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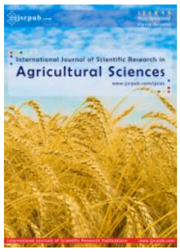

Editorial Publication

Soil Degradation: A Challenge to Sustainable Agriculture

Afroz Alam

Department of Bioscience and Biotechnology, Banasthali Vidyapith, Tonk-304 022 (Rajasthan), India
*Corresponding Author: afrozalamsafvi@gmail.com

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Abstract. Agricultural practices have a substantial impact on many ecosystems worldwide, and give rise to variety of ecological problems. Soil degradation is one the key areas in which agriculture impacts upon ecology. Soil erosion is a result of poor farming practices which cause removal of vegetation cover from soils, the use of large fields without boundaries to slow water movement and inappropriate ploughing techniques all stimulate soil erosion. Salinity of soil is another important factor which limits the use of this natural resource. In present review the causes, the cost of soil erosion and certain soil conservation practices have been discussed.

Keywords: Agriculture, conservation, degradation, erosion, farming, soil, salinity.

1. INTRODUCTION

Few ecosystems worldwide escape the impact of human activity, and one pervasive influence is agricultural activity, which necessarily involves gross changes to the local ecosystem, and may have more wide-reaching effects (Eswaran et al., 1997a).

Conservation and augmentation of quality of natural resources principally of soil and water are the central to ensuring food security of the growing population. Ever-increasing salinity of these two principal resources along with soil erosion is the foremost restraint on our capacity for sustainable agriculture to ensure food security. To avoid the productive lands from getting salinized as well as to make use of the existing salty land and water, it is necessary to correct the harmful condition through application of proper technology.

Soil degradation is the decline in soil characteristic originated by its inappropriate use, typically for agricultural, pastural, industrial or urban causes (Johnson and Lewis, 1995). It is a severe universal ecological crisis and may be aggravated by weather change. Soil degradation is one of the most important threats facing mankind which not only weakens the productive capability of an ecosystem but also affects overall climate (Barrow, 1991). Having already affected more than two billion hectares of land globally, the typical rate of soil degradation is almost 8-9 m ha/yr as per FAO/UNEP recent approximation. A large fraction of Indian land shows clear indication of advanced and nonstop degradation, frightening to destabilize our capacity to augment food production and improve pastoral poverty. The socio-economic and ecological consequences are massive (Beinroth et al., 1994).

It has been estimated that due to desertification and soil erosion the productivity of some lands has declined by 50%. For instance, in African countries, the yield reduction due to previous soil erosion may range from 2 to 40%, with an average loss of 8.2% for the continent (Darkoh, 1995; Eswaran et al., 1997b). Likewise, in South Asia, annual loss in productivity is estimated at 36 million tons of cereal equivalent valued at US$5,400 million by water erosion, and US$1,800 million due to wind erosion. Globally the annual loss of 75 billion tons of soil costs the world about US$400 billion per year, or approximately US$70 per person per year (Crosson, 1997).

Just about 3% of the global land surface can be regarded as or Class I land (Prime) and this is not occur in the tropics (Lal, 1994; 2009). An added 8% of land is in Classes II and III. This 11% of land must give food to the six billion people today and the 7.6 billion expected in 2020. Desertification is experienced on 33% of the global land surface and affects more than one billion people (Darkoh, 1995).

1.1. The causes of soil degradation

Good soil produces good vegetation which provides food and habitat for animals. A major concern of good soil management is keeping soil in place and maintaining its fertility. Once lost soil is irreplaceable i.e. 1 cm of soil may take more than 500 years to form, yet can be lost within a year. Soil erosion and the loss of fertility due to salinity as a result of poor farming practices are serious problems globally (Hartemink, 1995). Indigenous systems are insufficient alone to prevent agricultural land from continuing to loss productive soil, water and nutrient resources. This is partly because not all farmland is protected by conservation measures, but also because not all erosion arises from farmland. Both roads and urban areas concentrates water flows and nonagricultural areas are also subjected to erosion. Farmers may not be conserving soil and water due to lack of local knowledge and skills, or they may be unwilling to invest in conservation measures if the economic cost is greater than the benefits (Oldeman et al., 1992). For instance, the high price of wheat has encouraged winter cultivation in fragile environments, which has led to a large increase in soil erosion (UNEP, 1992; 1993; 1994). Soil erosion can in the order of 30-100 tons per hectare in fields where hedges have been removed. Erosion is greatest where there is little vegetation cover, such as during winter, and when slopes are long, such as big fields (Fahnestock et al., 1995). To farmers, erosion reduces the biological productivity of soils and the capacity to sustain productivity in the future. Soil erosion may also cause widespread flooding as soil becomes less able to retain water. The importance of land degradation among global issues is increased because of its blow on world food security and quality of the environment. High population density is not essentially related to land deprivation; it is what a inhabitants does to the land that decides the extent of dreadful conditions. Inhabitants can be a major advantage in overturning a trend towards degradation. Nevertheless, they need to be politically strong and economically motivated to care for the land, as survival agriculture, scarcity, and illiteracy can be important causes of land and environmental degradation (Mermut and Eswaran, 1997).

Ecosystem services provided by soils are vital to the carbon and water cycles and include cultural functions. There are strong links between climate change and soil condition (Virmani et al., 1994).

In simple terms, soil degradation includes physical, chemical and biological deterioration. Examples of soil degradation are loss of organic matter, unfavorable changes in salinity, acidity or alkalinity, and the effects of toxic chemicals, decreased soil fertility, decline in structural state, erosion, pollutants or excessive flooding.

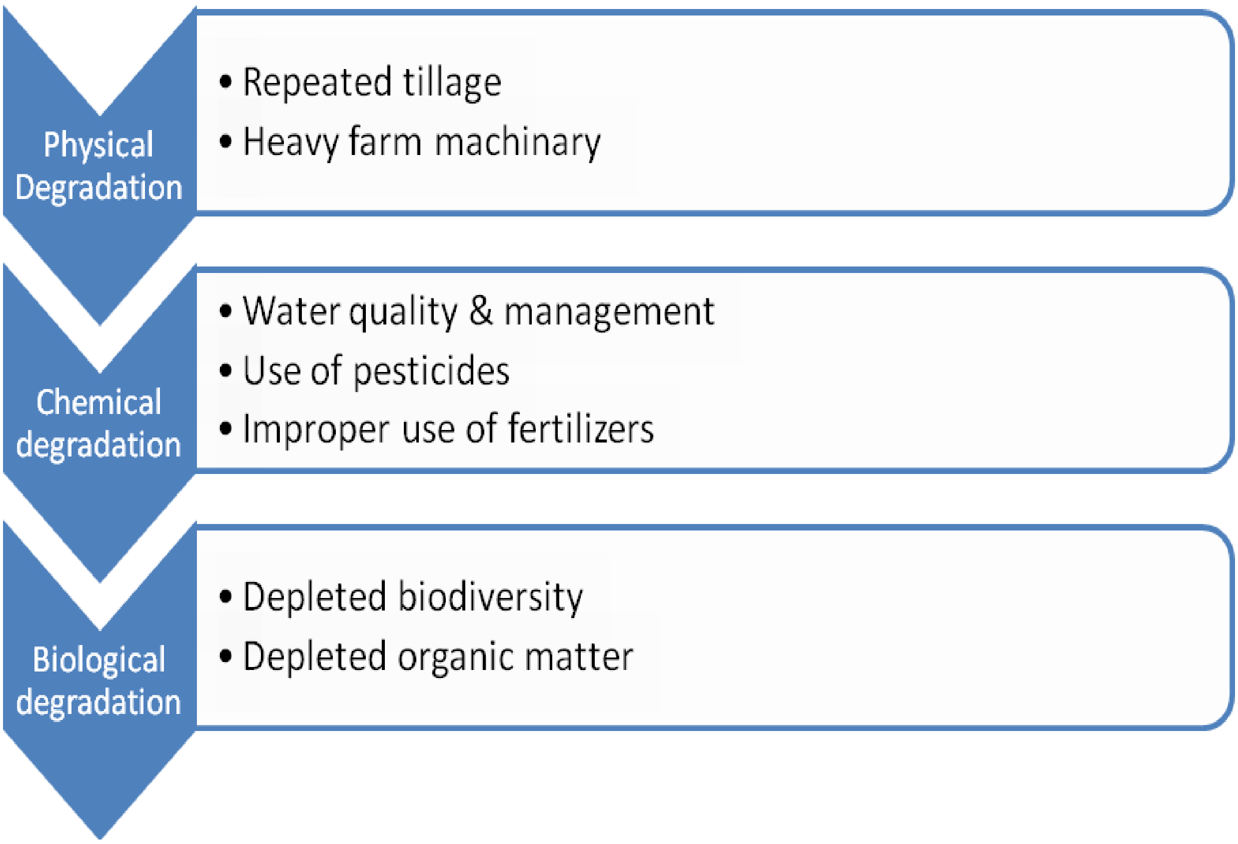

Fig. 1: Types of Land degradation

Degradation possibly caused physically by taking away of top soil through water and wind erosion, reduced capability to store water, augmented receptiveness to overflow and gradual absorption of soluble salts in root zone (Fig. 1). Overgrazing, increase of canal irrigation, unrestrained urbanization and surface mining etc. are some of the other actions that prop up degradation of soil.

Chemical degradation results in internal soil corrosion resulting from buildup of chemical substances like salts or loss of nutrients in addition through physical processes including water logging. The influences of physical and chemical degradation are straightforwardly noticeable. But the cost of biological degradation caused due to decline in organic matter, biomass carbon, decline in diversity and activity of flora and fauna are more restrained.

Salinity is the buildup of salt in soil and water to a level that impacts on the normal and built surroundings. Salinity occurs naturally in several parts of the landscape but in several cases has been worsens where human activities hasten the mobilization and buildup of salt. Today extend of salinity impacts farms, wetlands, rivers, irrigation areas, drinking water and infrastructure. It is a global issue at present. It has taken many decades for the problem to appear and will be with us for a long time to come. Solving it is a shared responsibility involving land managers, conservationists, native communities, scientists, businesses and all levels of government (Mackenzie et al., 1999).

Salinization is a prevalent problem in irrigated agriculture, dropping the world's irrigated area by 1–2% each year. The salinization badly affects agricultural land right across the country, but is most severe in dry areas such as Rajasthan. As a result crop growth and yield are poor in this particular region. This situation hits badly on the livelihood of farmers, reducing their profits or even forcing them their land.

Reducing the consequence of salinization in agriculture is decisive for attaining food security. But in India and other affected countries, lucid approaches for reducing or managing salinity in agriculture are inadequate.

1.2. The cost of Soil degradation

Most agricultural systems are based on short term-economic gain and as soil erosion occurs so gradually that it is almost imperceptible it may not, in the short-term, appears serious. Fifteen tons of soil lost from a hectare of land in single storm will diminish soil depth by 1 mm. However, tons of soil is ejected from various rivers into respective gulfs ever second. Eroded soil is not simply a loss of a valuable resource; it can cause air, water and land pollution. The great soil erosion event of the south and southwest USA in the 1930s lead to the area being called the ‘Dust bowl’ from the level of air pollution.

The main blow of soil degradation is a considerable reduction in the productivity of soil and land directly affecting those whose employment depends on this natural source. There are adequate evidences (Blaikie and Brookfield, 1987; Barrow, 1991; Johnson and Lewis, 1995) that undoubtedly reveal the fact that land degradation affects all aspects of life.

Certain agricultural practices also diminish soil fertility. Soil that is continually cropped or grazed will eventually lose its fertility because the normal cycle that returns mineral-rich dead plant matter to the soil is disrupted. Soil compaction that results from the use of heavy machinery can destroy the structure of soil, restrict water infiltration and lead to increased erosion. The problem of soil erosion is greatest in the third World where extensive areas of land are cleared for food production. Population growth puts stress on the need for increased agricultural production as well as the clearing of land for cropping and firewood supplies (Sajjapongse, 1998).

However, despite these problems, some efforts to improve erosion control have been successful. In Ethiopia, walls of rock and earth are built across hillsides to catch eroding soil. This forms natural terraces to help reduce further erosion. In Australia, wide-spread use of fencerows and hedgerows as physical barriers helps prevent wind erosion of agricultural fields (Mackenzie et al., 1999).

1.3. Soil conservation practices

Many issues that deal with those working in the domain of land resources comprise technologies to decrease degradation and also the techniques to evaluate and observe land degradation. A number of difficulties remain unreciprocated and these include predictability of land degradation, sufficiency of early warning indicators of land degradation, absence of land tenure and the resulting lack of stewardship, societal responsibility of soil scientists regarding anthropogenic induced decline in soil quality, development of full proof public policy, international collaboration to reduce the problem at global level, quantification of the aesthetic value of land, quantification of consumption of land etc (Stocking, 1986).

There are three steps involved in the management of the problem: assessment, monitoring, and application of mitigating technologies. All three steps are in the tasks of agriculturists and particularly, soil scientists. The last step without a doubt has the job for soil science, and over the past decade considerable advancement has been made in awaking the dangers of land degradation (Mabbutt, 1992).

Soil science has made noteworthy aid to the mission of soil resource assessment but its users have shown modest or no curiosity in the additional task of monitoring the resource base (Mermut and Eswaran, 1997; Tilman et al., 2002). This still remains a new area of investigation requiring guidelines, standards, and procedures. The challenge is to accept an internationally good enough method for this task. Soil scientists have a compulsion not only to show the spatial distribution of stressed systems but also to provide realistic estimates of their rates of degradation. They should develop early warning indicators of degradation to allow them to collaborate with others, such as social scientists, to develop and implement mitigating technologies. Soil scientists also have a role in assisting national decision-makers to develop appropriate land use policies.

1.4. Challenges and Management Strategies

Land degradation remains a serious global threat but the science concerning it contains both myths and facts (Greenland et al., 1994). The debate is perpetuated by confusion, misunderstanding, and misinterpretation of the available information. There are many, usually puzzling, reasons why land users allow their land to degrade. Many of the reasons are related to community opinions of land and the values they place on land. Degradation is also a slow unnoticeable process and so many people are not conscious that their land is degrading. Creating awareness and building up a sense of stewardship are important steps in the challenge of reducing degradation. Accordingly, suitable technology is only a fractional response. The key resolution lies in the behaviour of the farmer who is subject to economic and social pressures of the community/country in which they live. Food security, environmental balance, and land degradation are strongly inter-linked and each must be addressed in the context of the other to have measurable impact (Pimentel et al., 1995).

Important challenges include: Encouragement of the scientific community to build up an integrated programme for methods, standards, data collection, and research networks for evaluation and monitoring of soil and land degradation. Improvement of land use models that put together both natural and human-induced factors that contribute to land degradation and that could be used for land use planning and management. Strengthening of the information systems that connect environmental monitoring, accounting, and impact depth to land degradation, development of strategies that persuades sustainable land use and management and assist in the greater use of land resource information for sustainable agriculture. Making certain economic instruments for the assessment of land ruin and encourage the sustainable use of land resources, rationalization of the wide range of terminology and definitions with different meanings among different regulations associated with land degradation. Regularity of evaluation methods for the extent of land degradation. Development of non-uniform criteria for evaluating the severity of land degradation. Get the better of the difficulty in evaluating the on-farm economic impact of land degradation on productivity. There is an urgent need to address these issues through a multi-disciplinary approach, but the most urgent need is to develop an objective, quantifiable, and precise concept based on scientific principles.

2. CONCLUSION

It has been known for some time that a number of methods can be engaged to reduce soil erosion. By ploughing a field at right angles to the slope, furrows follow the contours of land rather than the slope. By using this contour ploughing system, water erosion is reduced. Planting crops on areas of bare field helps to prevent soil erosion. If leguminous (Family Fabaceae) plants are used as cover crops, nitrogen will be fixed and the nitrogen content of the soil increased. No-till farming is a system that consists of planting a narrow slit trench without ploughing the soil. By reducing soil disturbance, soil erosion is reduced (Ruppenthal, 1995). These systems, along with crop rotation can all be used to decrease soil loss and fertility. However, although these techniques are widely known, progress has been slow in establishing these practices. In addition, no-tilling farming often uses herbicides, invoking other problems. Therefore an international effort is required to combat this ever increasing problem for sustainable agriculture (UNCED, 1992). Organization like ICARDA is one such effort which is doing serious work in this direction through its nation partnerships with agricultural ministries and research agencies in Central Asia, Iraq, Iran and Egypt by providing research-based surviving tactics for farmers and water managers dealing with salinization. Their experience, the practices developed with partners, and research is also beneficial for other areas of the world where agricultural production is threatened by increasing levels of salinity, including India, Pakistan, China and other nations.

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Dr. Afroz Alam, working as Associate Professor in the Department of Bioscience and Biotechnology, Banasthali University, Rajasthan. He is currently supervising seven Ph. D. students in different aspects of Plant Science. He has vast experience of teaching and research in plant science. He has over 60 research publications in prestigious International and National Journals and a 4 text books with reputed publication houses to his credit. He is life member of various associations of Plant Sciences.