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LECTURE NO. 4

SOIL AND CLIMATIC CONDITIONS IN RAINFED AGRICULTURE



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Introduction

4.1 Soils:

- Rainfed soils are generally of poor quality (low fertility, high erodibility, fragile, shallow and susceptible to loss of physical integrity).
- These have very weak buffering and resilience capacity.
- The soils suffer from excess of salts (saline-alkali soils) in arid and semi-arid areas and acids (acid soils) in sub-humid and humid areas.
- Micronutrients and ameliorants (mainly lime) are deficient and need supplementation periodically.
- The soils are mostly coarse textured, highly degraded with low water retentive capacity, multiple nutrient deficiencies, and thus are not conducive for intensive cropping.



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The principal factors of soil formation are nature of parent material, climate, vegetation, soil organisms and topography, which are the same both in dry as well as in humid regions. However, in arid regions, physical weathering predominates soil formation. Erosion and re-deposition are the most important soil forming processes in arid regions. Rainfall is an important factor which affects the type and predominant properties of soils.

Soils developed in the semi-arid areas of Deccan Plateau are mainly Vertisols (black soils) and Alfisols (red and related soils), while in the arid zone of Rajasthan, they are Arid soils and Entisols.

- Inceptisols and Mollisols occur in humid and sub-humid regions.



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In drylands

1. 30% of soils are Alfisols and associated soils.
2. 35% by Vertisols and associated soils (having vertic properties) and
3. 10 per cent by Entisols of the alluvial areas.

Most of the Alfisols are sandy loams with a sub-soil alluvial layer of clay, **less water retentive** and prone to drought. The Vertisols are deep (15-240 cm) with a clay content of 30-70% and rich in bases. The clay types are smectite, montmorillonite and beidellite. The soils have **high water holding capacity**, frequently fertile and less drought prone.



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4.2 Characteristics of Dryland soils:

- Generally low in organic matter and alkaline to slightly acidic in reaction in the surface have calcium carbonate (CaCO_3) accumulation in the upper 150 cm of soil layer, weak to moderate profile development, coarse to medium texture and having low biological activity.
- Nearly $2/3^{\text{rd}}$ of India's land mass has **more than 3% slope** and is highly undulating.
- The top soil shows many textural groups like loamy sand, sandy loam, loam, silt loam to clay loam.
- The soils are predominantly coarse textured and hence retain less water and nutrients. Crops grown on them are prone to drought and nutrient deficiencies.



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The low organic matter content is due to sparse vegetation producing little residues. The top soil when eroded, is devoid of organic matter, thus resulting in deficiencies of several nutrients.

- Removal of vegetation, intensive agriculture, uncontrolled and excessive grazing, and large unprotected fields devoid of protective vegetation are known to cause wind erosion.
- The inherent properties of dryland soils lead to degradative processes in rainfed semi-arid tropics, impose the following constraints for successful crop production



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- ❑ Much reduced permeability.
- ❑ Poor or restricted root development
- ❑ Tillage and seeding problems
- ❑ Poor seedling establishment
- ❑ Uneven soil wetting
- ❑ Poor soil fertility

4.3 Climatic Constraints:

- ❑ The drylands of the world show great diversity in their temperature characteristics and precipitation patterns.



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4.3.1 Non-tropical drylands

- ❑ Cold ($< 10^{\circ}$ C) to mild winters ($10-20^{\circ}$ C)
- ❑ Mild ($10-20^{\circ}$ C) to very warm ($> 30^{\circ}$ C) summers.
- ❑ Moisture regime ranging from arid to semi-arid to sub-humid
- ❑ Variable precipitation patterns;
- ❑ Cold is a general but variable constraint, depending on severity of the winters, requiring adaptation of plants and crops;
- ❑ Agricultural systems are dominated by non-tropical crops with low water requirements (wheat, barley)



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- **With winter-rainfall patterns:**
Water needs of crops are lower as compared to tropical areas, therefore higher water use efficiency. C3-crops have a productivity advantage.
- **With summer rainfall patterns:**
Water needs of crops are higher than in winter rainfall patterns, but usually lower than in tropical areas. C3-crops adapted to higher temperatures, or C4-crops adapted to lower temperatures, have a productivity advantage.
- **With transitional rainfall patterns:**
Regimes with two rainy seasons, in summer and in winter, or with irregular unpredictable patterns.



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4.3.2 TROPICAL DRYLANDS

- Warm winters (20-30° C);
- Warm (20-30° C) to very warm (>30° C) summers
- Aridity regime ranging from arid to semi-arid to sub-humid;

Summer precipitation regimes are the norm, although they can be shifted to autumn; bimodal rainfall in the Horn of Africa;

- In view of the generally warm winters the growing season is not limited by temperature, and cold is not a constraint for crops or plants. However, the water requirements are higher in view of higher evaporative demand of the atmosphere.
- Production systems are dominated by tropical crops (millet, sorghum, rice). C₄-crops have a productivity advantage.



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THANK YOU