Soil Erosion

मृदा क्षरण एक भौतिक क्रिया है जिसके द्वारा मृदा प्रदार्थ एक स्थान से दूसरे स्थान पर पहुँचता है। मृदा प्रदार्थ किसी माध्यम (उदा० जल, वायु पशु व मनुष्य आदि) के द्वारा एक स्थान से दूसरे स्थान पर पहुँचता है। मृदा क्षरण कहलाता है

Definition

1- Soil erosion may be defined as ' detachment, transportation and deposition of Soil particle from one place to another under influence of wind, water and other gravity force is called soil erosion'

2- Soil erosion is a three phase phenomena, consisting the detachment of individual soil particles from the soil mass and their transport by erosive agents such as runing water and wind. when sufficient energy is no longer available with the erosive agent to transport the particles, then the third phase called 'deposition, take place'

Types of erosion

Erosion 2 प्रकार का होता है।

1- Geological erosion
2- Accelerated erosion → water Erosion, Wind Erosion

1- Types of water erosion:

जल क्षरण निम्न प्रकार के होते है।

1- Splash erosion (अपक्षरण या बूँद क्षरण)
2- Sheet erosion (परत क्षरण)
3- Rill erosion (क्षुद्र सरिता क्षरण)
4- Gully erosion (अवनालिका क्षरण)
5- Ravines erosion (खड्ड क्षरण)
6- Stream bank erosion (सरिता तट क्षरण)
7- Land Slides (भू-स्खलन क्षरण)

1- Splash erosion:

इस प्रकार का क्षरण जब वर्षा की बूंदें नंगी मृदा (अनावृत मृदा) पर प्रहार करने के परिणामस्वरूप उत्पन्न होता है इस प्रक्रिया में मृदा के छोटे-2 कण उपर उछालते है और पानी के साथ मिलकर बहने लगते है।

2. Sheet erosion:

इस प्रकार के क्षरण में मृदा की ऊपरी सतह एकरूप ढंग से हट जाती है तब उसे परत क्षरण कहा जाता है। इस प्रकार के क्षरण को समय से ध्यान न देने से किसानों को अधिक क्षति होती है क्योंकि उपजाऊ मिट्टी बहकर चली जाती है।

3- Rill erosion:

जब मृदा भार से लदा हुआ प्रवाहित जल ढालो के साथ-2 बहता है तो खेत में उंगलीकार नलो का निर्माण कर देता है
Rill erosion is Advance stage of Sheet erosion

4- Gully erosion:

जब मृदा सतह पर छोटी-2 नालिकाओं को ध्यान नही दिया जाता है। तो ढालो पर उनका वेग भी बढ़ता जाता है जिसे परिणाम

3

Rill धाराएं चौड़ी होकर Gully में बदल जाती है, आगे चलकर यही खड्डे (Ravines) में बदल जाती है।

(विस्तृत → जानकारी के लिए Google में Soil erosion types in Hindi or English डालकर Search करें / Video भी देखें)

Mechanics of water erosion

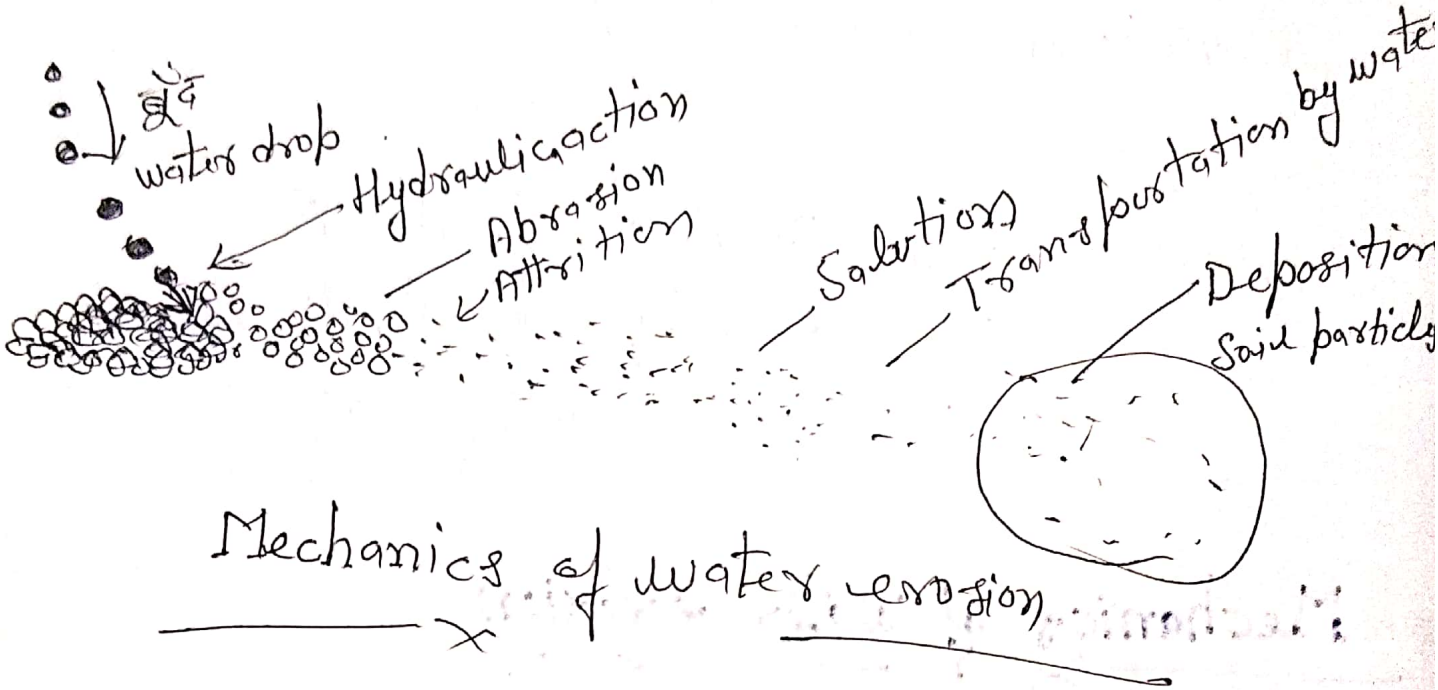
इस क्रिया में

1- Hydraulic action
2- Abrasion (अपघर्षण)
3- Attrition (संघर्षण)
4- Solution

(जलीय क्रिया) या रगड़ने की क्रिया या घिसाव)

5- Transportation
6- Deposition

उपरोक्त क्रियाओं के द्वारा वर्षा की बूंदों द्वारा पहले Hydraulic action के द्वारा संयुक्त मृदा से मिट्टी के कण अलग होते है एवं Abrasion के द्वारा मिट्टी के आपस में रगड़ते हुए Attrition (घिसाव) द्वारा छोटे-2 कणों में टूटकर Solution बन जाता है तथा अधिक जल के द्वारा Transportation कणों को नीचले ढलानों पर Deposition कर दिया जाता है। Soil water erosion की 6 चरणों में पूर्ण होती है।



Mechanics of water erosion

Factor affecting Water Erosion

1- Climate (जलवायु)

2- Soil (मृदा)

3- Vegitation (वनस्पति)

4- Topography (भूदृश्यावली)

Control of Water erosion

1- Agronomic Measures
2- Mechanical Measures

1. Agronomic Measures:

(i) Proper land use
(ii) Choice of crops
(iii) Contour farming
(iv) Strip Cropping
  - contour strip cropping
  - Buffer strip cropping
  - Field strip cropping
(v) Tillage
(vi) Organic Matter Management
(vii) Mulching
(viii) Cropping system

2- Mechanical Measures:

1- Bunding
  - contour bund
  - Side bund
  - Lateral band
  - Supplemental bunds
  - Marginal Bund
  - Shoulder bund

Bunding System
  - Contour bunding
    - Narrow based
    - Broad based
  - Graded bending
    - Narrow based
    - Broad based

2- Terracing

3- Conservation ditching

4- Contour trenching

5- Basin listing

6- Zing terrace

7- Half Moon terrace

8- Sub-Soiling

(viii) Adverse effect on public health

Control of water erosion :

Water erosion occurs simultaneously in two steps : Detachment of soil particles by falling raindrops and transportation of detached soil particles by flowing water. Therefore, water erosion can be minimized by preventing the detachment of soil particles and their transportation.

Principles of water erosion control are:

(i) Maintenance of soil infiltration capacity.
(ii) Soil protection from rainfall.
(iii) Control of surface runoff, and
(iv) Safe disposal of surface runoff.

Measures of water erosion control can be broadly grouped into three

1- Agronomic measures
2- Mechanical measures
3- Forestry measures

1-Agronomic measures : There are various ways and means to control water erosion or surface as discussed bellow.

(i) **Proper land use:** The land must be used according to its capability. This provides a good opportunity to check the runoff as well as soil erosion. The standard land capability classes

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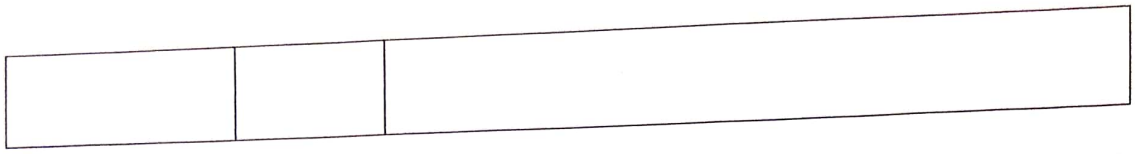
based on land slope and their proposed land use is given in the fallowing Table.

Land Capability Classification based on Land slope

Land classes	% slope	Adapted land use and soil conservation measures
A- Land suitable for cultivation		
Class i	0 - 1	Any crop with proper rotation and green manuring to maintain soil fertility
Class ii	1 - 3	Contour farming, contour strip cropping and contour bunding
Class iii	3 – 5	Intensive agronomical measures such as contour cropping, contour strip cropping, cover cropping, contour bunding or terracing
Class iv	5 - 8	Contour bunds or terraces and intensive agronomic measures. Mostly soil building and soil maintaining crops are to be grown.
A- Land not suitable for cultivation		
Class v	8 - 12	Permanent pasture with controlled grazing
Class vi	12 - 18	Pasture, grasses and forestry, restricted grazing
Class vii	18 -25	Forest with restricted felling, contour trenching as conservation measures
Class viii	➢ 25	Forest with complete closure to grazing and felling of trees.



(ii) Choice of crops : Row crops (erosion permitting crops) such as sorghum, maize, pearlmillet, etc are not as effective as soil conserving crops (erosion resistant crops) such as cowpea, groundnut, greengram, black gram, etc. legumes (smothering crops) provide better cover and protection to soil by way of minimizing the impact of raindrop and acting as obstruction to runoff

(iii) Contour farming: It is the practice of conducting field operations such as ploughing, planting and cultivation land across the slope rather than up and down hill contouring is one effective way to reduce runoff and erosion to place plant rows and tillage lines at right angles to the normal flow of surface runoff. The resistance to flow and the surface storage thus slow down the runoff and give the water more time to infiltrate into the soil instead of directly rushing off. Since lines of right angles to the normal flow of runoff water are lines of equal elevation or contour lines, that is why this method of farming is called contour cultivation or contour forming.

(iv)Strip Cropping : It is a system under which ordinary form crop are planted in relatively narrow strip across the slopes of the land in such a way that the strip of non-erosion resistant crops are always separated by strip of close growing erosion resistant crop. It is based on the principle that any thing that checks the down hill flow of water, reduces its capacity both to pick up soil particles and to carry them in suspension strips of close growing crops planted across the slope will decrease runoff and soil loss on that part of the field which they occupy . Basically, strip cropping is of **three** types.

(a)Contour strip cropping

(b) Buffer strip cropping

(c) Field strip cropping

(a) Contour strip cropping : It is the farming on sloping land in alternate strip of inter tilled row crops and close growing crops. These strips are placed at right angle to the direction of the natural flow of surface runoff water with the purpose of slowing down the runoff and filtering out in the close growing crop . The soil washed from the land of the inter tilled crop. In this way the rate of sheet erosion is reduced and gullying a practically eliminated.

(b) Buffer strip cropping : It is the placing of sod crop strips between contour planted strips of the crop of regular rotation. frequently, these buffer strips are located on steep or badly eroded areas that do not fit into the regular rotation. The contour strips of grass or other erosion resisting vegetation between or below cultivated strips or field are called buffer strips. A buffer strip is more or less permanent contour strip usually of available width planted grass or other erosion resistant vegetation between or bellow cultivated strips or field are called buffer strips. A buffers strips is more or less permanent contour strip usually of variable width planted grass or other erosion resistant vegetation which is not a part of regular farm rotation and which may not be harvesting. The area planted with erosion resistant crops a buffer strips system is much smaller than under a contour strip cropping system. The buffer strips usually vary between 8- 20 in width.

(c) Field strip cropping : Field strip cropping consists of strips of uniform width running generally perpendicular to the direction of the erosive force. For the control of runoff and erosion by water the strips run

across the general slope but do not curve to conform any contour. This practice is recommended only in areas where the topography is too irregular or undulating to make strip cropping practical. It is a system of strip cropping in which crops are grown in parallel strips laid out across the general slope but which do not fallow the contour. The strips of grasses or close growing crops are alternated with those of cultivated crops.

In a terraced field, the width of strip is usually adjusted to the terrace interval but on un terraced land the strips should be narrower than the standard terrace interval. In the latter, the width will be governed by the length and steepness of slope and by the permeability of the soil as all these factors affect the amount of runoff. As a general rule, the steeper the slope, narrower the strips. Strips should be wider than the 200 feet to meet the requirement of soil conservation but for practical farming they can seldom be narrower.

(V) Tillage : Tillage makes the soil loose and porus and consequently the soil becomes more absorptive for rain water thus decreasing the runoff. But this benefit is temporary. More over, loose soil is highly erodible. The main value of tillage in this connection is to help establish vigorous plant growth to achieve the main purpose of tillage and at the same time to conserve the soil, the fallowing considerations should be taken care : (i) till no more than necessary (ii) till only when the soil moisture is in the favorable range (iii) use herbicide wherever practical and (iv) plough erdible soil in the spring.

(vi) Organic matter management : Organic matter increases aggregation of soil and helps to make aggregates water stable. Consequently, it increases porosity and aeration there for, improves

infiltration and percolation capacity. This is turn reduces runoff and decreases the erosion hazard . Crop residuces and organic redidues should be managed in such a way that they oxidize slowly, this results in the relatively large amount of intermediate decomposition products that are active in cementing soil particles together.

(Vii) Mulching : Any material such as straw, plant residuces, laves, lose soil or plastic film placed on the soil surface to reduce evaporation, erosion or to protect plant roots from extremely low or high temperature is called mulch mulching has direct and indirect bearing on surface runoff and soil erosion. Mulching affects the physical conditions of soil such as (i) less direct impact of raindrops (ii) decreased amount and distance of splash (iii) less dispersion of surface soil (iv) less fluctuation of surface soil (vi) increased water holding capacity ((vii) higher infiltration capacity and increased amount of percolation and (viii) less runoff and water erosion.

(Viii) Cropping systems : Monocrapping of erosion permitting crops accelerate soil and water loss year after year. Inter cropping erosion permitting and erosion resistant crops their rotation have been found effective for soil and water conservation. As the legumes (cowpea, greeengram, horsegram. Blackgram) are effective for soil conservation due to their smothering effect, they should be sown in time to develop adequate canopy by the time of peak rate of runoff.

2- Mechanical measures :

When agronomic measures alone are not adequate mechanical measures are adopted to supplement the agronomic measures. Thus

the mechanical and agronomic measure are not the alternatives, but are complementary which should be used together, important principles to be kept in view while planning for mechanical measures to Rama Rao (1962) are :

- Increasing the time of concentration to allow more runoff water to be absorbed and held by the soil.
- Interrupting along slope into several short ones to maintain a critical velocity of runoff. And
- Protection against damage due to excessive runoff.

Mechanical measures consist of construction of mechanical barriers across the direction of the flow of water to retard or retain the runoff for reducing soil and water loss. These measures include contour bunding, graded bunding, terracing construction of grade stabilization structures.

1- **Bunding :** Bunding is constructing small embankment or earthen barriers across the slopes, Bund are constructed with the following objectives:

- To increase the time of concentration of rain water where it falls and thereby allowing rain water to percolate in to the soil.
- Conserving a long slope into several ones as to minimize velocity and there by reducing the erosion by runoff water.
- To divert runoff either for water harvesting purposes or for insitu moisture conservation.

Types of bund :

Types of bund :

1- **Contour bund :**The bunds constructed exactly on contour or with permissible deviation from the contour, are defined as contour bund.

2- **Side bund :** These bunds are formed at extreme ends of the contour bund, running along the slope of the bund.

3- **Lateral bund :** The lateral bunds are constructed between two side bunds, along the slope for preventing the concentration of water at one side and also to break the length of contour bund into convenient bits.

4- **Supplemental bunds** : The bunds constructed between two contour bund so as to limit the horizontal spacing to the maximum required, are nomenclatured as supplemental bunds.

5- **Marginal Bund :** These bund are formed at the margin point of the watershed, road, river etc, to define their boundary.

6- **Shoulder bund :** Such type of bunds are formed at the outer edge of the terraces, to hold the runoff over the top of the terrace and also to provide the stability to the terrace system.

Classification of bunding system :

The bunding systems are divided according to function, which they perform. It is given as under.

(A) **Contour Bunding**

(i) Narrow based

(ii)Broad based

(B) **Graded bunding**

(i) Narrow based

(ii) Broad based

(A) **Contour Bunding** : The formation of bunds passing through the point of equal elevation (I,e. on contour)of the land, is defined as contours bunding. The contour bunds ands and level terrace are the synonyms term. Therefore, sometimes contour bunding is also denoted as level terrace. The practice of contour bunding was firstly initiated in Maharashtra as famine relief work.

The contour bunding can be adopted on all types of permeable soils such as alluvial, red, laterite brown soil, shallow and medium black soil but clayey or deep black cotton soils are strictly avoided for this work, as these soils have the problem of crack development.

- This practice is suitable for those areas, which receive the annual rainfall upto 600 mm and existing soil involves greater permeability.
- Contour bunding is not technology feasible on the land slops, greater than 6%

(B) Graded bunding : The graded bund is also referred as channel terrace, used in the areas having rainfall greater than 700 mm per year. However, it can also be used in less rainfall areas ,provided that the soil of area should be in heavy texture. In such area what happens when rainfall takes place a large portion of water is ponded over the surface to remove this water same grade is provided to the channel. The grade, should lie within non-erosive limit. Normally minimum as 0.1 to maximum 0.5 allowed . It should also be noticed that, the grade of channel must be less than the actual land slope, In this condition , the

water flows at slow speed to that of flowing directly down the slope, causing not taken place soil erosion.

- It requires establishment of grassed waterway as an out let for safe disposal of surplus water, accumulated over bounded area.
- Graded contour bunding is not recommended on the land slops less than 2% or on the slopes greater than 8%.
- The grassed waterway needs an extra care about control of grazing of grasses grown in the section of waterway.

(C) Contour ditching : This types of soil and water conservation measure is more common in deep- black soil regions of Karnataka which is used as an alternative to the contour and graded bounding system. The shape of ditch is used as trapezoidal . They are constructed on contour, using same vertical interval as contour or graded bund (more preferably as 90m) contour ditches constructed so, act as mini water- storage pond, witch catchment area is the area left between two adjacent ditches.

2- Terracing : A terrace is an embankment or ridge of earth constructed across a slope to control runoff and minimize soil erosion .It is adopted on steep slopping land with sufficient soil depth, in rainfed areas, the bench terracing can be recommended only on the slopes ranging from 6 to 33%.

The main purpose of terracing are-

(i) To reduce slope (ii) to reduce the length of slope

(iii)to avoid accumulation of water (iv) to check excessive runoff

improve its storage. It is usually done before sowing. It is suitable for all soil types and crops.

6-Zing terrace : This refers to the practice of leveling the lower one-third portion of the land between contour bunds to help spreading of runoff water in the larger portion of the inter-bunded area and thus ensure better availability of water to crops.

7-Half-moon terrace : These are leveled aircular beds having 1 to 1.5 m diameter, cut into half-moon shape on the hill slope. These beds are used for planting and maintaining fruit trees in horticultural land use.