

Lecture 17 Soils of India

Introduction

The major soil groups of India and their properties

- India situated between the latitude of $08^{\circ}4'$ and $37^{\circ}06'$ N and longitudes of $68^{\circ}07'$ to $97^{\circ}25'$ E, has a geographical area of 329 Mha.
- India with a variety of landforms, geological formations and climatic conditions, exhibits a large variety of soils. The variety is so diverse that except few soil orders, India represents all the major soils of the world.
- The major soil group of India, according to the Genetic approach can be classified in to following soil groups:

Alluvial Soils:

- The name of Alluvial Soils is given to soils which have developed on parent materials transported by different agencies viz. water, ice, gravity and wind.
- They are by far the largest and the most important group of soils for crop production.
- They are extensively distributed in the states of Punjab, Haryana, Uttar Pradesh, Uttarakhand, Bihar, West Bengal, Assam and coastal regions of India and occupy an estimated area of 75 Mha in the Indo-Gangetic Plains and Brahmaputra valley alone.
- These soils are variable in texture, depending on the source of parent material and their place of deposition.
- They are coarser near the source and become finer near to sea.
- They are stratified and irregular distribution of organic matter with depth.
- They are either alkaline or acidic
- The profile development varies from undeveloped (A-C) to very developed (A-B-C) profiles.
- They are inherently rich in plant nutrients. In general, they are fairly sufficient in phosphorus and well supplied with potassium, but are deficient in nitrogen and organic matter.
- These are the best agricultural soils used for growing most agricultural crops. Because of unjudicious use of irrigation water some soils have been rendered waterlogged and pose problem of soil salinity and/ or sodicity.

Black(Cotton) Soils:

- The name black is given to soils that are very dark in colour and turn extremely hard on drying and sticky and plastic on wetting, and hence are very difficult to cultivate and manage.
- These soils are dominantly distributed in the central, western and southern states of India.
- They occupy an estimated area of 74 Mha.
- The soils developed on gneisses and schist are moderately shallow (50 - 80 cm) to moderately deep (80-120 cm), while those developed on basalt are very deep (>150cm)
- They are highly clayey (30-80 %)
- The pH ranges from 7.8 to 8.7, which may go up to 9.5 under sodic conditions.
- They have high exchange capacity because of smectite clay minerals.
- These have high water and nutrient holding capacity.

- These soils do not exhibit eluviation and illuviation process, because of churning.
- These have high bulk density because of the swelling and shrinking nature of the soil.
- The dark colour of the soil is due to clay-humus complex and presence of titaniferous magnetite minerals.
- They are highly sticky and plastic and pose problems in both agriculture and non-agricultural crops.
- These soils are poor in some available plant nutrients especially N,P,S and micronutrients.
- The main constraints to crop production are due to low workability, low infiltration, poor drainage and occasional moisture stress.
- These soils are used for growing cotton, millet, sorghum in Madhya Pradesh, Andhra Pradesh, Gujrat and Maharashtra states of India.
- Under irrigated conditions they can be used for a variety of other crops like sugarcane, wheat and citrus plantations.

Red Soils:

- These soils are generally red or reddish brown and derived from granites, gneiss and other metamorphic rocks.
- These soils are formed under well drained conditions.
- Eluviation and illuviation of clay, iron, aluminium and bases are the main soil forming processes.
- These soils are predominantly observed in the southern parts of the Indian Peninsula, comprising the states of Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra, Orissa and Goa and in North Eastern States.
- These soils are highly variable in texture, ranging from loamy sand to clay loam.
- They are shallow and poor gravelly in the uplands to very deep, fertile in the plains and valley.
- They are, in general, neutral to acidic in nature.
- The CEC and base saturation of these soils are relatively lower than those of black and alluvial soils.
- These soils are generally deficient in N,P and K. They are also poor in organic matter and lime contents.
- These soils show common presence of kaolinite clay minerals.
- The soils pose limitations of soil depth, poor water and nutrient holding capacity, surface crusting and hardening, excessive drainage and runoff.
- Under good management practices, these soils can be profitably used for variety of agricultural, horticultural and plantation crops, such as millets, rice, groundnut, maize, soybean, pigeonpea, greengram, jute, tea, cashew, cocoa, grapes, banana, papaya, mango etc.

Laterite and Lateritic Soils:

- The lateritic soils are those in which laterization is the dominant soil forming process.
- It is a compact to vesicular rock like material composed of a mixture of hydrated oxides of iron and aluminium with small amounts of manganese oxides and titania.
- They are generally observed on hill tops and Plateau landforms of Orissa, Kerala, Tamil Nadu etc.
- These are deeply weathered soils with high clay content.
- The lateritic soils are more widely distributed and occupy about 25 Mha of the total geographical area of India
- Kaolinite is the dominant clay mineral of these soils

- These soils lose bases and silica due to pronounced leaching with accumulation of sesquioxides and the soils are rendered acidic .
- These are low in CEC and base saturation.
- The major limitations posed by these soils are deficiency of P,K,Ca, Zn,B, etc and high acidity and toxicity of aluminium and manganese
- The laterites of lower topographic positions are used for growing rice, banana, coconut, arecanut and higher topographic positions for cocoa, cashew, tea, coffee, rubber etc.

Desert (Arid) Soils:

- A large part of the arid region belonging to western Rajasthan, southern Haryana and south west Punjab, lying between the Indus river and Aravalli hills, covering an area of 29 Mha.
- The soils of hot arid belts are comparable with those of Alluvial soils, but have an aridic moisture regime.
- The sandy material, under arid conditions , results in poor profile development.
- These are sandy to loamy fine sand in texture with clay content varying from 3.5% to less than 10%.
- Pale brown to yellowish brown in colour and have weak subangular blocky structure.
- Poor in nutrient(N,P,K,S and Zn) and water holding capacity. These are slightly to moderately alkaline in reaction(pH 7.8-9.2) because of calcareous nature.
- These soils may form gypsic horizon. Such gypsiferous soils need special attention to avoid formation of sink holes, if irrigated.
- The built up of organic matter is very low
- The major constraints of these soils are less water which restricts their use for raising agricultural crops. However, some areas are used for growing millet and pulses.
- If irrigated, they can be profitably used for growing two crops in a year.

Forest and Hill Soils:

- These soils developed under forest cover.
- In India , the total area under forest is estimated to be 75 Mha and is observed dominantly in the states of Himachal Pradesh, Jammu and Kashmir, Uttar Pradesh, Uttarakhand, Bihar, Madhya Pradesh, Maharashtra, Kerala and North-East region.
- The climatic conditions and altitude control the kind of forest species, the kind of forest and topography control the kind of soils and their degree of profile development. The major soils observed in different areas are
 - **Brown forest and Podsol:** In Northern Himalayas, developed on sand lime stone, conglomerate, granite, gneisses and schists under cool/cold humid climate (acidic environment)
 - **Red and Lateritic:** In Deccan Plateau, developed on igneous and metamorphic rocks(basalt, granite, gneisses) under tropical climatic conditions(slightly acidic, neutral or basic environments)

Podsol soils:

- The soils found under coniferous vegetation in the presence of acid humus and low base status.
- These soils are moderately to strongly acidic in reaction (pH 4.5-6.0)
- These soils are high in organic matter content(3.0-3.5%) and, in general, low(<50%) in base status.

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- These soils are variable in exchange capacity [10-15 cmol (p+) kg⁻¹]. The clay content varies from 20-30%
- These soils are deficient in P.
- These soils face a major problem of erosion by water.
- They are used for growing a variety of crops – rice, maize, soybean etc. on terraces and tea and other fruit crops on slopes.

Brown Forest Soils:

- These soils developed on sedimentary rocks/ or alluvium under subhumid to humid climate and mixed vegetation are Non Calcic Brown or Brown Forest soils.
- They are neutral to slightly acidic in reaction (pH 6.0-7.0).
- The calcareous members under sub-humid conditions may have a pH around 8.2.
- These are moderate to high in organic matter content (2-3%) which decreases with depth
- These are moderate in cation exchange capacity [15-20 cmol(p+) kg⁻¹] and exchange complex is almost saturated with bases (70-90%).
- The soils have great potential for growing agricultural crops such as rice, maize and fruit plants such as apple, almond, pear, apricot etc.

Salt Affected Soils:

- The soils occurring in the arid and semi arid regions and occupy about 10 Mha area of which 7Mha is sodic. These soils occur in the Indo-Gangetic plains followed by the Deccan (Peninsula)
- Plateau supporting black soils, the rest in the arid and coastal regions are saline.
- The sodic soils of the Indo-Gangetic plain, occupy relatively lower topographic positions where products of weathering accumulate during the monsoon rains by surface runoff.
- The saline soils of coastal region result from the rise of brackish ground water due to capillary action under excessive evaporation.
- The sodic soils pose serious problem of high sodium on the exchange complex, poor physical conditions, especially soil structure and drainage, nutrient and water availability and micronutrient deficiency.
- Another problem is of receding ground water in the central sectors and the south-west sectors of Punjab, Haryana and some parts of Rajasthan. The rise in ground water causes salinization of soils.
- The sodic soils once ameliorated by applying gypsum, are used for growing rice followed by wheat.

Soil Orders (as per Soil Taxonomy) representing different soil groups:

S.No.	Genetic System	Soil Taxonomy	
		Mainly	Occasionally
1	Alluvial Soils	Entisol, Inceptisol	Alfisol, Aridisol
2	Black(Cotton) Soils	Vertisols,	Inceptisols, Entisols
3	Red Soils	Alfisol, Ultisols	Inceptisols, Entisols
4	Laterite and Lateritic Soils	Ultisols	-----
5	Desert soils	Aridisol	Entisols
6	Forest and Hill Soils	Alfisols, Ultisols	Inceptisols

	Podsollic Soils Brown Forest Soils	Inceptisols, Mollisols, Alfisols	Entisols
7	Salt Affected Soils	Aridisols, Inceptisols,	Alfisols and Vertisols



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