

- 6 C : N ratio determines the net availability of nutrients to plants
- 7 The supply of nitrogen, phosphorus and sulphur are largely determined by C:N ratio of organic residues.

LECTURE 30

SOIL CLASSIFICATION

Classification is the grouping of objects in some orderly and logical manner into compartments. Classification of soils is the grouping of soils in orderly manner into different classes.

Early systems of classification: They are quite simple and practicable.

Economic classification: This system is adopted by the revenue department for grouping soils according to their productivity for the purpose of taxation.

Physical classification: It is based on the physical properties like soil texture. The soils are termed as sandy, loamy, clay etc. Based on soil structure, soils are classified as single grained soils, aggregated soils etc.

Chemical classification: It is based on the chemical properties of the soils. Calcareous soils, gypsiferous soils, alkaline soils, acidic soils etc.

Geological classification: Two broad groups are recognized.

i) Residual/sedentary soils – soils developed in-situ from the underlying rocks.

ii) Transported soils – soils developed from transported & deposited sediments.

Physiographic classification: In this system, the characteristics of the landscape were considered. The soils are termed as levee soils, terrace soils, mountain soils, hilly soils, upland soils, lowland soils etc.

Other types of classifications:

Based on organic matter content: Organic soils and inorganic soils.

Based on climate: Arid soils, humid soils, subhumid soils etc.

Based on vegetation: Prairie soils, grassland soils, forest soils, etc.

DIAGNOSTIC HORIZONS

A diagnostic horizon is one, which is formed as a result of pedogenic processes and having distinct properties or features that can be measured in terms of measurable soil properties. Based on the location in the soil profiles, these are divided into two categories.

Diagnostic surface horizons (epipedons)

Diagnostic sub-surface horizons (endopedons)

Epipedons: Gr. *epi*, over, and *pedon*, soil

Nine epipedons are recognized.

Mollic (L. *mollis*, soft) Epipedon

Umbric (L. *umbra*, shade) Epipedon

Anthropic (Gr. *Anthropos*, man made) Epipedon

Plaggen (Ger. *Plaggen*, sod) Epipedon

Ochric (Gr. *ochros*, pale) Epipedon

Histic (Gr. *histos*, tissue) Epipedon

Melanic (Gr. *melanas*, black) Epipedon

Folistic (L. *folia*, leaf) Epipedon

Grossarenic Epipedon (L. *grossus*, thick, aren, sand)

I. Mollic Epipedon: It is soft, thick, moist, dark coloured, humus rich horizon

1. The structure is not hard even under dry condition.
2. Rock structure is less than one – half of the volume
3. Colour with a value of 3 or less (moist), and of 5 or less (dry)
4. A base saturation (by NH_4OAc) of 50 percent or more;
5. An organic carbon content of 0.6 percent or more
6. 18 cm or more depth
7. Phosphate content of less than 1,500 ppm soluble in 1% citric acid
8. Some part of the epipedon is moist for 90 days or more.
9. The *n* value is less than 0.7

II. Umbric Epipedon: It has all properties of mollic epipedon except base saturation (BS is < 50%)

III. Anthropic Epipedon:

It shows some evidence of disturbance by human activity and meets all the requirements for a mollic epipedon, except for *one or both* of the following

1. 1500 mg/kg soil or more of P₂O₅ or
2. Dry for 9 months or more.

IV. Plaggen Epipedon: The plaggen epipedon is a human made surface layer 50 cm or more thick that has been produced by long continued manuring

V. Ochric Epipedon: all the properties are opposite to that of mollic epipedon.

Colour: Value 5.5 or more (dry), 3.5 or more (moist)

Organic matter : <1% (0.6%O.C)

Structure: Hard or very hard and massive when dry

Moist period: Dry for more than 3 months in a year

VI. Histic Epipedon: It is saturated for 30 days or more. Consists of organic carbon of 8 – 16% or more depending upon the clay content Of 0-60%.

VII. Melanic Epipedon: This horizon is commonly formed on volcanic ash deposits. It has andic soil properties in top 30cm, a colour value (moist) 2 or less, a melanic index of 1.7 or less and 6 % or more organic carbon

VIII. Folistic (L. folia, leaf) Epipedon: Saturated for < 30 days & consists of organic carbon of 8 – 16% or more depending upon the clay content Of 0-60%.

IX. Grossarenic Epipedon: It has sandy texture of thickness 100cm or more over an argilling horizon.

DIAGNOSTIC SUB-SURFACE HORIZONS (ENDOPEDONS)

Gr. *endon*, endo, within and *pedon*, soil). Formed below the surface of soil. Some of these are regarded as 'B' horizons and others as part of 'A' horizon.

19 endopedons are recognized. Important endopedons are

Albic horizon: (L. *albus*, white) Eluvial horizon 'E' formed below 'A' horizon

Light colored bleached horizon (value 4 or more), >85% by volume of albic materials, >1cm thick,

Argillic horizon: (L. *argilla*, white clay). Bt (textural 'B' horizon), subsurface horizon with a significantly higher percentage of clay than overlying horizon due to illuviation.

Calcic horizon: (L. *calcis*, lime). Illuvial horizon, Bk, Ck, 15cm or more thick, not hard and has 15 percent or more CaCO₃

Cambic horizon: (L. *cambiare*, to exchange). It is the result of physical alteration, chemical transformation of parent material. Hence, called altered B/ Brown B/ Structural B horizon (Bw).

Duripan : (L. *durus*, hard). Silica cemented hard sub-surface horizon. Bqm.

Gypsic horizon: L. *gypsum*, By, Cy. Illuvial horizon. 5% or more gypsum accumulated to 15 cm or more thick,.

Natric horizon: Nl. *Natrium*, sodium.

Argillic horizon +; (Btn). The argillic horizon has ESP >15,

Oxic horizon: Fr. *Oxide*, oxide, Bo. Intensively weathered horizon. Oxides are dominant.

Petrocalcic horizon: Gr. *petra*, rock.

Hard cemented calcic horizon. Ckm, Bkm

Petrogypsic horizon: Cemented/indurated gypsic horizon. Cym, Bym

Spodic horizon: Gr. *spodos*, wood ash. Bhs, Bh, Bs. =85% spodic materials. The horizon accumulates illuvial humus and / or sesquioxides.

LECTURE 31

SOIL TAXONOMY

In 1951 a decision was taken in US to develop a new system of classification because of the following defects in the genetic system:

Zonal, intra-zonal and azonal soils were not clearly defined

Classification is based on assumed soil genesis

Definition of certain taxa was based on virgin soils

Too much emphasis on soil colour

Taxa of lower category were defined in terms of comparative and subjective definitions

No suitable classes were provided at some of the category levels

Some families were not clearly defined

Nomenclature was a collection from several sources

Guy D smith was the leader of the New Comprehensive System. Series of approximations from 1953 to 1960 were made and were circulated to criticism for precision and revision. Each successive approximation was made more precise and more complete than one before and was evaluated by more people. Finally it was published as 7th approximation in 1960. It was supplemented in 1964 and 1967. It was released as Soil Taxonomy (USDA Hand Book No. 436) by the USDA Soil Survey Staff in 1975. Since that time it has undergone 9 revisions. Now second edition (1999) of Soil Taxonomy and 11th edition (2010) of Keys to Soil Taxonomy are being followed.

V V Dokuchaev (1846 – 1903) – Founder of Modern Pedology

C F Marbut (1920 – 1940) – Founder of American Pedology

Salient features of soil taxonomy:

- It is based on measurable soil properties
- It considers all such properties which affect soil genesis
- The nomenclature is most logical & helps in relating the place of taxon
- It is truly multi -categorical system with 6 categories
- It is an orderly scheme without prejudice and facilitate easy remembering of objects.

Advantages of soil taxonomy over other systems:

- It permits the classification of soils rather than soil forming processes
- It focuses on soils rather than related sciences such as geology and climatology
- It permits the classification of soils of unknown genesis
- It permits the greater uniformity of classification
- The soil with a different genesis but having identical properties are classified within the same unit

- There is no particular order for strictly hydromorphic and halomorphoc soils as in the other systems.

NOM ENCLATURE

The unique feature of *soil taxonomy* is the unusual – sounding nomenclature used to identify different soil classes. Although unfamiliar at first sight, the nomenclature system has a very logical construction and conveys a great deal of information about the nature of the soils named. The system is to learn after a bit of study. In an attempt to make the nomenclature more uniform, understandable and adaptable, new names/words were coined from many roots in Latin, Greek, with a few others from English, German, and Japanese languages.

The words selected were self explanatory, easily remembered, suggest properties of the object, suggest the place of taxon in the system, as short as possible, euphonic (easily pronounceable), and fit in as many languages as possible.

1. The names of the orders are coined words and have a common ending, sol (L. solum, soil). The names of orders are combination of two parts – 1. word containing the formative element and sol connected by vowel 'i' or 'o' for Latin and Greek words respectively.

Mollisol, Alfisol, Ultisol, Entisol, Histosol. Spodosol etc.

The formative elements of the order is carried out in the names of other categories of that order and used as an ending.

Udoll, Haplustert, Typic Haplustept

2. Each suborder name consists of two syllables. The first is the suggestive of a property of that suborder and the second the name of the order as reflected by the formative element of the order.

Udoll, Cryept, Ustalf etc.

3. Likewise, the name of the great group is coined by prefixing one additional word (distinguishing character of the great group) to the suborder name.

Durustalf, Hapludoll, Calciustert etc.

4. Subgroup name consists of the name of the great group modified by one or more adjectives (binomial nomenclature)

Vertic Haplustept, Typic Calciustert

5. Family names meet the need for making practical prediction for land use planning. It indicates particle size class, mineralogy class, and STR class.

Fine silty, kaolinitic, isohyperthermic, Typic Hapludoll

Hence it is a polynomial nomenclature.

6. The name of the soil series has no pedogenic significance but represent a prominent geographic name of a river, town, area or person where the series has been first recognized.

Patancheru series – red soils Kasireddipalli series – black soils.

LECTURE 32

SOILS OF INDIA

Geographic location: Asian continent, North of Equator,

Between $8^{\circ}4'$ & $37^{\circ}6'$ N latitude and $68^{\circ}7'$ & $97^{\circ}25'$ E longitude

Extent: 329mha or 329×10^4 sq.km (3.29 msq.km)

ALLUVIAL SOILS

Extent: 75 mha

Soil formation: Parent material: River alluviums from erosion products of rivers, coastal alluviums from coastal sands; and deltaic alluviums from Heterogeneous sediments

Salient features:

Texture is variable. Coarser near source & finer in proximity to the sea (delta)

Fluvial in nature, stratified which is reflected in their texture and OM distribution.

Colour depends on parent material

Depth depends on geographic position,

Calcium carbonate content is variable

Mostly alkaline (aridic & ustic SMR) or acidic (udic SMR only) in reaction.

Profile development is variable A – C to A-B-C profiles

Inherently rich in plant nutrients – fairly sufficient in P and K but deficient in N and OM.

Potentialities: River alluviums and deltaic alluviums are best agricultural soils. Wheat, rice, sugarcane and other crops can be grown well

Constraints:

Stratification restricts leaching and drainage

Extreme sandy nature that promotes excessive leaching of water and plant nutrients

Hydromorphic condition that promotes reduction and results in poor aeration for plant growth.

They can be rendered saline where evaporation exceeds rainfall (aridic).

The river alluviums and deltaic alluviums are becoming waterlogged and salt affected due to injudicious use of irrigation water.

Due to intensive use for cultivation, secondary problems are arising like deficiency of S and Zn.

Receding ground water and rising ground level in some areas.

Management:

Judicious use of I.W & fertilizers. Providing drainage facilities

BLACK SOILS

Extent: 74Mha

Soil formation:

Parent material: Generally basic parent material like basalt rich in lime, soda feldspars and clay. Semiarid-subhumid climate, Lower/ plain topography

Soil Properties:

Black colour - clay humus complex / titaniferous magnetite,

30-80%clay (highly argillaceous), clay - clay loam, smectite clay,

Extremely hard on drying and very sticky and very plastic on wetting

Because of swell-shrink nature, they develop deep wide cracks, gilgai relief, slickensides in lower depths due to churning / argillopedoturbation.

$\text{SiO}_2/\text{R}_2\text{O}_3$ 3 – 3.5, high B.D (1.5 – 1.8 Mg m^{-3}) due to compaction in lower layers, high total pore space, pH (7.8 - 8.7/9.5), CEC (35 – 55 cmol/kg), BS up to 100%, CaCO_3 (up to 40%), WHC (150 - 250 mm/m)

Generally low OM. High nutrient holding capacity.

Low HC and permeability. Hence ill drained and more runoff.

Constraints:

Deep black soils: Narrow workable moisture, poor trafficability, high draft power (heavy soils), low permeability, poor drainage, low HC,

High EC and salinity in sub-soil.

Micronutrient deficiency in calcareous soils.

Potentialities & Land Use:

Inherently fertile, suitable for dry farming, under rainfed conditions cotton and millets, under irrigation rice, sugarcane etc., can be grown

Management: ICRISAT – Dry season / pre-monsoon sowing, BBF

RED SOILS

Extent: 25 to 30% of GPA of the country. 70Mha

Extent in AP: Geographical area of the state 27.4Mha (2,74,000sq.km, 100sq.km = 1 ha).

Red soils 65, laterite soils 1, black soils 25, alluvial 5 and coastal sands 3% in AP.

Present in all the districts of the state.

Other names: Morphologically they are red loams, red earths, red & yellow soils. Brown soils are called parwa while red soils are called rakar.

Soil formation:

The name red is given to soils rich in **sesquioxides** that have developed of archean origin (granites, gneisses).

Generally red soils are formed on well drained, **stable higher landforms** (higher topography).

Under hot, semi-arid to humid sub-tropical climate,

The weathering is **moderately intense** and leads to enhanced decalcification.

Some weathering products are **leached out** leaving behind the less mobile elements (Si, Fe, Al). The Fe and Al under **oxidized** conditions, form sesquioxides imparting **red colour**.

Salient features:

Red to yellow (hydration & coatings of Fe and Al oxides 30 – 40%),

Is to c texture, Shallow to deep,

Low to high clay, kaolinitic / illitic, low WHC & NHC

Well to excessively drained as evident from their colour,

CN ratio 10:1, pH 6 - 7.5,

CEC low (25 – 40 cmol/kg of clay) and BS is low to medium,

SiO₂/R₂O₃ 2.5 – 3.0, Low nutrient status (O.C, N, P, K, lime)

Constraints: Shallow depth if formed on elevations, soil erosion, sub-surface hardening, sub-surface ahrd pans, surface crusting, rapid drying, excessive drainage or some times runoff, high surface soil temperature in dry areas, deficient in OM, N, P Ca. High in Fe₂O₃ & Al₂O₃, kaolikinite, allophanes - P fixation, though K is sufficient - fast depletion due to continuous cropping.

Crusting and hardening of red sandy soils (chalkas): Reasons:

Proportion of clay to sand +silt ratio (3:7) – strength 36kg/cm² on drying

Presence of free iron oxides which form irreversible bonds with clay fraction

Sealing pores by rain drops force– dispersion of soil particles.

Management: tillage with spike roller, pulling thorny bush to break the crust.

Mulching of seed lines Sowing on the sides of the ridges

Incorporation of slowly decomposable organic residues– paddy husk, grounut pod shells, coir pith etc.

Potentialities & Land use:

Under good mangement practices, these soils are good for agricultural, horticultural and plantation crops.

Management: Application of organic materials and proper fertilization.

LATERITE SOILS

Extent: 25 Mha

Other names: The term 'laterite' was coined by Buchanan in 1807 for highly ferruginous, vesicular, unstratified deposits of Malabar hills.

Soil formation: Basic parent material, sub-tropical to tropical climate,

higher topography under rain forest vegetation. The siliceous matter is leached during weathering and sesquioxides are left behind.

Lateritic soils are formed under same climatic conditions but alternate wet and dry conditions are not required.

Soil Properties: Red colour (5YR or redder), highly weathered hence very deep soils, high clay % (not due to migration but due to *in situ* alteration), open texture, massive structure, narrow $\text{SiO}_2/\text{R}_2\text{O}_3$ (<2) ratio, strongly acidic,

LAC (<16cmol/kg clay), BS = 40% (low), kaolinite dominant, low OM

Constraints: High permeability, low AWC, highly leached,

Chemically degraded, low nutrient reserve, deficiency of P, K, Ca, Zn, B etc.,

Strongly acidic, high P fixation, Al & Mn toxicity.

Land Use: Generally used for plantation crops & shifting cultivation (should be 20 years or more), In low level areas - rice, banana coconut & high level areas - coffee, cocoa, rubber, tea are grown

Management: Liming and fertilization (rock phosphates and silicates)

COASTAL SANDS

Occur all along coast 3 to 12 km away on both east and west coast.

They are derived from marine sediments

Properties: Deep to very deep, Ground water at as depth of 2 to 5 mts. Brackish ground water, Occasionally saline with neutral pH. Sandy texture with negligible clay content, Single grain structure. Loose consistence, Light soils. Rapid permeability, excessively drained. Low WHC and NHC. Low OM, low fertility, low CEC and BS

Land use: Owing to extreme sandy nature, these soils are able to withstand irrigation with high saline water – Doruvu technology can be followed

Constraints: During cyclone periods – these soils are inundated due to tidal over – flow
