Lecture 4 Agronomical Measures for Water Erosion Control

4.1 Mechanics of Water Erosion Control

The different geological actions generated by the flowing water over the land surface by which soil erosion take place may be described as below.

(a) Hydraulic Action: when water runs over the soil surface then it compresses the soil, as a result the air present in the voids exerts a pressure on the soil particles, which leads to the soil detachment. The pressure exerted by the air present in the voids is known as hydraulic pressure. The soil particles detached in this process from their places, are scoured by the running water. The hydraulic action is more effective, especially when soil is in loose condition.

(b) Abrasion: In this geologic action, the soil particles mixed the running water, create an abrasive power in the water by which the capacity of flowing water to scour the soil particles get increased. Due to this effect greater soil particles are eroded by flowing water. The river bank erosion and erosion from bottom of the valley are results of abrasion action of running water.

(c) Attrition: This action includes the mechanical breakdown of loads running along the moving water due to collision of particles with each other. It can be expressed in other way that when big size rock fragments, boulders or pebbles are present in the moving water of streams or river, then they are broken due to striking actions with each other. The broken particles are moved along with the flowing water. They generate abrasion effects on the bottom and banks of the water course. This effect pronounces the water erosion.

(d) Solution: This process is associated with the chemical action between the running water and soil/rocks. Occurrence of this type of erosion is observed in those areas, where existing rocks/soil are easily dissolved in the water. Actually due to this action, the soil or rock materials are dissolved in the running water due to chemical action and are carried away along the water flow.

(e) Transportation: It is the process by which soil particles which are dissolved in the running water are carried away from one place to another. The transportation of particles depends upon the velocity of running water load present in the water, impediments/obstacles present in flow path of water and carrying capacity of running water. During water erosion, the process of soil transportation by running water is completed under the following forms:

i) **Solution**: The water soluble contents present in the water are transported by the water in solution form. Normally, certain dissolved chemicals such as calcium carbonate etc. derived from rocks are transported in solution form by the running water.

ii) **Suspension:** Suspension process involves the transportation of finer soil particles present in suspension form in the flowing water.

iii) **Saltation and Surface Creep:** The saltation mechanism is responsible to transport the medium size soil particles which can not be carried in suspension form due to their large sizes, but are mixed in water and flow over the stream bed in the form of mud. The saltation and surface creep share a major part of sediment load, transported by running water. The transportation of soil particles by the surface creep action takes place for the coarser soil particles activated through the actions of jumping, collision and creeping.

(f) Deposition: The deposition of load mixed in the running water take place under following conditions:

i) The force acting in the direction of water flow and responsible for transport of the load becomes very less compared to the resisting force acting in the opposite direction, then the materials get deposited on the bed.

ii) Presence of surface obstruction such as trees, shrubs etc. in the flow path of running water tends to reduce the velocity of running water and as a result the soil load mixed in the water gets deposited.

Whenever there is meandering of the river or the stream, the velocity of flow on the concave side of the river reduces drastically and deposition of the load occurs on that side.

4.2 Agronomical Measures of Water Erosion Control

Soil conservation is a preservation technique, in which deterioration of soil and its losses are eliminated or minimized by using it within its capabilities and applying conservation techniques for protection as well as improvement of soil. In soil and water conservation, the agronomical measure is a more economical, long lasting and effective technique. Agronomic conservation measures function by reducing the impact of raindrops through interception and thus reducing soil erosion. They also increase infiltration rates and thereby reduce surface runoff. Widely used agronomic measures for water erosion control are listed below.

4.2.1 Contour Cropping

Contour Cropping is a conservation farming method that is used on slopes to control soil losses due to water erosion. Contour cropping involves planting crops across the slope instead of up and down the slope (Fig. 4.1). Use of contour cropping protects the valuable top soil by reducing the velocity of runoff water and inducing more infiltration. On long and smooth slope, contour cropping is more effective as the velocity of flow is high under such

situation and contour cropping shortens the slope length to reduce the flow velocity. Contour cropping is most effective on slopes between 2 and 10 percent.

Fig. 4.1. Contour cropping. (Source: www.studyblue.com)

4.2.2 Strip Cropping

Strip cropping is the practice of growing strip of crops having poor potential for erosion control, such as root crop (intertilled crops), cereals, etc., alternated with strips of crops having good potentials for erosion control, such as fodder crops, grasses, etc., which are close growing crops (Fig. 4.2). Strip cropping is a more intensive farming practice than contour farming. The farming practices that are included in this type of farming are contour strip farming, cover cropping, farming with conservation tillage and suitable crop rotation. A crop rotation with a combination of intertilled and close growing crops, farmed on contours, provides food, fodder and conserves soil moisture. Close growing crops act as barriers to flow and reduce the runoff velocity generated from the strips of intertilled crops, and eventually reduce soil erosion. Strip cropping is laid out by using the following three methods:

Fig. 4.2. Strip cropping. (Source: www.milford.nserl.purdue.edu)

i) **Contour strip cropping:** In contour strip cropping, alternate strips of crop are sown more or less following the contours, similar to contouring. Suitable rotation of crops and tillage operations are followed during the farming operations.

ii) **Field strip cropping:** In a field layout of strip cropping, strip of uniform width are laid out across the prevailing slope, while protecting the soil from erosion by water. To protect the soil from erosion by wind, strips are laid out across the prevailing direction of wind. Such practices are generally followed in areas where the topography is very irregular, and the contour lines are too curvy for strict contour farming.

iii) **Buffer strip cropping:** Buffer strip cropping is practiced where uniform strip of crops are required to be laid out for smooth operations of the farm machinery, while farming on a contour strip cropping layout. Buffer strip of legumes, grasses and similar other crops are laid out between the contour strips as correction strips. Buffer strips provide very good protection and effective control of soil erosion.

4.2.3 Mulching

Mulches are used to minimize rain splash, reduce evaporation, control weeds, reduce temperature of soil in hot climates, and moderate the temperature to a level conducive to microbial activity. Mulches help in breaking the energy of raindrops, prevent splash and dissipation of soil structure, obstruct the flow of runoff to reduce their velocity and prevent sheet and rill erosion (Fig. 4.3). They also help in improving the infiltration capacity by maintaining a conductive soil structure at the top surface of land.

Fig. 4.3. Mulching of cropped field. (Source: www.fao.org)

4.2.3.1 Types of mulching material: To protect the land from erosion different types of materials are used as listed below.

1. Cut grasses or foliage
2. Straw materials
3. Wood chips
4. Saw dusts
5. Papers
6. Stones
7. Glass wools
8. Metal foils
9. Cellophanes
10. Plastics

The mulches may be broadly classified into the following five types:

1. **Synthetic mulch:** It includes organic and inorganic liquids that are sprayed on the soil surface to form a thin film for controlling the various atmospheric agents acting on the soil surface. The different synthetic mulching materials are: resins, asphalt emulsions, latex and cut back asphalt, canvas etc.
2. **Petroleum mulch:** The petroleum mulches are easier to apply and also less expensive. These mulches are available in the form of emulsions of asphalt in water, which can be sprayed on the soil surface at ambient temperature to form a thin film in continuous form that clings to soil, but does not penetrate deep inside the soil. The mulch film promotes uniform and rapid seed germination and also plays a significant role for vigorous growth of seedling. An ideal surface film is also stable against erosion, sufficiently porous to allow water into the soil, yet insoluble in water and resistant enough to the forces of weather, causing it to last as long as necessary for vegetation to become established.
3. **Conventional mulch:** The mulches such as hay or straw are more effective than the petroleum mulches. These mulches not only conserve the moisture and reduce the fluctuation of soil temperature, but also protect the soil from rain drop impacts and hold the excess surface water in contact with the soil, so as to increase the infiltration rate and thereby reduce the runoff and soil erosion. In addition, during day hours these mulches also absorb as much insolation as bare soil does, but little energy is conducted downward. This causes the surface

of the mulch to become hot and the underlying soil to remain cool. On the other hand, during night hours, the mulch cools down permitting the soil to remain warm. The paper mulches also counted under conventional mulch are reported to produce remarkable results. Paper mulches are observed to increase the soil temperature, especially of the surface soil layers. There are several evidences to show that paper mulching gives better performance in improvement of soil condition, besides promoting the earthworm activity. But at the same time, caution has to be taken against the toxic elements of chemicals leached out of the paper. The bituminized treated papers have toxic effects on the plants.

4. **Stone mulch:** It involves the spreading of stone pieces on the ground surface to conserve the moisture and also to reduce the wind erosion. It is a very old practice, followed in arid zones. Soil under the stones tends to be in moist condition, but the temperature of that soil becomes slightly higher. The soils lying below the stones, harbor small animals and involve high nitrification. The stone mulching is also used for trapping the dew, particularly in those locations where significant dew fall takes place. Central arid zone research h institute Jodhpur, has reported the use of rubble mulch, which is simply combination of small fragments of stones and bricks. This mulch provides better results on moisture conservation compared to the stone mulching, synthetic mulching and mulching made by straw materials.
5. **Organic mulch:** The tree branches, twigs, leaves, leaf litter, grasses, weeds etc. are used as organic mulch to cover the soil surface. The organic mulches are found superior to the artificial mulches in respect of conservation of moisture, reduction in evaporation and runoff. Use of this mulch controls the evaporation more effectively, particularly when rainfall takes place at frequent intervals, but it is not very effective when the numbers of rains are few and scattered. In other words, organic mulch does not conserve the moisture available due to infrequent rains and small showers, but these mulches may be quite effective for large rains lasting for several days which results in a wet surface with the availability of excess surface water for deep percolation. Further, the light mulches are almost ineffective for controlling the evaporation, because moisture conserving efficiency of mulch is inversely related to their capacity to absorb water or to extract it from the soil by capillary action. Resistant mulches do not decay shortly but last for a long time. As a result they are more effective for conserving the soil moisture.