Lecture 11
Soil erosion

Types of erosion

Natural or geologic erosion ranges from very little in undisturbed lands to extensive in steep arid lands. Geological erosion takes place, as a result of the action of water, wind, gravity and glaciers and it takes place, at such slow rates that the loss of soil is compensated for the formation of new soil under natural weathering processes. It is sometimes referred to as normal erosion.

Accelerated erosion caused by the disturbances of people (cutting forests, cultivating lands, constructing roads and buildings etc.) and is increasing as the population increases. In this erosion, the removal of soil takes place at a much faster rate than that of soil formation. It is also referred to as abnormal erosion.

Causes of Water Erosion

Water erosion is due to the dispersive action, and transporting power of water. Water erosion of soil starts when raindrops strike bare soil peds and clods, resulting the finer particles to move with the flowing water as suspended sediments. The soil along with water moves downhill, scouring channels along the way. Each subsequent rain erodes further amounts of soil until erosion has transformed the area into barren soil. Water erosion may occur due to the removal of protective plant covers by tillage operation, burning crop residues, overgrazing, overcutting forests etc. inducing loss of soil.

Raindrop / Splash Erosion

Rain drop splash erosion results from soil splash caused by theimpact of falling rain drops. The continued impact of raindrops compacts thesoil and further seals the surface-so that water cannot penetrate into the soil and as a result causing more surface run off.

Sheet Erosio*n*

Sheet erosion is the removal of a fairly uniform layer of surface soil by the action of rainfall and runoff water on lands having a gentle or mild slope, and results in the uniform "skimming off of the cream" of the top soil with every hard rain, In this erosion, shallow soils suffer greater reduction in productivity than deep soils. It is slow process but

dangerous. Movement of soil by rain drop splash is the primary cause of sheet erosion.

Rill Erosion

Rill erosion is the removal of surface soil by running water, with the formation of narrow shallow channels that can be levelled or smoothed out completely by normal cultivation. Rill erosion is more apparent than sheet erosion. Rill erosion is more serious in soils having a loose shallow top soil. This type of soil erosion may he regarded as a transition stage between sheet and gully erosion.

Gully Erosion

Gully erosion is the removal of soil by running water, with the formation of channels that cannot be smoothed out completely by normal agricultural operation or cultivation. Gully erosion is an advanced stage of rill erosion. Unattended rills get" deepened "and widened every year and begin to attain the form 'of "gullies. During every rain, the rain water rushes down these gullies, increasing their width, depth and length.(Fig :8)

Stream Channel Erosion

eam channel erosion is the scouring of material from the water channel and the cutting of banks by flowing or running water. This erosion occurs at the lower end of stream tributaries. Stream bank erodes either by runoff flowing over the side of the stream bank, or by scouring or undercutting. Scouring is influenced by the velocity and direction of flow, depth and width of the channel and soil texture.

Harmful Effects of Water Erosion/Constraints

Water erosion causes various damages to the lands as follows:

(i) Loss of top fertile soil. The surface soil lost as runoff consists of fertile soils and fresh or active organic matter.

(ii) Accumulation of sand or other unproductive coarse soil materials on other productive lands. In the plains, fertile lands have been made unproductive by the deposition or accumulation of soil material brought down from the hills by streams and rivers.

(iii) Silting of lakes and reservoirs. Soil erosion from the catchment areas of reservoirs results in the deposition of soil, thus reducing their storage capacity

(iv) Silting of drainage and water channels. Deposition of silt in

drainage ditches in natural streams and rivers reduces their depth and capacity

and overflows and flooding of downstream areas increase with damage to agricultural crops and also man-made structures.

(v) Decreases water table. With the increase in runoff, the amountof water available for entering the soil is decreased. This reduces the supply of water to replenish the ground water in wells, the yield of well isreduced.

(vi) Fragmentation of land. Water erosion especially gully erosionmay divide the land into several valleys and ridges and thus fields become smaller and more numerous. Crop rows are shortened, movementfrom field to field is obstructed and a result the value of land is decreased.

Wind erosion

Soil erosion by wind has caused an accumulation of eroded particles in loess, a type of soil which makes up some of the world's mostfertile and productive regions. Soil conditions conducive to wind erosion are most commonly found in arid and semi-arid areas where rainfall is insufficient and no vegetative cover on the land. The most serious damage caused by wind erosion is the change in soil texture. Since the finer soil particles are subject to movement by wind, wind erosion gradually removes silt, clay and organic matter from the top soil, leaving the coarser soil material.

Wind erodes the soil in three steps

The soil particles are carried by the wind in three ways namely saltation, suspension and surface creep.

Saltation: It is a process of soil movement in a series of bounces or jumps. Soil particles having sizes ranging from 0.05 to 0.5 mm generally move in this process. Saltation movement is caused by the pressure of the wind on the soil particle, and collision of a particle with other particles. The height of the jumps varies with the size and density of the soil particles, the roughness of the soil surface, and the velocity of the wind.

Suspension. Suspension represents the floating of small sized particles inthe air stream. Movement of such fine particles in suspension is usually started by the impact of particles in saltation. Once these fine particles are picked up by the particles in saltation and enter the turbulent air

layers, they can be lifted upward in the air and .they are often carried for several miles before being redeposit elsewhere. Dust particles will fall on the surface only when the wind subsides or the rain washes them down.

Surface Creep. Surface creep is the rolling or sliding of large soil particles along the ground surface. They are too heavy to be lifted by the wind and are moved primarily by the impact of the particles in saltation rather than by direct force of the wind. The coarse particles tend to move closer to the ground than the fine ones.

Threshold Velocity. Threshold velocity is the minimum wind velocity required to initiate the movement of soil particles. Threshold velocity varies with the soil conditions and nature of ground surface.

Impact of erosion on crop yield

- Erosion reduces the capacity of the soil to hold water leading to severe water stress.
- Erosion contributes to losses of plant nutrients, which wash away with the soil particles. Because sub-soils generally contain fewer nutrients than top-soils, more fertilizer is needed to maintain crop yields. This, in turn, increases production costs. Moreover, the addition of fertilizer alone cannot compensate for all the nutrients lost when topsoil erodes.
- Erosion reduces yields by degrading soil structure, increasing soilerodibility, surface sealing
- and crusting. Water infiltration is reduced, and seedlings have a harder time breaking through the soil crust. Erosion reduces productivity because it does not remove topsoil uniformly over the surface of a field. Typically, parts of an eroded field still have several inches of topsoil left; other parts may be eroded down to the subsoil. This makes it practically impossible for a farmer to manage the field properly, to apply fertilizers and chemicals uniformly and obtain uniform results. He is also unable to time

his planting, since an eroded part of the field may be too wet when the rest of the field is dry and ready.