trees and Non-Timber Forest Products (NTFPs), techniques, food, fodder and fuel security. ◈ ***Research and Extension*** needs. ***Social / Urban Forestry*** - Objectives, scope and necessity; People's participation.
- ***Tree Improvement And Seed Technology*** : General concept of tree improvement, methods and techniques, variation and its use, provenance, seed source, exotics; quantitative aspects of forest tree improvement, seed production and seed orchards, progeny tests, use of tree improvement in natural forest and stand improvement, genetic testing programming, selection and breeding for resistance to diseases, insects, and adverse environment.
- ***Forests Soils*** : Classification, factors affecting soil formation; physical, chemical and biological properties. ***Soil Conservation*** : Definition, causes for erosion; types – wind and water erosion; conservation and management of eroded soils/areas, wind breaks, shelter belts; sand dunes; reclamation of saline and alkaline soils, water logged and other waste lands. Role of forests in conserving soils.
- ***Watershed Management*** : Concepts of the watershed; the role of mini-forests and forest trees in overall resource management, forest hydrology, watershed development in respect of torrent control, river channel stabilization, avalanche and landslide controls, rehabilitation of degraded areas; hilly and mountain areas; watershed management and environmental functions of forests; water-harvesting and conservation; groundwater recharge and watershed management; the role of integrating forest trees, horticultural crops, field crops, grass, and fodders.

Degree level + PYQ Based

(In short)

PYQs Analysis



Silviculture systems

1. 'Selection system' is applied to [Assam PSC (ACF) 2012]
   (a) uneven aged crop
   (b) miscellaneous stands
   (c) afforestation
   (d) future protection

2. Uniform system is applied to [Assam PSC (ACF) 2012]
   (a) virgin forests
   (b) create even-aged crop
   (c) afforestation
   (d) high-valued timber

3. Is 'uniform system' ideal for management of catchments of a river? [Assam PSC (ACF) 2012]
   (a) No
   (b) Yes
   (c) Not at all
   (d) Partly ideal

4. Was conversion of natural forests to uniform system after World War-II to get more valuable timber and outturn a correct policy for conservation of biodiversity in Assam? [Assam PSC (ACF) 2012]
   (a) Yes
   (b) No
   (c) Unwarranted
   (d) Detrimental

5. Any silvicultural management input in ecosystem [Assam PSC (ACF) 2012]
   (a) affects biodiversity adversely
   (b) does not affect biodiversity
   (c) is enriched in biodiversity
   (d) None of the above

6. Seeding felling means [Assam PSC (RFO) 2013]
   (a) Opening the canopy of matured stand
   (b) Felling of middle-aged trees
   (c) Felling of seed-bearing trees
   (d) Opening the canopy of thickly grown seedlings

7. The supreme Court of India in WP(C) NO202/95 (T N Godavarman-vs-Union of India and 0rs) had passed orders in respect of [Assam PSC (RFO) 2014]
   (a) Ban on felling of trees
   (b) De-reservation of forest areas
   (c) Transportation of timber logs outside the state
   (d) All of the above

8. Form of forest produced by retaining certain trees of the old crop after regeneration is completed is known as [Assam PSC Ass. Soil Conservation Officer (ASCO) 2021]
   (a) High forest with standards
   (b) Selection system
   (c) Two storied high forest
   (d) Wedge system

9. Under which system, mature trees are scattered over the whole area of the forest and felling should proceed annually over the whole area of the estate? [Assam PSC Ass. Soil Conservation Officer (ASCO) 2021]
   (a) Selection system
   (b) Irregular shelterwood system
   (c) Uniform system
   (d) Coppice system

10. Which of the following is the felling cycle of bamboo in India? [Assam PSC Ass. Soil Conservation Officer (ASCO) 2021]
    (a) 3-4 years
    (b) 4-5 years
    (c) 5-6 years
    (d) 5-10 years

11. High forest refers to [Assam PSC Ass. Soil Conservation Officer (ASCO) 2021]
    (a) Forest regenerated through cutting
    (b) Forest regenerated through seeds
    (c) Forest regenerated through coppice
    (d) Forest regenerated through tissue culture plant

12. Forests that are generated from seed are called [Assam PSC (RFO) 2021]
    (a) Coppice forests
    (b) Even-aged forests
    (c) Pure forests
    (d) High forests

Agroforestry – Social forestry

13. Is ***Jhooming*** a silviculture system? [Assam PSC (ACF) 2012]
    (a) Yes
    (b) No
    (c) Not a system at all
    (d) Partly a system

14. ***Jhooming*** encourages more luxuriant forest to grow. Do you agree? [Assam PSC (ACF) 2012]
    (a) No
    (b) Yes
    (c) Partly does
    (d) No effect

15. Which one of the following is not the object of ***farm forestry***? [Assam PSC (RFO) 2013]
    (a) To release cow-dung for use as manure
    (b) To help development of cottage industry
    (c) Increase in production of industrial timber
    (d) To beautify the villages and countryside

16. In the roadside ***avenue plantation***, the most preferred species of plants in Assam will be [Assam PSC (RFO) 2013]
    (a) *Tectona grandis, Shorea assamica, Bombax ceiba*
    (b) *Shorea robusta, Acacia catechu, Psidium guajava*
    (c) *Lagerstroemia speciosa, Cassia fistula, Mimosops elengi.*
    (d) *Dalbergia sissoo, Melia azadirachta, Pongamia pinnata.*

17. **Social *forestry*** programme was launched to [Assam PSC (RFO) 2013]
    (a) Produce fuel, fodder and small wood
    (b) Produce only fuel wood
    (c) Produce industrial timber
    (d) None of the above

18. ***Shifting cultivation*** does not mean [Assam PSC (RFO) 2013]

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(a) Shifting of sites in rotation
(b) Cultivation at a place for 10 years
(c) Slash and burn before cultivation
(d) None of the above

19. ***Social forestry*** programme was launched in India to [Assam PSC (RFO) 2014]
(a) Produce timber for industries
(b) Produce fuel wood, fodder and small wood
(c) Produce only fuel wood
(d) Produce fruits and fuel wood

20. Primary objective(s) of the ***Social Forestry*** is/are [Assam PSC (RFO) 2014]
(a) Supply of fuel and fodder
(b) Supply of timbers to households for day-to-day use
(c) Aesthetic value
(d) All of the above

21. ***Shifting Cultivation*** is a process which involve [Assam PSC (RFO) 2014]
(a) Slash and burn
(b) Felling of trees
(c) Clearance of jungles
(d) All of the above

22. The species of plant which should not be used for road side plantation in the ***Social Forestry*** scheme is [Assam PSC (RFO) 2014]
(a) *Acacia catechu*
(b) *Delonix regia*
(c) *Ficus religiosa*
(d) *Bauhinia purpurea*

23. The most suitable species for plantation in ***Fuelwood*** scheme is [Assam PSC (RFO) 2014]
(a) *Shorea robusta*
(b) *Michelia champaca*
(c) *Anthocephalus cadamba*
(d) *Acacia auroculeformis*

24. ***Taungya Cultivation*** is helpful in [Assam PSC (RFO) 2014]
(a) Solving non-employment problems to an extent
(b) Reducing cost of plantation
(c) Controlling weeds in the area
(d) All of the above

25. ***Social Forestry*** is a forestry which aims at producing flow of protection and recreation benefits for the community. This definition was given by [Assam PSC Ass. Soil Conservation Officer (ASCO) 2021]
(a) Westoby
(b) Brandis
(c) Sunderlal Bahuguna
(d) SIDA

26. Which of the following is not the type of agroforestry system? [Assam PSC Ass. Soil Conservation Officer (ASCO) 2021]
(a) Agri silvicultural system
(b) Silvopastoral system
(c) Agrosilvopastoral system
(d) Social forestry system

27. The ***Taungya*** system was first evolved in [Assam PSC Ass. Soil Conservation Officer (ASCO) 2021]
(a) Java
(b) India
(c) Burma
(d) Indonesia

28. The order and arrangement in which crops are grown in time space including fallows is called [Assam PSC Ass. Soil Conservation Officer (ASCO) 2021]
(a) Crop rotation
(b) Cropping calendar
(c) Crop sequence
(d) Cropping pattern

29. The term '***Taungya***' is used for shifting cultivation in [Assam PSC Soil Conservation Ranger (SCR) 2021]
(a) India
(b) Indonesia
(c) Burma
(d) Sri Lanka

30. Agroforestry system can be categorized based on [Assam PSC Soil Conservation Ranger (SCR) 2021]
(a) Structural basis
(b) Functional basis
(c) Ecological basis
(d) All of the above

31. The sustainable land use system involving trees combined with agriculture crops on the same unit of land is termed as [Assam PSC (RFO) 2021]
(a) Agroforestry
(b) sustainable forest management
(c) Social forestry
(d) farm forestry

Tree Improvement

32. The selection of seed production areas is made on the basis of [Assam PSC (RFO) 2013]
(a) Phenotypic character of tree
(b) Genotypic character of tree
(c) Age of trees
(d) Locality of seed producing tree

33. The best quality of seeds can be obtained from [Assam PSC (RFO) 2013]
(a) Clonal seed orchard
(b) Seedling seed orchard
(c) Seed production areas
(d) Middle-aged trees

34. Plus trees are with superior [Assam PSC Ass. Soil Conservation Officer (ASCO) 2021]
(a) Phenotype
(b) Genotype
(c) Phenotype-genotype
(d) All of the above

35. The most commonly used experimental design in tree breeding is [Assam PSC Ass. Soil Conservation Officer (ASCO) 2021]
(a) Lattice design
(b) Compact family design
(c) Lattice square
(d) Randomized complete block design

36. In DNA, adenine is paired with [Assam PSC Ass. Soil Conservation Officer (ASCO) 2021]
(a) Thymine
(b) Cytosine
(c) Glucose
(d) Fatty acid

37. The most common type of gel used in DNA separation is [Assam PSC

Ass. Soil Conservation Officer (ASCO) 2021]
(a) Agar – agar
(b) Gelatine
(c) Agarose
(d) Polyacrylamide

38. A tree which has a superior phenotype for growth, form, wood quality or other desirable character is called [Assam PSC Soil Conservation Ranger (SCR) 2021]
(a) Plus Tree
(b) Elite Tree
(c) Candidate Tree
(d) Check Tree

39. Which of the following stains is used to stain chromosomes? [Assam PSC Soil Conservation Ranger (SCR) 2021]
(a) Safranin
(b) Leishman's stain
(c) Acetocarmine
(d) Methylene blue

40. The technique of obtaining a large number of plantlets by tissue culture method is called [Assam PSC Soil Conservation Ranger (SCR) 2021]
(a) Plantlet culture
(b) Micropropagation
(c) Organ culture
(d) Micropropagation

Soil science

41. Which of the following conditions has a bearing on bacterial activity? [Assam PSC (RFO) 2013]
(a) Soil moisture
(b) Temperature
(c) Both of the above
(d) None of the above

42. Which of the following statements is correct? [Assam PSC (RFO) 2013]
(a) Aerobic bacteria require oxygen for survival
(b) Anaerobic bacteria do not require oxygen for survival
(c) Facultative bacteria can thrive both in presence and absence of oxygen
(d) All of the above statements are correct

43. The soil air is composed of oxygen, nitrogen, carbon dioxide, water vapours, etc. Which of the following is correct? [Assam PSC (RFO) 2013]
(a) Oxygen = 20.6
(b) Nitrogen = 75 – 79.2
(c) Carbon dioxide = 2.03 – 0.25
(d) Water vapour = 0.30 to 3.0

44. Which of the following statements is correct? [Assam PSC (RFO) 2013]
(a) Laterite soil is brick red in colour
(b) Peaty soils have high organ matter content
(c) Alkali soils have high sodium carbonate content
(d) Saline soils are known solonetz

45. Which of the following is the correct classification of sedimentary rock adopted by Dr. Harker? [Assam PSC (RFO) 2013]
(a) Arenaceous, e.g., limestones,
(b) Argillaceous, e.g., conglomerates and sandstones
(c) Calcareous, e.g., Clay a shale
(d) Pyroclastic, e.g., Fragment volcanic deposits formed und. The sea

46. Metamorphic rocks are produced the change brought about by [Assam PSC (RFO) 2013]
(a) Heat
(b) Heat, pressure and chemical Agencies
(c) Pressure and chemical agencies
(d) Heat and pressure

47. Reclamation of alkali soils may be done by [Assam PSC (RFO) 2013]
(a) Application of gypsum only
(b) Application of gypsum and sulphur
(c) Application of lime, and organic matter
(d) All of the above

48. In order to prevent soil erosion and conserve the soil, which of the practices is not recommended? [Assam PSC (RFO) 2013]
(a) Contour farming
(b) Monoculture
(c) Terracing
(d) Alley cropping

49. Which one of the following is active factor in soil formation? [Assam PSC (RFO) 2013]
(a) Climate
(b) Parent rock
(c) Topography
(d) Time

50. Sal (*Shorea robusta*) grows best in soil with pH value [Assam PSC (RFO) 2013]
(a) 3 to 4
(b) 4.5 to 5.5
(c) 6.5 to 7.5
(d) 7.6 to 8

51. Increase in pH in soil results decreased supply of [Assam PSC (RFO) 2013]
(a) Calcium
(b) Potassium
(c) Magnesium
(d) Iron

52. Arid soils range from [Assam PSC (RFO) 2014]
(a) Red to black in colour
(b) Red to dark red to colour
(c) Red to brown in colour
(d) Red to dark brown in colour

53. Which among the following is not a factor responsible for soil color? [Assam PSC Ass. Soil Conservation Officer (ASCO) 2021]
(a) Organic matter
(b) Free oxides of iron
(c) Moisture content of the soil
(d) Temperature of the soil

54. The smallest soil particle is [Assam PSC Ass. Soil Conservation Officer (ASCO) 2021]
(a) Clay
(b) Silt
(c) Sand
(d) Gravel

55. Which among the following does not influence total pore space of a soil? [Assam PSC Ass. Soil Conservation Officer (ASCO) 2021]
(a) Organic matter

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(b) Depth of soil
(c) Soil organism
(d) Soil consistence

56. The broad and fundamental groups of soil textural classes are recognized as [Assam PSC Ass. Soil Conservation Officer (ASCO) 2021]
(a) Sand, Silt and clays
(b) Dust, sand and clays
(c) Silt, clays and water
(d) Dust, water and colour

57. The soil conditions and characteristics such as water movement, heat transfer, aeration, bulk density and porosity will be much more influenced by [Assam PSC Ass. Soil Conservation Officer (ASCO) 2021]
(a) Soil structure
(b) Soil color
(c) Soil texture
(d) Soil temperature

58. _____ is the main source of supply of moisture to forest trees [Assam PSC Ass. Soil Conservation Officer (ASCO) 2021]
(a) Gravitational water
(b) Rainwater
(c) Capillary water
(d) Hygroscopic water

59. Which of the following soils is susceptible to wind erosion? [Assam PSC Soil Conservation Ranger (SCR) 2021]
(a) Sandy soil
(b) Chalka soil
(c) Crusting soil
(d) Red sandy loam soil

60. Which type of soil is most suitable for nursery? [Assam PSC Soil Conservation Ranger (SCR) 2021]
(a) Clay
(b) Sandy
(c) Sandy loam or loamy sand
(d) Red soil

61. Who is the father of Soil Science? [Assam PSC Soil Conservation Ranger (SCR) 2021]
(a) Dokuchaev
(b) Justus von Liebig
(c) J. W. Leather
(d) Marbut

62. The bacteria living in the module help in fixation of free nitrogen from the air in the form of [Assam PSC Soil Conservation Ranger (SCR) 2021]
(a) Nitrite
(b) Nitrates
(c) Nitric
(d) Nitrogen

63. NPK are called as [Assam PSC Soil Conservation Ranger (SCR) 2021]
(a) Macronutrients
(b) Micronutrients
(c) Secondary nutrients
(d) Beneficial nutrients

64. Which of the following tree species helps to increase soil fertility through N2-fixation? [Assam PSC Soil Conservation Ranger (SCR) 2021]
(a) *Dalbergia grandiflora*
(b) *Dipterocarpus macrocarpus*
(c) *Hevea brasiliensis*
(d) *Alnus nepalensis*

65. ***Chlorosis*** in plants occurs due too [Assam PSC (RFO) 2021]
(a) high sunlight intensity
(b) low sunlight intensity
(c) absorption of yellow pigment from soil
(d) deficiency of Mg and Fe in the soil

66. Soil organic matter [Assam PSC (RFO) 2021]
(a) Increases water holding capacity
(b) Maintains soil temperature
(c) Increases nutrients in soil
(d) All of the above

67. The continuous circulation of water among the hydrosphere, atmosphere and lithosphere is called as [Assam PSC (RFO) 2021]
(a) nutrient cycle
(b) Water cycle
(c) Watershed
(d) hydrological cycle

CHAPTER 1

SILVICULTURE SYSTEM
INTRODUCTION

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

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

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

OR

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

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

1.1 CLASSIFICATION

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

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

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

1.2 NEEDS OF SUCH CLASSIFICATION ?

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

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

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

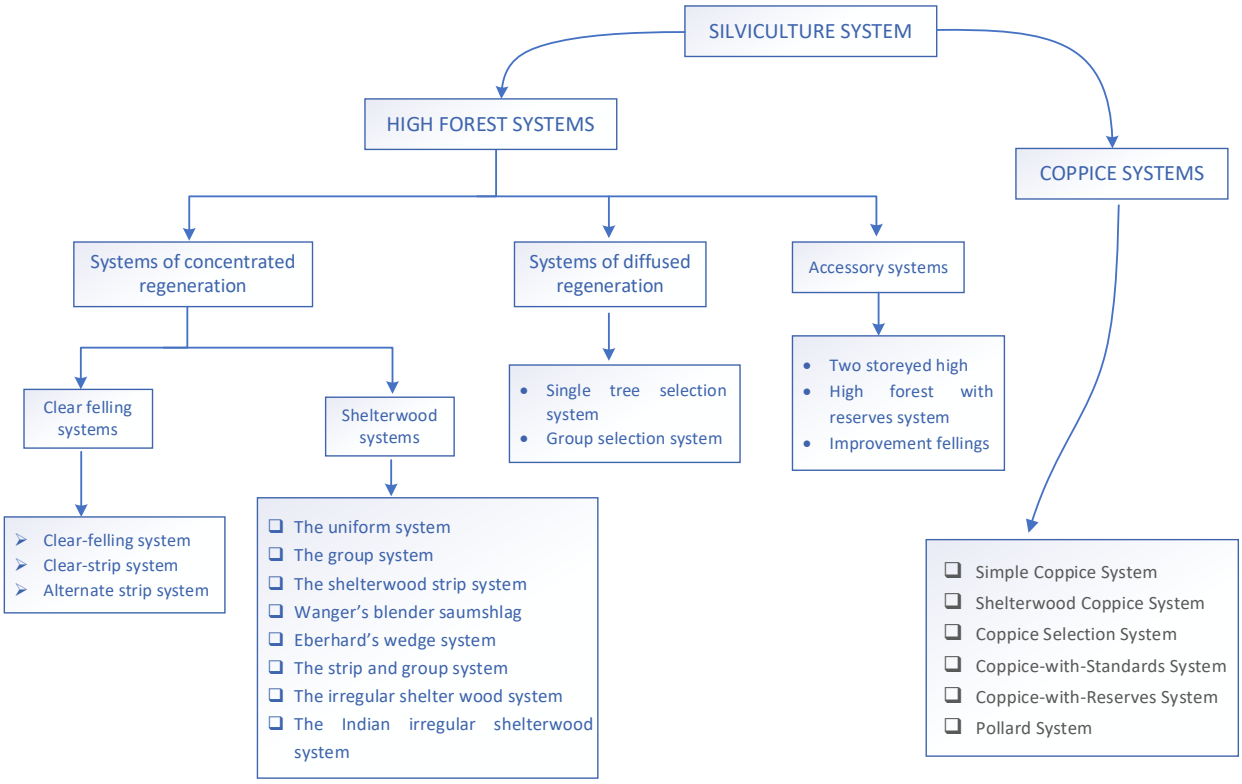


Figure 1.1 : Silviculture system classification

EXERCISE – 1.1

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

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

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

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

CHAPTER 2

CLEAR FELLING SYSTEM

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

- The area to be clear-felled each year in uniformly productive sites is 1/n of the total area allotted to this system, where n is the number of years in the rotation and is usually referred to as the ***Annual Coupe***[***]

2.1 SPECIFICATIONS

- **Removal or felling of the mature crop** : The *coupe should be felled and removed in a single operation*. However, some mature trees may be retained as a frost protection measure or as insurance against failure, but their number should be minimal.
- Methods of obtaining regeneration :-

  (a) **Artificial regeneration** : Primarily achieved through artificial means, either by departmental plantations or through various Tungya methods (village Tungya, lease Tungya, departmental Tungya).

  (b) **Natural regeneration** : Occasionally supplemented by seeds stored in the area or received from outside sources.

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

- Tending : Employed as a crucial *tool to control weed growth* and its detrimental effects on plantation efforts. The frequency (Number) of weeding is determined by the growth rate and density of weeds, alongside the growth rate of the forest plants themselves. Cleaning, climber cutting, replacement of old casualties, thinning, etc. followed subsequently.
- Characteristics of the new crop : **Absolutely** *Even-Aged*. If there is no regeneration failure or forest fire accident, the system gives a *normal series of age gradation*.

2.2 ADVANTAGES

- It is one of the *simplest types of silviculture systems*. All things are removed in one operation. So, it does *not require a high degree of skill* in marking and cutting.

CHAPTER 3

SHELTARWOOD SYSTEM

As described in the previous chapter, the entire cropped area is clear-felled in one operation and restocked, either artificially or naturally (occasionally), in the Clear-felling System. However, this creates some issues, such as :

- Artificial regeneration requires a lump sum investment and a one-time, high labour demand.
- Its success depends on the correct choice of species, the use of proper techniques, favourable climatic conditions (such as adequate rainfall), and freedom from adverse biotic factors.
- Soil erosion is an issue due to the opening up of the tree cover.

Therefore, when large sums of money are not available for artificial regeneration, or when natural regeneration of the species is not possible on a clear-felled site due to inadequate seed supply or adverse climatic and soil conditions, **alternative methods must be considered**.

The alternative is to emulate nature and remove the over-wood gradually, in two or more successive fellings, depending on the progress of regeneration. Since regeneration occurs under the shelter of the over-wood, such systems are called ***Shelterwood Systems***. As the over-wood is removed in multiple operations, they are also known as ***Systems of Successive Regeneration Fellings***.

In other words, Shelterwood Systems involve the *gradual removal of the entire stand in two or more successive fellings that extend over a portion of the rotation*. The process begins with the opening of the canopy to allow natural regeneration under the shelter of the remaining over-wood. As the natural regeneration progresses, the over-wood is gradually removed. When the regeneration no longer requires protection, the shelterwood is removed completely, allowing the newly established crop to utilize the growing space effectively.

The varying patterns of regeneration fellings, and their distribution in space and time, result in a variety of shelterwood systems.

- Uniform shelterwood system or simply called 'Uniform system'.
- Group system
- Shelterwood strip system
- Strip and group system
- Wagners blender saumschlag system
- Eberhard's *Wedge* system
- Irregular shelterwood system
- Indian irregular shelterwood system

CHAPTER 4

SELECTION SYSTEM

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

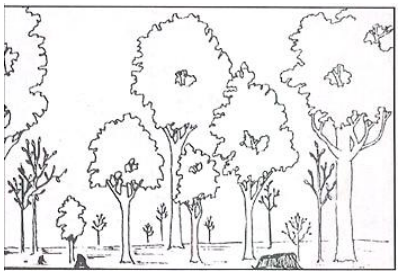
SINGLETREE SELECTION SYSTEM	GROUP SELECTION SYSTEM

⇩

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

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

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



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

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

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

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

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

SINGLETREE SELECTION SYSTEM	**GROUP SELECTION SYSTEM**

⇩

CHAPTER 6

COPPICE SYSTEM

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

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

TYPES : Based on the pattern of felling

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

6.1 SIMPLE COPPICE SYSTEM

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

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

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

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

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

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

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

CHAPTER 9

MANAGEMENT OF BAMBOO SYSTEM

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

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

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

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

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

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

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

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

CHAPTER 1

AGROFORESTRY
[INTRODUCTION]

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

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

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

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

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

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

► **ATTRIBUTES OF AGROFORESTRY**

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

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

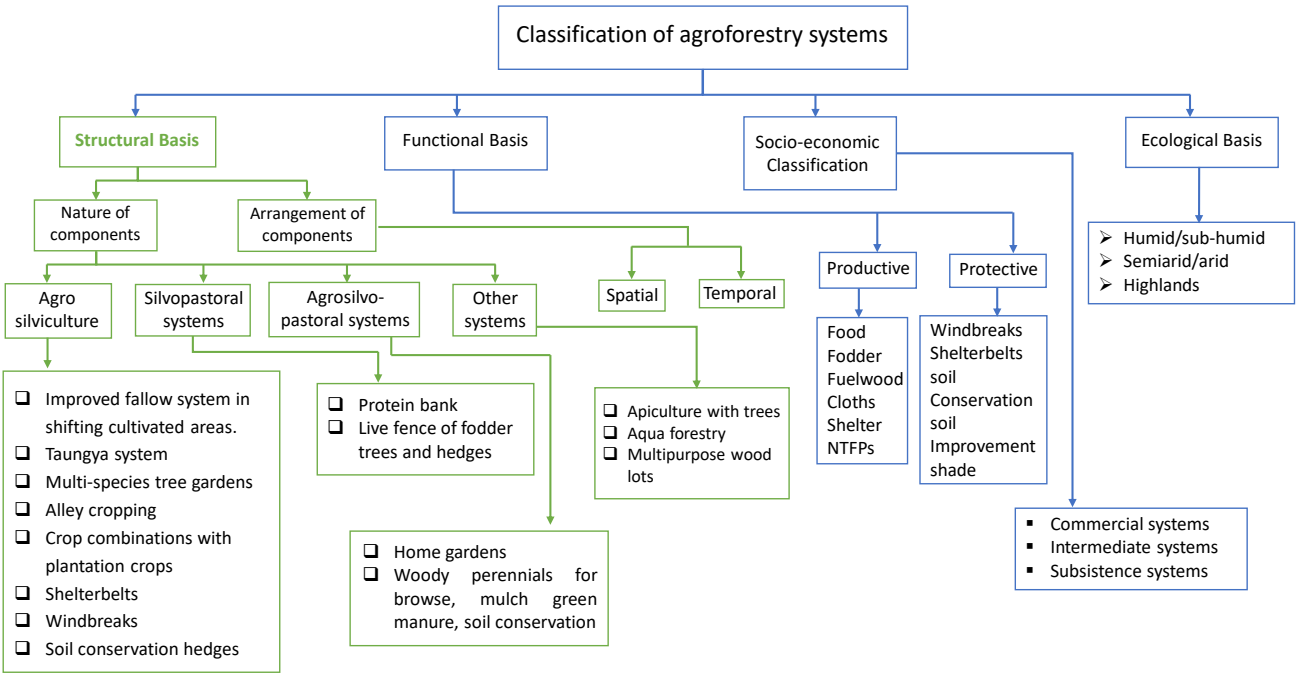
CHAPTER 2

CLASSIFICATION OF AGROFORESTRY

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

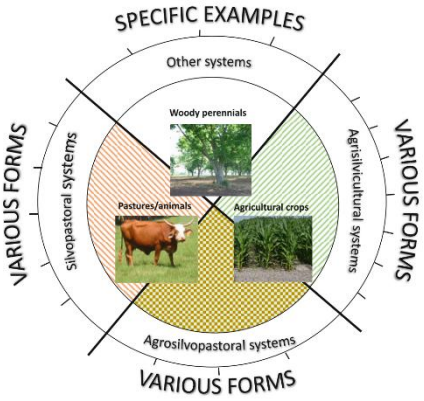
- ► Structural Basis
- ► Functional basis
- ► Socio-economic Basis
- ► Ecological basis

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



2.1 | STRUCTURAL CLASSIFICATION

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



2.1.1 | NATURE OF COMPONENT

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

CHAPTER 3

CHOICE OF AGROFORESTRY SYSTEM

3.1 | CHOICE OF SPECIES FOR AGROFORESTRY

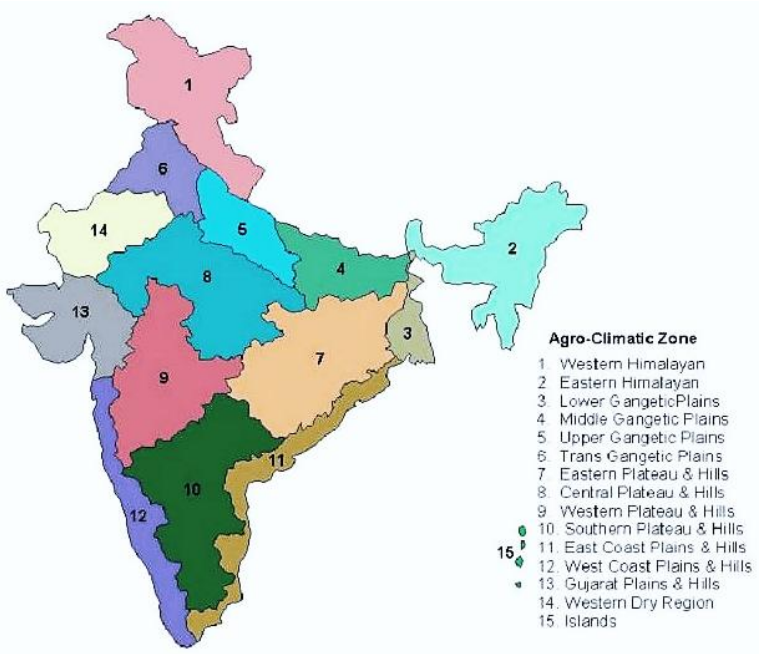
Agroforestry requires trees with special characteristics like –

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

3.2 | AGRO-CLIMATIC ZONES OF INDIA

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

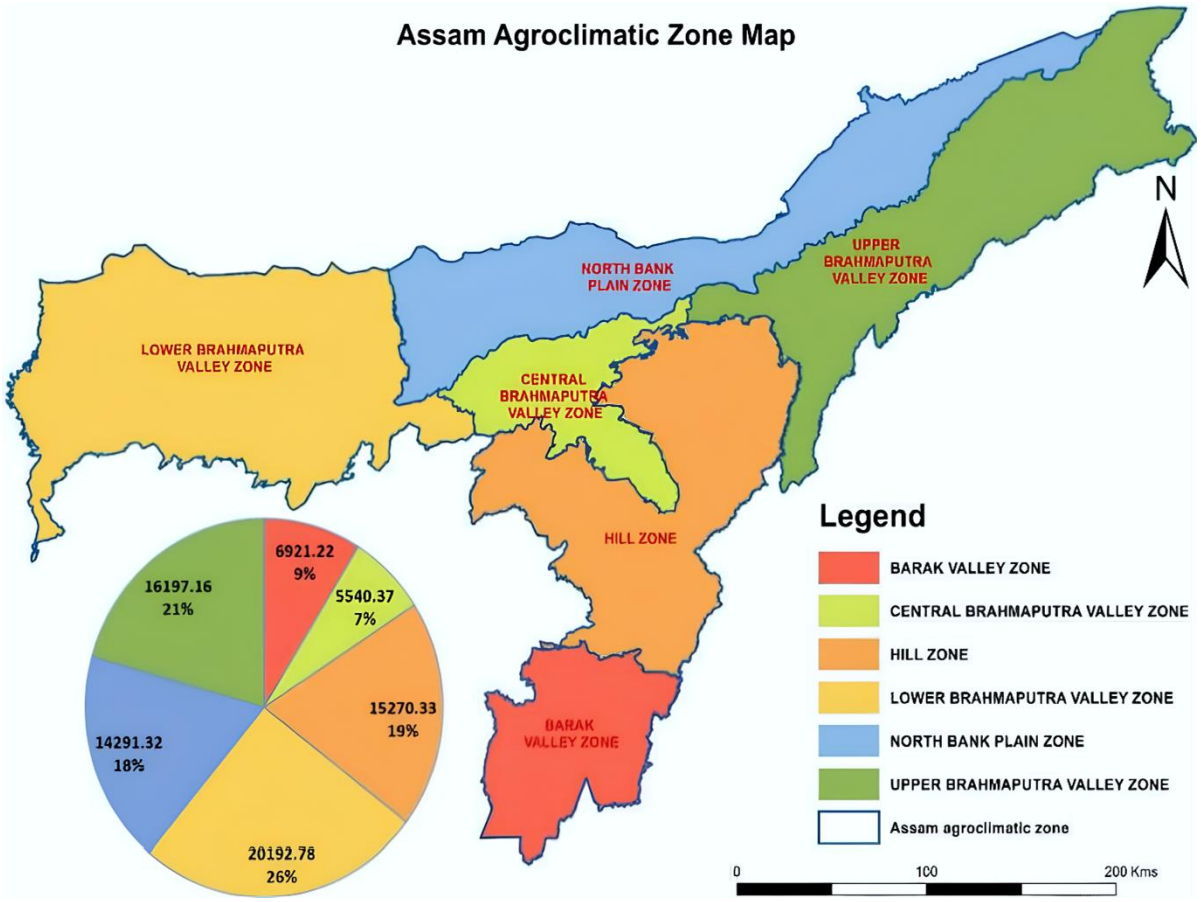
AGRO-CLIMATIC ZONES IN MADHYA PRADESH = 11



- High nutritional value fodder and acceptability to animals
- High calorific value fuelwood
- Absence of toxic substances in foliage and root exudates (Allelopathy)

NITROGEN-FIXING TREES FOR AGROFORESTRY PRACTICES

Timber yielding NFTs	*Acacia nilotica, Dalbergia spp., Casuarina equisetifolia, etc.*
Forage yielding NFTs	*Albizia lebbeck, Albizia procera, Leucaena leucocephala, Sesbania sesban, Gliricidia sepium, Prosopis cineraria, Prosopis juliflora, etc.*
Green manure yielding NFTs	*Sesbania grandiflora, Gliricidia sepium*
Fuelwood yielding NFTs	*Acacia nilotica*
NFTs for arid and semi-arid regions	*Albizia lebbeck, Acacia tortilis, Acacia senegal, Cassia siamea, Prosopis juliflora, Prosopis cineraria, Dalbergia sissoo, etc.*
NFTs for humid and' sub-humid regions	*Gliricidia sepium, Leucaena leucocephala, Sesbania sesban, Casuarina equisetifolia, Acacia auriculiformis, etc.*
NFTs for tropical highlands	*Alnus nepalensis, Acacia mearnsii, etc.*

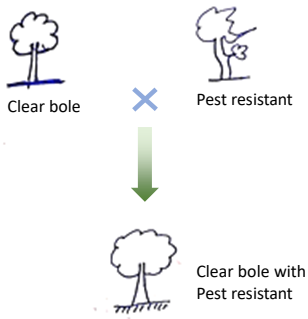


CHAPTER 1

TREE IMPROVEMENT INTRODUCTION

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

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



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

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

Types of heritability

(a) Broad sense heritability – it is the ratio of total genetic variance to the total phenotypic variance.

$$H^2 = \frac{V_g}{V_p}$$

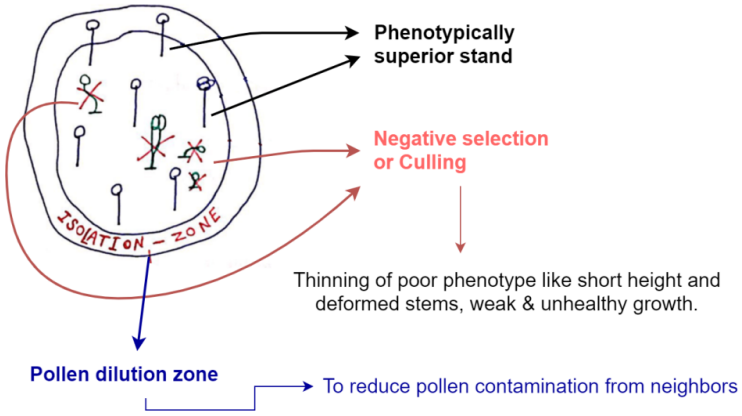
CHAPTER 3

SEED PRODUCTION ARES

The seed production area is a *phenotypically superior stand* of important *commercial forest tree* species in the *Permanent Forest Estate*, consisting of *vigorously growing trees* upgraded by *thinning of poor phenotypes* and treated and managed in such a manner as to *produce large quantities of seed*.

Another definition - The seed production area is a phonologically superior stand made up of *vigorously healthy trees*, upgraded by thinning to remove poorer phenotypes and treated and managed to cause *abundant seed production*. Seed stands are a stage before the formation of a seed orchard.

Furthermore, the seed production area is a *natural or planted stand* or group of stands, set aside, periodically rouged, and treated to stimulate seed production. The genetic quality of the seed is not known.



PURPOSE

- To ensure the continuous supply of larger quantities of high-quality seeds with the known origin for our Afforestation/reforestation and other plantation works. Until such time the seed orchards come into production.
- Reduce harvesting pressure from wild populations.
- Reduce collecting costs
- Increase reliability of supply and enable seed bank stockpiling (including of seed of species that are rare or difficult to collect in the wild).
- Providing opportunities for alternative land use like windbreaks, soil improvement, etc., with income generation.

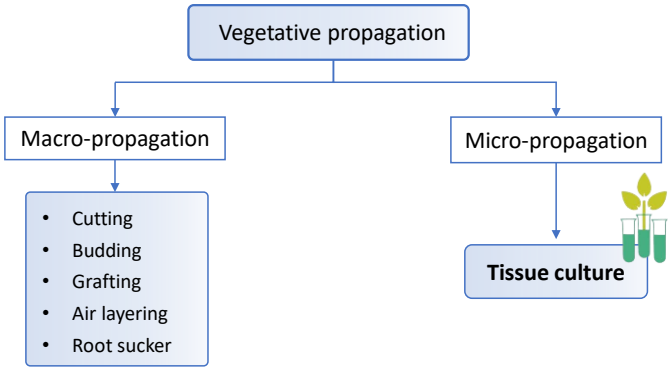
ADVANTAGES

- Increase reliability of supply and enable seed bank stockpiling (including of seed of species that are rare or difficult to collect in the wild).
- Reduce harvesting pressure from wild populations.

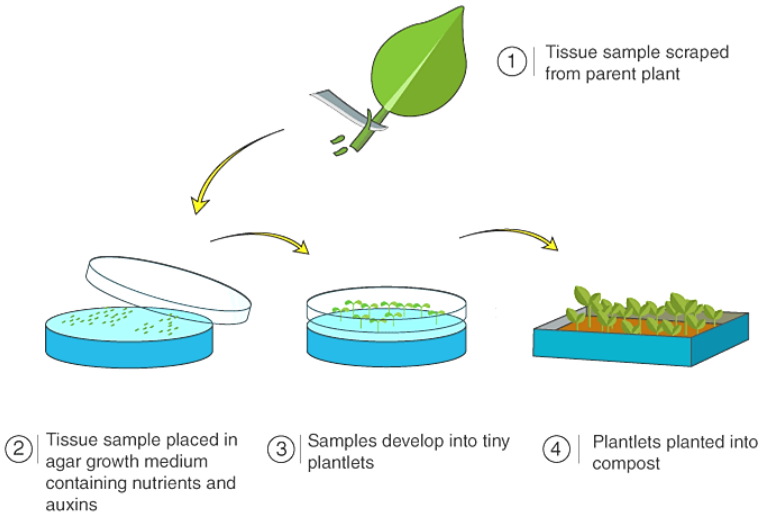
CHAPTER 7

BIOTECHNOLOGY IN TREE IMPROVEMENT

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



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



IMPORTANCE OF MICRO-PROPAGATION / TISSUE CULTURE TECHNIQUES

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

CHAPTER 1

FOREST SOIL

[INTRODUCTION]

1.1 WHAT IS SOIL ?

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

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

PEDON ?

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

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

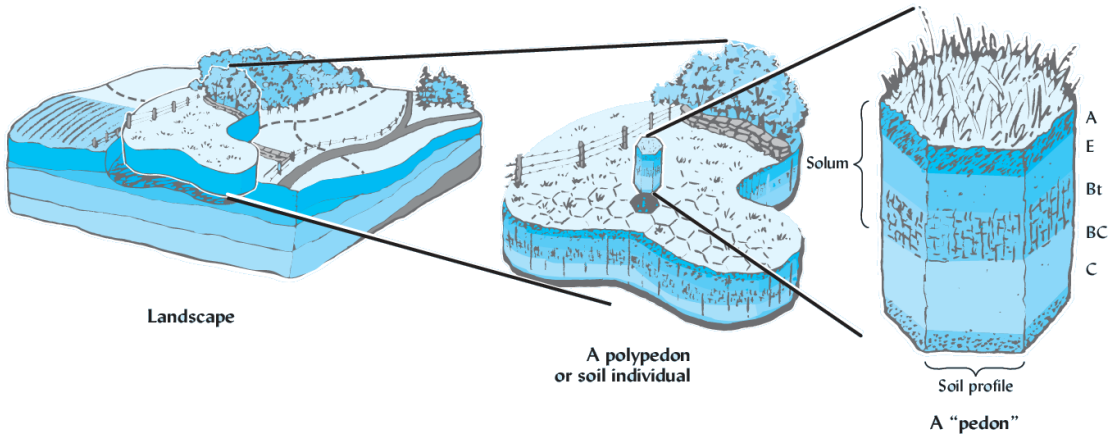


Figure 1.1 : Pedon is a natural body of soil that is large enough to allow classification of the soil.

PEDOLOGY : Pedology = Pedon + Logos = Greek word
↓ ↓
Soil/Earth Study

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

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

CHAPTER 2

ROCKS & THEIR FORMATION

2.1 INTRODUCTION

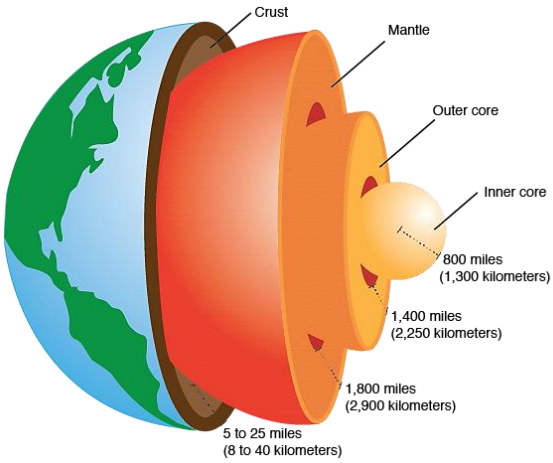
Earth formed about *4.6 billion years* ago from a mixture of gas and dust around the sun. The dust particles were drawn together by drag, forming clumps of rock called *planetesimals*. These planetesimals collided with each other, growing into Mars-sized *protoplanets*. Earth's final size was achieved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

EARTH STRUCTURE

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

COMPOSITION OF *Earth Crust****

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



✍ ***O–Si–Al, Fe–Ca–Mg***

2.2 WHAT ARE ROCKS

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

BASED ON THE MODE OF FORMATION

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

Characteristics

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

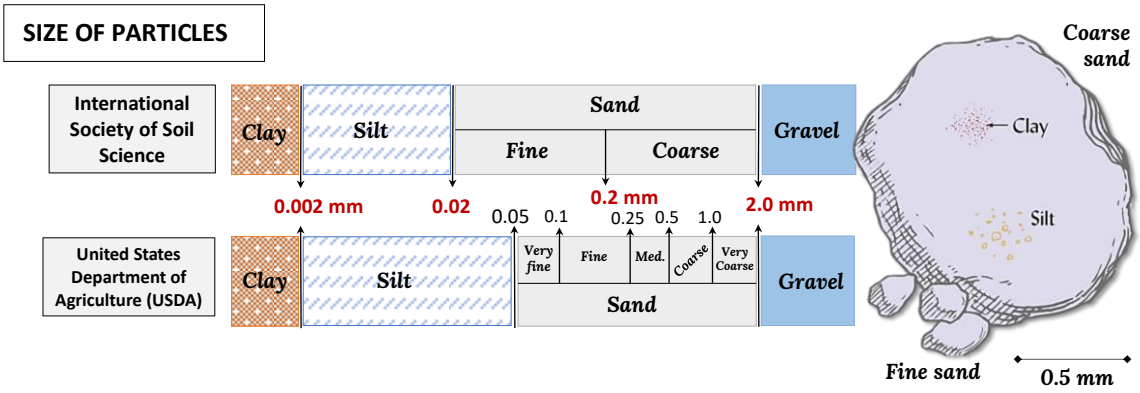
✍ Rocks are formed from the molten material known as *Magma*.
✍ *Petrology* = The study of rocks (in Greek, Petra means rock, Logos means science).
✍ *Petrogenesis* = Study of the origin of rocks.

CHAPTER 6

SOIL PHYSICAL PROPERTIES

6.1 SOIL TEXTURE

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



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

EXERCISE

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

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

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

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

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

CHAPTER 7

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

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

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

- 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 CO_2 and H_2O, 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)**,

CHAPTER 8

AFFORESTATION OF DIFFICULT SITES

CONTENT

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

8.1 HOT DESERT AND SHIFTING SAND DUNES

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

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

(*Source* : Westland Atlas of India 2019)

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

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

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

CHAPTER 9

WATERSHED MANAGEMENT

9.1 WHAT IS WATERSHED ?

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

Or

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

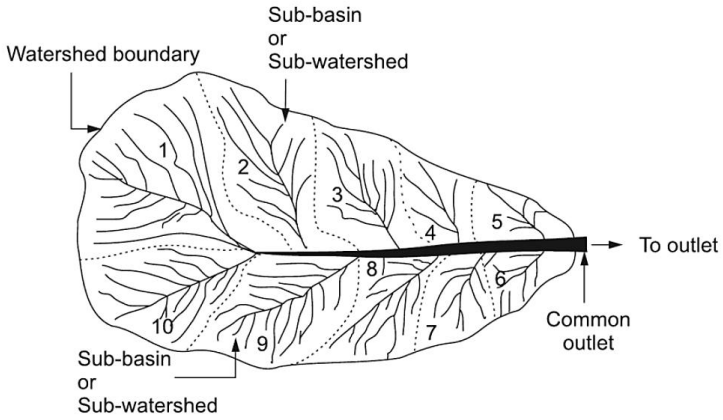


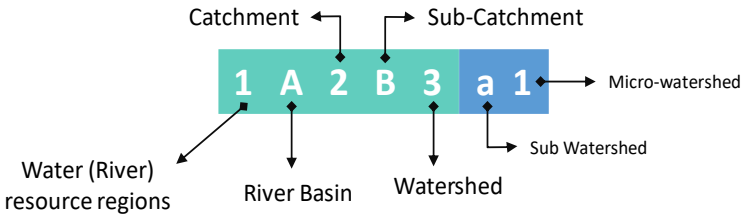
Figure 1.1 Definition sketch of watershed.

WATERSHED MANAGEMENT

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

OBJECTIVES OF WATERSHED MANAGEMENT?

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



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

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

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

Correct Answer : (c)

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

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

Correct Answer : (c)

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