Soil Conservation

• Soil conservation means the use and preservation of the natural resources of earth and their protection from destructive influences misuse, decay, fire, or waste.

• The aim of soil conservation methods is to prevent soil erosion, prevent soil's overuse and prevent soil contamination from chemicals.

• There are various measures that are used to maintain soil health, and prevent the above harms to soil.
Principles of soil conservation

1. To protect soil from the effects of rain drops.
2. To slow down the flow of water when it flows on slope.
3. Reduction of wind velocity near the places where vegetation cover grows.
4. To grow vegetation cover which might catch and hold the moving particles of soil?
5. To increase soil fertility and productivity.
Soil Erosion

• Soil erosion is the removal of soil from soil surface by the action of water or wind.

• Naturally, it is a smoothing or leveling process with soil and rock particles being carried, rolled and washed downstream under the influence of wind, water and gravity.

• Erosion is caused by natural or human factors. Human factor in soil erosion are: deforestation, over-grazing, construction activities and mining activities.
Types of Erosion

1. Mass movement
   • This involves the downward movement of soil and rock under the assistance of gravity.
   • There are many forms of mass movement including soil creep, earth flow, slumps, landslips, landslides and rock avalanches.
   • Although relatively infrequent, large mass movement events are dramatic, resulting in permanent loss of houses, roads and agricultural land.
• Landslips, slides and earth flows occur on steep slopes with high clay content.

• It is triggered by over-saturation of soils from excessive rainfall.

• Rainfall increases soil weight, and lubricates layers within the soil.
2. **Water erosion**

- Water erosion is a two-part process involving the detachment and transport of soil particles.
- The water erosion process consists of discrete stages from rain drop impact to the formation of gully erosion.
- Each stage has its own processes and characteristics.
- Controlling or preventing water erosion requires an understanding of each step in the erosion process.
There are three steps to accelerated erosion by water:

1) **Detachment or loosening** of soil particles caused by flowing water, freezing and thawing of the topsoil, and/or the impact of falling raindrops.

2) **Transportation** of soil particles by floating, rolling, dragging, and/or splashing.

3) **Deposition** of transported particles at some place lower in elevation.
3 steps of water erosion

Detachment

Transport

Deposition
Forms of Water erosion

- **Splash erosion** or rain drop impact represents the first stage in the erosion process.

- Splash erosion results from the bombardment of the soil surface by rain drops.

- Rain drops behave as little bombs when falling on exposed or bare soil, displacing soil particles and destroying soil structure.
• **Sheet erosion** occurs as a shallow 'sheet' of water flowing over the ground surface, resulting in the removal of a uniform layer of soil from the soil surface.

• Sheet erosion occurs when rainfall intensity is greater than infiltration (sometimes due to crusting).
• **Rill erosion** results from the concentration of surface water (sheet erosion) into deeper, faster-flowing channels.

• As the flow becomes deeper the velocity increases detaching soil particles and scouring channels up to 30cm deep.

• Rill erosion represents the intermediate process between sheet and gully erosion.
• **Gully erosion** is responsible for removing vast amounts of soil, irreversibly destroying farmland, roads and bridges and reducing water quality by increasing the sediment load in streams.

• Once established, gully erosion can be difficult to control.

• In most cases a combination of approaches, including the use of vegetation, fencing, diversion banks and engineering structures are required.
Wind erosion

- Wind erosion involves the detachment, transportation and re-deposition of soil particles by wind.

- Wind erosion is common on flat, bare areas with dry, sandy soils, or anywhere the soil is loose, dry, and finely granulated.

- Sandy soils are very susceptible to erosion, however clay soils which have been pulverized by powered tillage implements or worked when they are too dry are also susceptible to wind erosion.
Soil Erodibility

• Soil erodibility can be described as the susceptibility to the effects of wind and water on the soil structure.

• This property is expressed as an erodibility index, where low values indicate high susceptibility to erosion, and high values correspondingly indicate a low susceptibility to erosion.
The erodibility index is determined by combining the effects of slope and soil type, rainfall intensity and land use.

These aspects are represented by terrain morphology (soil and slope), mean annual rainfall and broad land use patterns.
Management practices that reduce erosion

- Increase vegetative cover, especially close to the soil surface.

- Increase the content of soil organic matter which helps improve soil structure.

- Plant windbreaks and shelterbeds to reduce wind erosion.

- Use contour furrows, terraces, plowed strips, and/or ridges to reduce or deflect runoff.
Methods of Controlling Soil Erosion

- **Crop Rotation:** Crop rotation decreases soil loss and preserves the productivity of land.

- **Strip Cropping:** It involves the planting of crop in rows to check the flow of water.

- **Terracing:** Here slope is made to several flat strips for plantation and cultivation. The method of dividing slope into several flat fields is called terracing and each of the terrace works as an embankment of earth, built across the slope to control runoff and reduce erosion.
• **Aforestation:** By the process of a forestation establishment of new forests is one of the methods for soil conservation.

• Planting on land is the successful method for soil conservation.

• **Planning of wind break trees:** It is also one of method to check soil erosion.

• So strong tall plants should be planted densely, as a boundary on the fields.
Evaluation and prediction of Erosion

- Soil erosion occurs at widely varying rates over the landscape or a field.

- Direct measurement is impractical and difficult to measure.

- Variety of erosion prediction methods is available; each is best at performing a particular task; no single prediction method meets all needs.

- Must consider major factors of climate, soil, topography and land use.
REVISED UNIVERSAL SOIL LOSS EQUATION (RUSLE)

- RUSLE is an erosion prediction model that predicts longtime average annual soil loss resulting from raindrop splash and runoff from specific field slopes in specified cropping and management systems and from rangeland.
The equation of the model is:

\[ A = RKLSCP \]

where...

- \( A \) = Annual Soil Loss in mt/ha
- \( R \) = Rainfall factor
- \( K \) = Soil erodibility constant
- \( LS \) = Slope percentage and length factor
- \( C \) = Cropping/cover factor
- \( P \) = Cultural practice
• **RUSLE** was developed by the USDA-Agricultural Research Service, and first released in 1993.

• This technology has been implemented in field offices of the USDA-Natural Resources Conservation Service and is being used nationally and internationally for prediction of erosion.
WATER EROSION PREDICTION PROJECT (WEPP)

• The WEPP model is a process-based, distributed parameter, continuous simulation, erosion prediction model for use on personal computers.

• The model is applicable to hill slope erosion processes (sheet and rill erosion), as well as simulation of the hydrologic and erosion processes on small watersheds.
WIND EROSION PREDICTION EQUATION (WEQ)

• This model shows how wind erosion is a function of five factors and their interactions.
• \( E = f (I \ C \ K \ L \ V) \)
• Where…
• \( E \) = Predicted soil loss due to wind erosion
• \( I \) = Soil erodibility factor
• \( C \) = Local wind erosion climate factor
• \( K \) = Roughness factor
• \( L \) = Length of field factor
• \( V \) = Vegetative cover factor
OTHER MODELS

• **ANSWERS** (Areal nonpoint source watershed environment response simulation, 1980).

• **SWAT** (Soil and Water Assessment Tool) - simulate impact of contrasting scenarios of land use and tillage cropping systems on non-point source pollution.

• **EPIC** (Erosion productivity impact calculator – estimate crop yield reduction due to erosion).
• **GUEST** (Griffith University Erosion System Template, Yu 2003): estimates erosion based on the simultaneous transport and deposition processes.

• **EUROSEEM** (European Soil Erosion Model, Morgan 1998); compute sediment transport, erosion and deposition over land surface throughout a storm.

• it can be applied to individual fields or small catchment; simulates interrill erosion.
Erosion Control Methods, Water and Soil fertility

1. Vegetative methods:
   - Hydroseeding, and mulching
   - High density planting
   - Multiple cropping
   - Cover cropping
     Maintain crop residue cover e.g planting of cover crops to prevent detachment of soil by rain drops.
   - Soil conditioners e.g polymers
   - Strip cropping
   - Agroforestry
   - Maintain organic matter
2. **Mechanical methods:**

- Terracing
- Diversion structures/waterways e.g. check dam, trap sediments.
- Protect surface soils with geotextiles or mulch.
- Conservation tillage: Conservation tillage is any tillage planting system that leaves at least 30% of the field surface covered with crop residue after planting is completed.
Types of Conservation Tillage

- No till planting
- Strip rotary tillage
- Till planting
- Mulch tillage
- Reduced tillage
- Contour bund
- Contour tillage
- Minimum tillage
• The concept of the conservation of soil takes into account, the strategies for preventing the soil from getting eroded and preventing it from losing its fertility due to an adverse alteration in its chemical composition.