End Semester Examination, 2013

AR-7281

Model Answer

Class: M.Sc. II Sem. (Forestry) **Paper: Forest Soils & Watershed Management**

Section -A

Q.1. Base of earths crust is:

Answer: (a.) Moho

Q. 2. Which of the following component is not provided by the soil to the plants?

Answer: (d.) Light

Q. 3. The volume of solids in Forest soils is:

Answer: (c.) 50%

Q. 4. What is the total number of soil orders?

Answer: (a.) 12

Q. 5. Regolith is unconsolidated mass of soil lying:

Answer: (a.)Above the bed rock

Q. 6. Organic soils are rich in:

Answer: (c.) Organic matter and Humus both.

Q. 7. Frankia fixes atmospheric Nitrogen in:

Answer: (b.) Non Legumes

Q.8. Which of the following gas is present in soil air?

Answer: (b.) O_2

Q. 9. What is the ideal size of a nursery bed?

Answer: (a.) 10m x 1m

Q.10. In which year the Govt. of India has passed the Clean Air Act?

Answer: (a.)1970

Section-B

Q. 2. Define earths crust and highlight important functions of the soil?

Answer:

The earths crust, approximately 50 kms in thickness is the outer portion of the lithosphere between the ground surface and the Moho. The crust has been divided into two sub-zones called sial and sima. The sial is a heterogeneous mixture of rocks and the sima a homogeneous plastic or semi plastic concentric layer that behaves like a solid, the sial floats on the sima which in turn floats on the lower concentric layer called mantle. The sial; contains about 65-75% silica.

Functions of the soil:

Soil has a three fold function to perform:

1. Physical
2. Chemical
3. Biological

1. Physical:

(a.) Mechanical support for growing plant. Plants stand erect because of the hold exerted by the soil on plant roots. The roots are ramified and they are thus anchored in the soil mass.

(b.) Soil acts as a reservoir of air and water. The plants absorb water through their roots from the reservoir, and the roots breathe in oxygen from the air stored in soil mass. The soil also stores the sun's heat and supplies it to the growing plant.

2. Chemical:

Soil is a store house of plant nutrients. Soil contains a large number of minerals both organic and inorganic orgin. The mineral matter derived from the weathering of rocks

and minerals constitutes the organic compounds while the decaying plant and animal remains furnish the organic compound. Plant obtains nutrients from these compounds. The inorganic compounds supply nutrients like calcium, magnesium, sodium, potassium, iron, aluminum, phosphorus, sulphur, chlorine etc. while the organic compounds mainly supply Nitrogen. Hydrogen is taken by the plants from water, oxygen partly from water and partly from air while carbon is taken mainly from carbon dioxide of atmosphere or air.

3. **Biological:**

Soil is the habitat of both micro and macro organisms. The macro organisms are worms, rodents and insects. The micro organisms are fungi, bacteria, actinomycetes, algae and protozoa. Among the worms nematodes and earthworms are important organisms. They aerate the soil and disintegrate the soil mixture into smaller constituents. These micro organisms attack the dead remains of plants and animals to obtain their nourishment as well as decompose these complex compounds like protein, cellulose, and starch etc. In this way, the micro organisms dispose of dead plants and animal remains and at the same time liberate plant nutrients to make the available to the plants.

Q. 3. What are the different components of the soil? Describe the composition of forest soil?

Answer:

Definition: Soil affords a medium for anchorage of plants and a store house of minerals and water. There are four components of soil, these are:

1. **Mineral matter**: obtained by decomposition of rocks.
2. **Organic matter**: is obtained by decay of plant residues, animal remains and microbial tissues.
3. **Water:** obtained from atmosphere in the form of snow, rain, dew and other form of precipitation.
4. **Air:** is obtained partly from atmosphere and partly as a result of the reactions and microbial activity taking place in the soil.

Composition:	Air	25%
	Water	25%
	O. M.	45%
	M. M .	05%

The fifth component of the soil is soil organism, microorganism and and small soil animals, insects, worms, ants, termites, gatropods, arthopods and nematodes etc. Air and water are present inside the soil pores and they are increasing or decreasing by the increase and decrease of each other. During dry season air is more in the soil and during wet season water is more inside the soil.

Plant growth depends on six factors namely,

1. Light
2. Mechanical support
3. Nutrient supply
4. Water supply
5. Oxygen supply
6. Heat.

Composition of forest soil:

Solids: 50% by volume.

20% by weight.

a. Inorganic 95% (by wt.)

1. Sand and Silt 70% by wt.
2. Clay 30% by wt.

b. Organic :(3-10%, by wt.)

1. Humus.
2. Soil micro and macro organism.

c. Gases: 30% by (Volume):

1. Oxygen 20%
2. Nitrogen 78.6%
3. Argon 0.9%
4. CO_2 0.5%

Q. 4. Define biome and write down the names of the biome of the globe. Describe characteristics of Tropical forest soils?

Answer: Large land areas with similar environmental conditions and characteristic plant communities are called biomes. Biomes are generally named after the major type of vegetation found there. The predominant of each biome is determined by complex interplay of rainfall and temperature.

The different major biomes of the globe are:

1. Tropical rain forest
2. Troipical deciduos forest
3. Desert
4. Savanna and tropical shrub forest
5. Temperate deciduos forest
6. Temperate Rain Forest
7. Grassland
8. Coniferous forest
9. Tundra and Alpine
10. Ice caps

Characteristics of Tropical forest soils:

1. These soils lie between the tropic of cancer and tropic of Capricorn around the equator.
2. Experiencing low base saturation which means the nature of soils is acidic, high rainfall 900-2000mm, high temperature >26^{0}C highly weathered soil.
3. Drainage is very good and relative humidity is high and low cation exchange capacity, poor in nutrients.

4. Tropical forests are characterized by high temperature and humidity, ensure never ending supply of litter reaching the forest floor, is rapidly decomposed, thus the nutrient cycle is rapid.
5. Soil is acidic, vegetation is luxuriant.
6. Nutrient reserve required by the vegetation is luxuriant.
7. Nutrient reserve required by the vegetation is contained in above ground biomass.
8. Parent material weathering in Tropical soil is deeper than other group of soils
9. Weathering removes a large part of silica from the silicate minerals anoxic horizon, high in hydrous oxides of iron and aluminum .Oxisol rich in sesquoides and typically associated with rain forests.
10. Laterization is responsible for appearance of oxides and iron and aluminum with surface.
11. Acidic in nature, sandy textured, OM content is generally high
12. Nitrogen content is 2500-5000 kg/ha in surface soils.
13. Not suitable for permanent agriculture because OM of the soils oxidized very quickly.

Q.5. What do you mean by forest soil survey? Write down the objectives and detailed methodology of forest soil survey?

Answer: Forest soil survey:

Soil survey, or **soil mapping**, is the process of classifying soil types and other soil properties in a given area and geo-encoding such information. It applies the principles of soil science, and draws heavily from geomorphology, theories of soil formation, physical geography, and analysis of vegetation and land use patterns.

In a broader concept, Soil survey involves the classification, mapping, evaluation, interpretation of forest land and involves pre requisites of forest management.

Classification: Grouping of land areas based on similarities and differences in properties. of soil.

Mapping: An exercise of delimiting homogenous land areas at the scale of 1:50,000.

Evaluation: is an assessment of the functional relations ship within lean areas.

Interpretation: is the development and presentation of interpretive management recommendations for classification of map units. It requires keen observation, statistical analysis of large volume of data and constant feedback without interpretation.

Objectives of soil survey:

1. To classify soils.
2. To show distribution of soils on maps.
3. To find out their best use.
4. To predict their performance (yield) under different management practices.

Methodology:

1. USDA method of mapping soil
2. Coile, 1952 soil based land inventory system.
3. Total site classification system. Hills, 1952.
4. German site type ecological site classification.Schelenker, 1964.

Q. 6. Write short notes on the following:
(i) Effects of canopy cutting on forest soils.
(ii) Land use types and soils of India

Answer:

(i) Effects of canopy cutting on forest soils:
The various effects of canopy cutting on forest soils are as follows:
1. Intensity of cutting and light cutting:
a. Sites are exposed to strong winds.
b. On steep slopes prevent runoff and erosion.
c. On hot and dry sites conserve moisture and retain humus decomposition.
2. Moderate cutting:
Improves competition of stand, remove surplus trees, secure sunlight.
3. Heavy cutting:
Opens the canopy and gives distance between crowns and helps in the development of crown diameter.

(ii) Land use types and soils of India:

Different land use types in India are: forests, pastures, farming, human settlements and such other useful purposes.

Type of Land uses:

India is one of the largest countries of the world. It ranks seventh in respect of size, and second in respect of population. The total land area of India is 32 lakh 87 thousand square kilometers. Three major types of lands are found in India in respect of its relief, such as, mountains, plateaus and plains. About 29% of our total land areas are mountains, 28% plateaus and 43% plains.

About 80% of the total land area of India is utilized by man. This land utilisation of man is influenced by the relief, climate, soil as well as man's social and economic conditions.

According to use, lands in India are utilized as forest-lands, pasture and grazing lands, agricultural or farm lands, settlement and other such purposes.

Forest Lands:

India was covered with dense forests in primitive ages. More and more lands were needed for agriculture, settlement industry, roads etc. with the growth of population. So man utilized land by cutting down and cleaning the forests in order to fulfill his growing needs. Now only about 22% of the total land area of our country is covered with forests.

Pastures and Grazing Lands:

There are pastures and grazing lands of about 4% of the total land area of India. These are mainly seen in hilly areas. We don't have any definite grassland area. So, pastures are almost mingled with the forests of hilly areas and dwindled forests of the foot hills.

Land for Agriculture or Farm Lands:

India is primarily an agricultural country. About 55% of the total land areas are used for growing food-crops, vegetables, cash crops and fruit. Food-crops are grown on about 45% of land out of the total 55% under cultivation. Vegetables and fruit are grown on the rest of the lands and some lands are left without any cultivation occasionally.

Land under human settlement etc.:

About 19% of the total lands in India are being used for settlement of villages, towns, roads and rail-roads, airports, factories and for educational, health and administrative organizations. As per 1981 census, there were 3,949 towns, 557, 137 villages having human settlements and 48,087 villages having no human settlement.

Soils of India:

1. Alluvial Soil in India

They are by far the largest and the most important soil group of India. They are composed of sediments deposited by rivers and the waves. Their chemical composition makes them one of the most fertile in the world. Usually deficient in nitrogen and humus (thus fertilizers are needed).

Occupy the plains (from Punjab to Assam) and also occur in the valleys of Narmada and Tapti in M.P. & Gujarat, Mahanadi in the MP and Orissa, Godawari in A.R and Cauvery in T.N.

Can be divided into Khadar (new) and Bhangar (older, more clayey and kankary) alluvium.

2. Black Soil in India

- Also called Regur and is ideal for cotton crop. These soils have been formed due to the solidification of lava spread over large areas during volcanic activity in the Deccan Plateau, thousands of years ago.
- They are black due to compounds of iron and aluminium (also because of titaniferous magnetite).

Mainly found in Deccan Plateau – Maharashtra, Gujarat, M.P, Karnataka, Andhra Pradesh, and Tamil Nadu.

- Apart from cotton cultivation, these fertile soils are suitable for growing cereals, oilseeds, citrus fruits and vegetables, tobacco and sugarcane.
- They have high moisture retention level.
- Lack in phosphorus, nitrogen and organic matter

3. Red Soil in India

- They are mainly formed due to the decomposition of ancient crystalline rocks like granites and gneisses and from rock types rich in minerals such as iron and magnesium. The term 'red soil' is due to the wide diffusion of iron oxides through the materials of the soil.
- Covers almost the whole of Tamil Nadu, Karnataka, Andhra Pradesh, S.E. Maharashtra, and Chhattisgarh, parts of Orissa, Jharkhand and Bundelkhand.
- Generally deficient in nitrogen, humus and phosphorus, but rich in potash.
- Suitable for rice, millets, tobacco and vegetables (also groundnuts and potatoes at higher elevations).

4. Laterite Soil in India

- Found in typical monsoon conditions – under conditions of high temperature and heavy rainfall with alternate wet and dry periods. The alterations of wet and dry season leads to the leaching away of siliceous matter and lime of the rocks and a soil rich in oxides of iron and aluminum compounds is left behind. Maharashtra,
- Found in parts of Western Ghats, Eastern Ghats, Rajmahal hills, Karnataka, Kerala, Orissa, West Bengal, Assam, Tamil Nadu, etc.
- Poor in nitrogen and minerals.
- Best for tea, coffee, rubber, cinchona, coconut and suitable for rice and millet cultivation if manured.

5. Arid and Desert Soils

- A large part of the arid and semi – arid region in Rajasthan and adjoining areas of Punjab and Haryana lying between the Indus and the Aravallis receiving less than 50 cm of annual rainfall is affected by desert conditions.
- This area is covered by a mantle of sand which inhibits soil growth.
- The phosphate content of these soils is as high as in normal alluvial soils. Nitrogen is originally low but its deficiency is made up to some extent by the availability of nitrogen in the form of nitrates. Thus the presence of phosphates and nitrates make them fertile soils wherever moisture is available.
- The changes in the cropping pattern in the Indira Gandhi Canal Command Area are a living example of the utility of the desert soils.

6. Saline and Alkaline Soils

- In the drier parts of Bihar, UP, Haryana, Punjab, Rajasthan and Maharashtra, the salt – impregnated or alkaline soils. Known by different names : Reh, kallar, USAR, etc.
- Some of the salts are transported in solution by the rivers and canals, which percolates in the sub – soils of the plains.
- The accumulation of salts makes the soil infertile and renders it unfit for agriculture.

7. Peaty and Marshy Soils

- Originate in the humid regions as a result of accumulation of large amounts of organic matter in the soil. They contain considerable amounts of soluble salts and 10 – 40% of organic matter.
- Peaty soils are found in Kottayam and Alappuzha districts of Kerala, where it is called Kari.
- Marshy soils, high in vegetable matter, are found in northern Bihar, coastal parts of Orissa, Tamil Nadu and West Bengal and parts of UP.

8. Forest and Mountain Soils

- Such soils are mainly found on the hill slopes covered by forests. The formation of these soils is mainly governed by the characteristic deposition of organic matter derived from forest growth.
- In the Himalayan region, such soils are mainly found in valley basins, depressions and less steeply inclined slopes. Apart from the Himalayan region, the forest soils occur in higher hills in south and the peninsular region.
- Very rich in humus but are deficient in Potash, phosphorous and lime and needs fertilizers.
- Plantation of tea, coffee, spices and tropical fruits.

Q. 7. What do you understand by fixation of Nitrogen? Explain it and describe losses of nitrogen from the soil?

Answer:

Biological Nitrogen Fixation (BNF), discovered by Beijerinck in 1901 (Beijerinck 1901), is carried out by a specialized group of prokaryotes. These organisms utilize the enzyme nitrogenase to catalyze the conversion of atmospheric nitrogen (N_2) to ammonia (NH_3). Plants can readily assimilate NH_3 to produce the afore mentioned nitrogenous biomolecules. These prokaryotes include aquatic organisms, such as cyanobacteria, free-living soil bacteria, such as *Azotobacter*, bacteria that form associative relationships with plants, such as *Azospirillum*, and most importantly, bacteria, such as *Rhizobium* and *Bradyrhizobium*, that form symbioses with legumes.

Fixation of Nitrogen:

1. Nitrogen Fixation by Free-Living Heterotrophs/Non-NF:

Many heterotrophic bacteria live in the soil and fix significant levels of nitrogen without the direct interaction with other organisms. Examples of this type of nitrogen-fixing bacteria include species of *Azotobacter*, *Bacillus*, *Clostridium*, and *Klebsiella.*

2. Associative Nitrogen Fixation

Species of *Azospirillum* are able to form close associations with several members of the *Poaceae* (grasses), including agronomically important cereal crops, such as rice, wheat, corn, oats, and barley. These bacteria fix appreciable amounts of nitrogen within the rhizosphere of the host plants.

3. Symbiotic Nitrogen Fixation

Many microorganisms fix nitrogen symbiotically by partnering with a host plant. The plant provides sugars from photosynthesis that are utilized by the nitrogen-fixing

microorganism for the energy it needs for nitrogen fixation. In exchange for these carbon sources, the microbe provides fixed nitrogen to the host plant for its growth.

4. Legume Nodule Formation

The *Rhizobium* or *Bradyrhizobium* bacteria colonize the host plant's root system and cause the roots to form nodules to house the bacteria. The bacteria then begin to fix the nitrogen required by the plant.

Losses of Nitrogen:

1. Mineralization of Nitrogen:

The process of conversion of organic Nitrogen to the ammonium form is known as mineralization. The release of nitrogen from organic matter decomposition is a major source of usable nitrogen.

2. Nitrification of Ammonium

The process of oxidizing ammonium cations to nitrate ions by bacteria is called Nitrification.

3. Denitrification

The conversion of Nitrate NO_3 to $N_{2\ gas}$ or its oxides, (N_2O) is known as Denitrification.

4. Ammonium Volatization

Loss of fertilizers in the form of gaseous ammonia.

Q. 8. Define watershed. Why there is a need of watershed and how will you demarcate a watershed?

Answer:

Watershed is an independent drainage unit. Or,

A watershed is defined as a topographical delineated geographical area in which the entire runoff tends to converge, through the existing drainage system to the common outlet of the area for subsequent disposal. One watershed is separated from another by a natural boundary known as water divide or ridge line.

Terms related to watershed:

1. **Simple order watershed:** It comprises a little stream.
2. **River Basin:** This is the entire drainage area of a major river system which is comprised of large number of watersheds.
3. **Catchment area:** The geographical area in the stream side which catches runoff for the storage structure.

Need of watershed:

India is an agrarian country nearly 70% of the population lives in rural areas and depends directly upon agriculture for its main livelihood and owing to the high population pressure there is an increasing demand for fuelwood, fodder, fuel and utilization pattern of some basic natural resources, may bring the need for adopting large scale watershed management practices in the country.

Future needs:

Owing to the high population pressure and increasing demand for natural resources there is a need for integrated watershed management and is believed to be one of the very important step towards the sustainable development of our agriculture system.

Sustainable agriculture:

The increasing pressure being exerted by farming communities on available land and water has been causing stress to the agriculture as it is essential for human survival, it will be prudent if agricultural practices are made such that the productivity of land and water is enhanced without depleting the health of these two vital resoureces.This would make agriculture practices sustainable.

Soil erosion:

It is estimated that in India about 6,000 million tonnes of soil are lost every year due to erosion, therefore there is need to improve the status of land, water and plant resources through the approach of watershed management for the following outcomes;

-Reduction in soil erosion in general and top soil from arable lands in particular.

-Reduction in velocity of runoff.

-Reduction of severity of floods

-Augmentation of soil moisture resources and surface water storage.

Irrigation facilities:

Watershed is an important aspect for irrigation facilities. According to the NCA, even if the entire irrigation potential of the country is developed, more than 50% of arable lands will remain rainfed. Productivity of rainfed areas can be enhanced and stabilized by watershed management practices.

In situ water management:

In situ water management practices, attempts are made to store and utilize as much water in the upper reaches as possible and this can be possible by the watershed management approach.

Forest and agriculture:

Both crops and forest are essential for the survival of mankind. On the other hand we need to grow more food by bringing more land under agriculture and on the other grow more forests to meet our needs of timber and non-timber forest produce. It is the matter of debate as to how much of India's lands should be used for agriculture and how much for forest. Adoption of watershed management will be helpful in determining the fate of both.

Demarcation of watershed Boundary:

Demarcation of watershed boundary requires the drainage map of the area. Use of topo sheet or satellite imagery is very useful for this purpose.

The approximate boundary of a small watershed can also be demarcated in the field by visual inspections involving two surveyors. One of the surveyors walk along the main stream in the upper stream direction opposite to the flow direction until the highest point or the ridge liner is reached. The second surveyor stationed at the outlet lower reaches of the stream, by looking at the sky line, guides the first surveyor to move a bit forward or backward to make him stand exactly at the highest point. The process is repeated for all the streams to demarcate an approximate boundary in the field. The process is repeated for all the streams, tributaries to demarcate an approximate boundary in the field. A further fine turning of the boundary of the main watershed and its constituent micro watersheds is possible by making enquiries with local farmers about the general flow direction of surface run-off observed after a heavy rainfall.