e ISSN–2321–7987 | ●●● Article ●●● |Visit us : *www.researchjournal.co.in*|

Effect of soil erosion on Indian agriculture

Ashish Dwivedi[1] and Vineet Kumar[2]
[1]Department of Agronomy, SardarVallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) India
[2]Department of Soil Science, SardarVallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) India
(Email:ashishdwivedi842@gmail.com)

Soil erosion is a world-wide challenge for sustainability of agriculture especiallyin the tropical region. The rates of soil erosion that exceed the generation of new top soilare a dynamic process which leads to decline in the soil productivity, low agricultural yield and income. The balance between soil-forming and depleting processes is of utmost importance for attaining long-term sustainability in any production system. Land degradation in the form of soil erosion is a major problem in the semi-arid region of Lower Chambal Valley. In the present study Land sat satellite images for the years of 1977, 1990 and 2000 have been used to identify the change in degraded land in the region. Evidences suggest that the rate of encroachment of arable land is high and is equal to spreading rate of degraded land. The data obtained by field survey reveal that productivity of crop land is negatively correlated with share of degraded land to gross cropped area. The productivity of agriculture, measured through gross value of output per area, is comparatively high in villages having fewer shares of degraded land and *vice-versa*. Simple linear regression model explains high variation of productivity by high share of degraded land (above 50 % of gross cropped area).

Soil erosion is a world-wide challenge for sustainability of agriculture especially intropical region. It is the process of detachment and transport of soil particles. Erosion can decrease rooting depth, soil fertility, organic matter in the soil and plant-available water reserves (Lal, 1987). The rates of soil erosion that exceed the generation of new top soil area dynamic process which may lead to a decline of soil productivity, and result in lower agricultural yield and income, at least in the long run. The balance between soil-forming and depleting processes is of utmost importance for attaining long-term sustainability in any production system. Soil being a non-renewable resource and the basis for 97 per cent of all food production (Pimentel, 2007), strategies to prevent soildepletion are critical for sustainable development. For developing suitable soil conservation strategies, knowledge of the prevailing and permissible rates of soil erosion is an essential pre-requisite. In order to adequately understand the complex issues related to land degradation, it is necessary to identify the underlying causes and gain a comprehensive understanding of the physical, economic, political, institutional and social dimensions.

What is soil erosion? : Soil erosion is the process of detachment of soil particles from the parent body and transportation of the detached soil particles by wind and water. Generally soil erosion is called as the creeping death of the soil. Soil erosion is considered as negative soil pollution.

What are the causes of soil erosion? :

– Soil loss is maximum in region with high population densities. Globally the present rate of soil erosion is over 2500 million tonnes year^{-1}. The chief causes of soil erosion include:

– Land use changes involving destruction of forests and grasslands for expansion of agriculture and other commercial activities.

– Overgrazing of pastures

– Fallowing of land for a longer duration.

– Overuse of chemical fertilizers under intensive cultivation practices destroys the soil structure consequently the soil becomes susceptible to erosive forces.

– Shifting cultivation by tribal population.

– Continuous cultivation of the same crop.

What are different types of soil erosion? : Soil erosion is of various types. However, based on the rate at which soil loss takes place, there are two main types of soil erosion.

Geologic erosion: It occurs under natural conditions by itself without any interference of man. It is very slow process and state of balance between loss and build up is hardly lost.

Accelerated soil erosion: This type of soil erosion is very rapid and never keeps pace with the soil formation. This is most serious type of loss, generally caused by an interference of an agency like man and other animals.

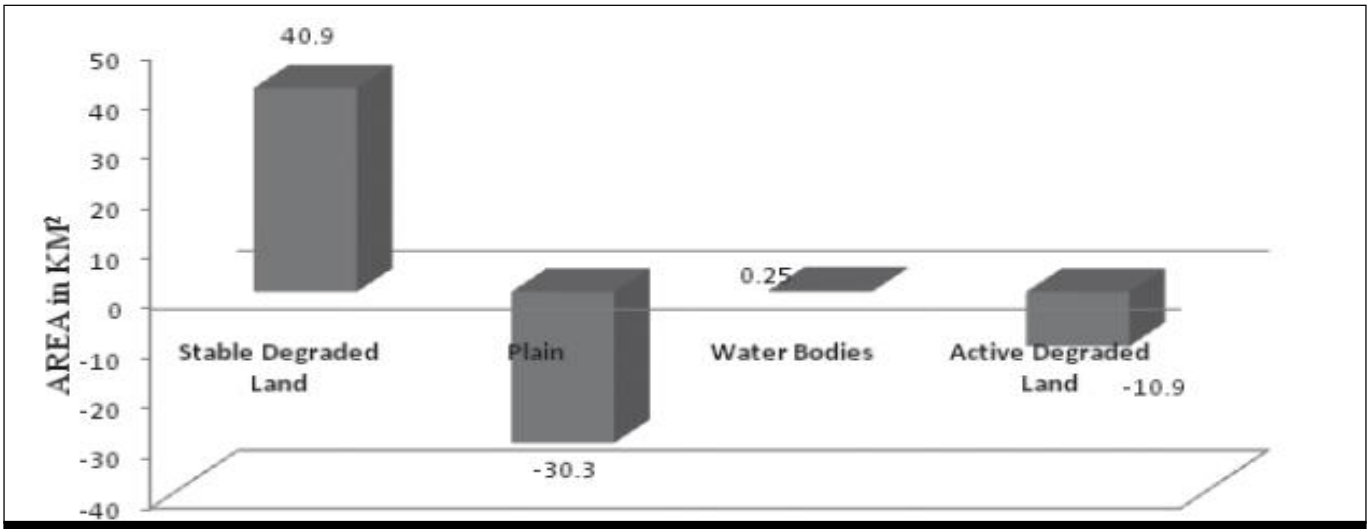

Fig. 1 : Changes in Land Cover in the Study Area: 1977-2000

What are agents of soil erosion ? : Depending on the agents of erosion, soil erosion is called as water erosion or wind erosion.

Water erosion: It is caused by the action of water, which removes the soil by falling on as rain drops, as well as by its surface flow action. The characteristic soil losses are sheet erosion, rill erosion, gully erosion, ravines, lanslides or slip erosion and stream bank erosion.

Sheet erosion : It is least conspicuous and is first stage of erosion. In this type of erosion soil is removed uniformly like a thin covering from large area.

Rill erosion : When the runoff starts, channelization begins and erosion is no longer uniform. Incisions are formed on the ground and erosion is more apparent than sheet erosion. This is the second stage of erosion.

Gully erosion :The results due to convergence of several rills towards the steep slope, which form together wider channels (grooves) of water known as gullies. Gullies are the most spectacular symptoms of erosion. If unchecked, cultivation becomes difficult.

Ravines: These are manifestation of a prolonged process of gully erosion, typically found in large expanse of deep alluvial soils. They are deep and wide gullies and their formation indicates very advanced stage of gully erosion.

Landslides or slip erosion : Landslides occurs in mountain slopes. The hydraulic pressure caused by heavy rains increases the weight of the rocks at cliffs which come under the gravitational force and finally slip. In this type of erosion water and gravity works together. Generally landslides cause blockage of the traffic on roads.

Stream bank erosion : This type of erosion takes place on the banks of fast running rivers. Here the surface current cuts the margin of the bank laterally. Once much of the soil from beneath is cut away the top soil of the river banks tumbles down into the water with big splash. This type of erosion is also known as riparian erosion.

Wind erosion: Soil erosion by wind is common in arid and semi-arid regions where the land is bare and devoid of vegetation or soil is sandy and the vegetation is poor and sparse. Over-grazing in these areas exposes soil to wind erosion. In India erosion by wind affects approximately 50 million hectares of land, most of which is in Rajasthan. *Saltation, suspension* and *surface creep* are the types of erosion caused by wind.

Saltation : Saltation is the first stage of movement of soil particles in series of jumps. In arid zone where rainfall is scanty, drainage is poor and high temperatures prevail, water evaporates quickly leaving behind the salts. The major portion of such salty soil is carried out by wind in the form of small leaps which is caused by direct pressure of wind on small particles of soil. Soil particles jump up vertically into air and rise to a height of 30 to 60 cm and fall through the air. Generally 50 to 75% of the weight of soil lost by wind erosion is carried in saltation.

Suspension: Floating of fine dust particles through the air is known as suspension. The particles are smaller than 0.1 mm in diameter. Generally 3 to 4 % of the weight of soil lost by wind erosion is carried in suspension.

Surface creep: The heavier particles larger than 0.5 to 3 mm in diameter that are not easily thrown up by wind are simply pushed or spread along the surface by wind. Generally 5 to 25% weight of the soil lost by wind erosion is carried in surface creep.

Table 1 : Distribution of land cover classes

Land cover classes	1977		1990		2000	
	Km^2	%	Km^2	%	Km^2	%
Stable degraded land (Vegetation cover)	49.9	6.4	46.9	6.0	90.8	11.6
Plain	349.8	44.6	333.1	42.5	319.5	40.7
Water bodies	69.1	8.8	69.5	8.9	69.3	8.8
Active degraded land	315.8	40.2	335.1	42.7	304.9	38.9
Total	784.5	100	784.5	100	784.5	100

What are the effects of soil erosion? : The topsoil removed by wind and water ultimately comes to rest as sediment. Erosion is the major cause of upset of the ecosystem at the point of sedimentation as the eroded materials are rich in chemical fertilizers and pesticides. Soil erosion causes siltation of rivers, lakes and dams. Silt chokes estuaries and harbours. Eroded soil is deposited on riverbeds, raising their levels and leading to devastating floods. Eroded sediment usually is the richest part of the soil, the nutritive topsoil containing most of the organic matter. Thus it leads to land degradation and to decline in its productivity. Soil erosion also accelerates aridity and lowers the level of sub-soil water. Uncontrolled wind erosion owing to deforestation leads to decline in rainfall. One of the probable reasons why moisture-laden clouds pass over Western Rajasthan without precipitating is fine dust suspended in the air over the desert. This dust is, indeed, the direct result of wind erosion caused by deforestation.

What is soil conservation? : Soil being a important natural resource which feed the human and livestock population need to conserved against the erosive forces. Since water and wind are the chief agents of erosion, the actual art of soil conservation is based on certain basic principles, which include

– Protection of soil from impact of rain drops.

– To prevent water from concentrating and moving down the slope in a narrow path.

– To slow down the water movement when it flows along the slope.

– To encourage more water to enter the soil.

– Reduction in wind velocity near the ground by growing vegetation cover, ridging the land etc.

– To grow strips of stubble or other vegetation cover which might catch the moving particles of soil.

What are erosion preventive measures? : Measures to prevent erosion may be broadly grouped as *agronomic, chemical, mechanical, forestry,* agrostological and *other measures*:

Agronomic measures: Agronomic measures include *contour cultivation, tillage, mulching, crop rotation, strip cropping, trash farming, cover crops* and *dry farming* practices. Soil erosion can be controlled by these methods when the slope is gentle *i.e.* less than 2 %. When these methods are used in combination, erosion can be reduced even if the slope is more than 2 %.

Contour cultivation: Contour cultivation includes contour ploughing, contour sowing and other intercultural operations. By ploughing and sowing across the slope, each ridge of plough furrow and each row of the crop act as an obstruction to runoff, providing more opportunity for water to enter into the soil and reduce soil loss. Contour cultivation is a very simple practice and can easily be practiced.

Tillage: Tillage is opening of soil for seed bed preparation. The tillage is distinguished into conventional tillage and conservational tillage. Conventional tillage includes ploughing twice or thrice by harrowing and planking. It leaves no residues on the soil surface. Conservation tillage is disturbing the soil to the minimum extent necessary and leaving crop residues on the soil. Conservation tillage practices which include *zero tillage* and *minimum tillage* can reduce soil loss upto 99% over conventional tillage. In most cases, conservation tillage reduces soil loss by 50% over conventional tillage.

Mulching : It refers to covering the soil with plant residues. It is effective against wind as well as water erosion. Mulches reduce soil moisture evaporation and increase amount of soil moisture by addition of organic matter to soil.

Crop rotation :It refers to alternate growing of crops. It

decreases soil loss and preserves the productivity of land. The growing of same crop year after year depletes the soil minerals. Use of legumes in crop rotation maintains the fertility of the soil.

Strip cropping : It is a system of crop production in which long and narrow strips of erosion resisting crops (close-growing crops) are alternated with strips of erosion permitting crops (erect-growing crops). The strips are laid across the slope. Strips of close-growing crops reduce the transporting and eroding power of water by forming obstruction to run off and filter out the soil from the runoff and retain it in the field.

Trash farming : It is a technique of soil conservation where chopped crop residues are spread and ploughed in order to produce a better tilth in the soil.

Cover crops : Cover crops are the crops grown to cover the soil during off-season. Certain cash crops like peanuts cotton, soyabean etc. do not produce enough residue to provide adequate ground cover. Cover crops usually legumes are used to provide the needed protection against erosion and also add nitrogen to soil.

Dry farming : This practice is useful for croplands grown in low and moderate rainfall areas, where ordinary farming is at risk. Crop production, animal husbandry and growing grazing fields are the only possibilities of checking erosion. Some of them are land fallowing, strip-cropping, crop rotation etc.

Chemical measures: Breakdown of aggregate by the falling rain drops is the main cause of detachment of soil particles. Soils with stable aggregates resist break down and thus resist erosion. Aggregate stability can be increased by spraying chemicals like Polyvinyl alcohol at 480 kg ha^{-1}, the rate, however, depends on the type of soil. Soils treated with Bituminincrease water stable aggregates and infiltration capacity of soil.

Mechanical measures: The mechanical measures are adopted to supplement the agronomical measures when the later alone are not adequate. These measures include Basin listing, Sub-soiling and Contour terracing.

Basin listing : It is constructing of small basin along the contours to retain water which also reduces its velocity. It is especially effective on retentive soils having mild slopes.

Sub-soiling: This method consists in breaking with a subsoiler the hard and impermeable subsoil to conserve more rain-water by improving the physical condition of a soil. This operation promotes greater moisture penetration into the soil, reduces both run-off and soil erosion.

Contour terracing : It is constructing a channel along the slope to intercept or direct the run off water. This may be :

– *Channel terrace* : To dig channels at suitable intervals and the excavated soil deposited as a wide, low ridge along the lower edge of the channel.

– *Broad based ridge terrace* : To construct ridge along both the sides of the channel; and

– *Bench terrace* : To construct a number of platforms along contours or suitable graded lines across the slope.

Forestry measures: Afforestation of eroded lands is best method of erosion control. The standing vegetation and dried leaves on the floor intercept the rain and reduce the impact of rain drops. Thus averting the erosion process. Moreover, the decomposition of fallen dead plant parts *i.e.* leaves and twigs not only increase the fertility of the soil but also improve the soil structure, which resist the soil erosion.

Agrostologicalmeasures : Grasses are helpful in control of soil erosion, hence they are used as erosion-resisting plants. Grasses are grown in strips between the crops. Agrostological measures include :

– *Lay farming* : This aim to grow grasses in rotation with field crops, which helps in building up the structure of soil and improving its fertility and

– *Retiring lands to grasses* : It involves to grow grasses on such lands where major proportion of the top soil has been eroded. Generally grasses are allowed to grazing under suitable climate conditions.

Other measures: These include:

– *Gully control*: To check the formation or widening of gullies by constructing bunds, dams, drains or diversions through which excess run off water is channelled.

– *Stream bank protection*: To grow vegetation alongside the river bank, to construct drains, concrete or stone pitching etc. For checking the cutting and caving of river banks

References :

Lal, R. (1987). Managing the Soils of Sub-Sahara Africa. *Sci.*, **236** : 1069-1086.

Pimentel, D. (2007). Habitat Factors in New Pest Invasions, In : Kim, K.C., McPheron, B.A. (Eds.), Evolution of Insect Pests—Patterns of Variation, Wiley, New York, pp.165–181.

Received : *14.12.2017* ***Revised :*** *18.04.2018* ***Accepted :*** *01.05.2018*