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IMPACT OF SOIL EROSION ON AGRICULTURE

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Abstract

Soil erosion is a world-wide challenge and shows adverse effect on agriculture. Soil erosion leads to the damage of topsoil resulting in decline in the soil productivity. For long term sustainability in agriculture, balance between soil farming and depletion plays an important role. Soil erosion caused by many factors such as deforestation, overgrazing and use of agrochemicals etc. Due to soil erosion, lack of water and nutrients issues faced by the crop production. In order to prevent soil erosion and improve the crop production, various techniques can be used such as vegetation, applying mulches, matting the soil, bunding, reduce watering and jetties etc. In this regard, this review paper focused on the impact of soil erosion on agriculture. Soil erosion shows adverse effect on crop production in different ways such as loss of nutrients, soil depth and availability of water etc. By adapting the proper land management systems can prevent the soil erosion in the future

Key words: Agriculture, Land, Organic matter, Soil Erosion, Water, Wind.

Introduction

Erosion depletes the viability of all natural environments, including agricultural, woodland, and pasture ecosystems, by removing soil from land surfaces[1]. The world's most important environmental issues include soil erosion, the scarcity of water, climate change as a result of pollution of carbon combustible, eutrophication of fresh water and underwater shorelines and habitat loss. Nearly 66% of the global population is reportedly malnourished, the largest number ever recorded of malnourished people[2]. More food will be needed as the global population exceeds seven billion people and is projected to hit 9.3 billion by 2050. Consider that over 99.7% of human food (calories), whereas less than 0.3% of marine and aquatic food (calorie) is processed on the ground[2]. Productivity and quality are important to the maintenance and expansion of world food supplies for all agricultural soils. Humanly-induced soil degradation and resultant harm of all agricultural land have for many years led to a decrease in the production of the remaining land, partly offset by nitrogen and phosphate fertilizers, resulting in abandonment of productive agricultural soil. The loss of cropland caused by soil erosion involves the processing, and application of nitrogen and phosphate enzymes to the new cropland, of new cultivations from forest and pastureland. Furthermore, the valuable plant, animal, and soil microorganisms are reduced by soil erosion.

Soil degradation is the greatest enemy for agriculture: a considerable environmental risk to sustainable and development life and to the effects of the climate and food security crisis. This is particularly so in areas with significant problems such as watersheds in Indonesia, India, the Philippines and elsewhere. Protection from soil erosion can address various problems in these areas by means of sustainable land management. Earth erosion, compacted soil, poor organic matter, lack of soil structure, insufficient internal drainage, salinization and problems of soil acidity are examples of soil depletion[3]. While this is extreme in them, other types of soil loss also result in soil erosion. Soil degradation is an all-around natural occurrence. Water and wind lead to soil erosion and every year across the globe they add to a significant amount of soil depletion. Soil erosion may be an unnoticed, slow process, or rapidly, resulting in substantial topsoil loss. The depletion of land can all be a result of reduced crop production capacitance, less productivity of the surface water and degraded irrigation networks. This review paper discussed about the impact of soil erosion on agriculture and diverse factors that causes soil erosion. How these factors contributing in soil erosion that leads to the adverse effect on agriculture.

Soil Erosion And Its Causes

Soil erosion is a step-by-step mechanism in which particles of soil are separated by water or wind, thereby making it possible for the soil to deteriorate. Soil erosion and poor quality of water as a result of deforestation and surface runoff have become major issues all over the world. The problem could worsen to the point that the land can no longer be farmed and must be abandoned. Owing to mismanagement of land and natural resources, many agricultural civilizations have collapsed, and the past of such civilizations serves as a strong reminder to conserve our natural resources. Soil erosion can have a negative impact on agriculture by lowering yields and quality of crops. The agriculture sector is under the pressure to respond to provide enough food to feed our developing society in a period where the population of the world is growing [4]. Climate change and deforestation, on the other hand, are causing soil erosion, which is reducing agricultural production around the world.

2.1.Causes of Soil Erosion:

A permanent surface covering on the soil surface, such as trees, pastures or prairies, is the only possible means of alleviating erosion. However, soils in grassy fields and crop areas are less capable of maintaining and are more vulnerable to erosion in contrast to initial woodland soils. As these soil areas have reduced water absorption potential, there are more floods (and their commercial, social and environmental effects). There are various factors involves in the soil erosion. The four major causing factors shown in the Figure 1.

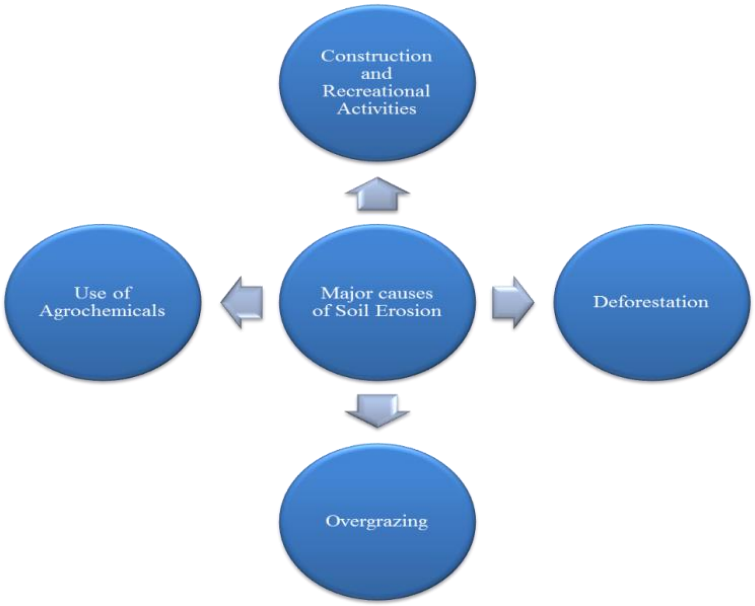

Figure 1: Schematic illustration of Major Causes of Soil Erosion

2.2.Deforestation:

Demands for products like coffee, soybeans, palm oil and wheat are on the increase in the population, clearing land for agriculture. Unfortunately, it raises the likelihood that native trees may be eroded and replaced by new trees which do not always hang onto the soil. When topsoil (the richest nutrient portion of the soil) is lost over time, agriculture would be threatened.

2.3.Overgrazing:

Continuous bovine growth induces overgrazing. Since plants have little time to regenerate, animals are flattened and compacted. During this process, topsoil sediments are carried elsewhere. In the other side, the remainder of soils may lose their capacity for penetration, resulting in further water depletion from the climate.

2.4.Use of Agrochemicals:

Chemicalists in pesticides and fertilizers are a common way for farmers to increase their returns on (often monocultural) crops. In comparison, overuse of phosphoric chemicaments contributes to the production of dangerous bacteria, resulting in an imbalance of soil moisture in the microorganism. The chance of flooding increases and sediments wash away in rivers and the neighboring areas (because of the wind and water behavior) thereby contaminates the local living environment, if the soil deteriorates. Farmers use tillage methods to prepare crops by applying fumes and fertilizers, soil leveling and invasive crop elimination to grow them also have a considerable impact. This is not just accurate but also dramatically essential. Tillage speeds up soil erosion and surface runoff because it brews the composition of the soil.

2.5.Construction and Recreational Activities:

When buildings and roads avoid free flow of water, they add to the degradation of the surface. It is flooding neighboring regions rather than accelerating deforestation. In addition, motor sports such as motocross will damage environments, change them (though smaller than other causes) and erode soil.

Types Of Soil Erosion

Soil erosion is a widespread problem in rural and urban areas. If people want to save their soils, it is necessary to understand the different types of erosion that can occur (discussed in Table 1)[5].

Table 1: List of Different Types of Soil Erosion and Their Explanation.

Type of Soil Erosion	**Explanation**
Sheet erosion	Sheet erosion by water is almost undetectable. Erosion has taken its toll on the soil, as shown by lighter-colored soils.
Wind erosion	Wind erosion is very noticeable. Water erosion, though a concern is usually much more serious.
Rill erosion	Heavy rains cause rill erosion, which produces small rills around hillsides, rendering farming difficult.
Gully erosion	Water runoff removes soil along drainage lines, forming gullies; some are vast and difficult to reach with farm machinery.
Ephemeral erosion	Ephemeral Erosion is a form of erosion that occurs naturally in depressions. The field can be crossed by farm vehicles, which distinguishes it from gully erosion.
Bank erosion	The erosion of a stream's or river's banks is known as bank erosion. Subsurface irrigation systems and surface water runoff are typically discharged by built drainage channels and natural streams. These drainage ways are gradually becoming undercut, scourred, and slumped.

Impact Of Soil Erosion On Agriculture

Soil erosion is a gradual process where the soil is separated by water or wind and eroded, which may deteriorate the soil. Soil loss and low water quality have been significant problems in the world because of erosion and surface runoff. The problem could worsen to the point that the land can no longer be farmed and must be abandoned. Many pastoral cultures have collapsed due to the mismanage of land and natural resources, and the history of those civilizations is a reminder that our natural resources have been conserved. Erosion is a major problem both for fertile farmland and for water quality issues. Sediment control must form an integral part of each soil management scheme in order to improve water and soil quality. Topsoil eroded can be transported by

wind or water through streams and other waterways. Land erosion generates sediments, mainly caused in upland regions by sheets and rill erosion and to a lesser degree by cyclical erosion of slopes and drainages.

As a result of soil erosion, crop yield is reduced. Soil erosion increases water flow in order to reduce water infiltration and water storage. Soil erosion increases water flow. In addition, in the erosion process, organic matter and essential plant nutrients are removed from the soil. Not only do these improvements hamper vegetative productivity, but also reduce the existence of significant biota and soil biodiversity. These variables interact, making it almost impossible to distinguish between their individual effects. These factors are discussed below:

4.1.Water Availability:

As all vegetation requires immense quantities of water to expand and produce fruits, water is a significant productivity constraint in all terrestrial habitats. For eg, a hectare of maize will be eaten by about seven million liters of water in a three month season and will lose another two million liters to the soil[6]. Water drainage is the tremendously as the surface is drained by precipitation, leading to a reduction in water entry into the soil.

4.2.Nutrient Loses:

Eroded soil carries plant nutrients including nitrogen, phosphorus, potassium and calcium. Usually, the degraded soil retains the residual soil, three times as many nutrients per unit weight. Fertile Topsoil contains between 1 and 6 kg of nitrogen, 1 to 3 kg of phosphorus, and between 2 and 30 kg of potassium; and eroded Topsoil contains between 0.1 and 0.5 kg of nitrogen per ton[7]. A large quantity of fertilizer is also used to offset crop production nutrient deficiency. When the soil base is about 300 mm thick and only 10-20 tons of ground per hectare per annum are lost, commercial fertilizer and/or cattle manure can supplement the nutrient base[8]. However, replacement strategy is expensive for the farmers as well as for the economy, and most poor farmers are unable to afford fertilizer. Fossil-fuel fertilizers are not only dependent on fertilizers, but they can also affect human health and pollute soil, water and air.

4.3.Soil Organic Matter:

Organic matter content in fertile soils is approximately 100 tons per hectare (4 percent to 5 percent of total topsoil weight)[9]. The organic matter in the soil contains 95 percent of the nitrogen and 25 to 50 percent of the phosphorus[10]. Because most organic soils exist as decaying leaves and stems close to the surface of the earth, erosion greatly reduces the organic soil. Fine organic particles are removed from the soil through wind and water erosion leaving larger particles of soil and rocks. Several experiments have found that the soil dissolved by water or wind is 1.3 to 5 times richer than that left behind in organic matter. For instance, reducing organic soil content from 0.9% to 1.4% (assuming organic soil content is 4% to 5%) decreased the yield capacity for grain crops by 50 percent[11].

Since it aids in the creation of soil aggregates and thus increases soil porosity, soil organic matter is a valuable resource. The improved soil structure improves water penetration and, as a result, increases the soil's overall productivity. Organic matter also helps with caution exchange, increases the development of plant roots and promotes soil microbial growth. Because of its degraded soil composition and nutrient losses, the productivity of the ecosystem decline as the organic matter layer is exhausted, as determined by plant biomass. The total biomass and biodiversity of biota have declined considerably in these ecosystems besides poor yields.

4.4.Soil Depth:

Plants that are growing need soils that are deep enough for their roots to reach. A suitable soil depth is also needed by various soil biota, such as earthworms. This means that the root of plant space will be depleted and plants stunted as erosion reduces soil depth from 30 cm to less than 1 cm in depth for thin soils.

Prevention Of Soil Erosion

Soil erosion is a problem not only because of the effects it has on plant growth, but also because of the effects it has on water quality. Soil is a vital natural resource that nourishes and promotes plant growth, among other things. Wind and water will erode it when soil is left uncovered and exposed. There are some techniques by which soil erosion can be prevented (shown in Figure 2).

Figure 2: Schematic Representation of Possible Ways to Prevent Soil Erosion.

5.1.Vegetation:

Planting vegetation is the easiest and most natural way to avoid soil erosion. As soil erosion on the bare earth is higher, the soil must be kept covered by planting and cultivating grass. The grass slows the flow of water and prevents it from coming into direct contact with the surface. Plants develop root systems, which help to stabilize the soil and avoid erosion. Plants prevent rain from splitting the soil apart by blocking rain and reducing the effect of the drop on the soil through their leaves.

5.2.Applying Mulches:

Another way of preventing soil erosion is to use mulches. Mulch on the soil surface helps the soil to slowly absorb water while still protecting it from rain and restoring pH levels. Mulching is obtained from dead leaves and broken wood coating the soil. Mulching offers tree and plant protection from harsh weather. Mulching encourages water to reach the field slowly, minimizing heavy rain or irrigation effect. Mulches tend to avoid acidity in the soil and prevent weeds. Organic-made mulches are broken down over time, enhancing the structure of the soil and fertility.

5.3.Matting the Soil:

Biodegredients such as mulch, straw, cocoa and wood chips are added to the soil through matting. These are maintained in combination with biodegradable coconut nets. The way to throw a biodegradable tapestry into the ground. The matting substance decomposes or delays decomposition and over time becomes a soil fertilizer.

5.4.Building Retaining Walls:

It's possible that sloping land will fall downwards before it's stabilized. The supporting wall at the slope's bottom will prevent the soil from creeping and slowing the collapse. Water leakage is often prevented by the retaining wall. Runoff water causes more erosion, which can be countered by a stone or concrete wall.

5.5.Turn Hill Side into Contour Farming:

Soil erosion is more common on sloping ground. It's almost difficult to cultivate on the steepest slopes. Reduce soil erosion by dividing the hill into terraces that extend around the slope. The soil should be positioned uniformly along the slope in order to avoid soil erosion. Contour agriculture serves as a buffer, catches and retains rain water to increase infiltration and to provide a more uniform delivery of water.

5.6.Bunding:

A bund is a technique for erosion-prevention which requires a block on the surface rush to slow water flow. It helps manage soil depletion by the accumulation of runoff in the watershed. The channel of contours may be dug in the same way across the river. Contour bonds are built in areas with low precipitation and permeable soils.

5.7.Reduce Watering:

Too much watering of a garden or field can lead to soil erosion. Using less water whenever possible. A drip irrigation system is the safest option. No water flows over the surface to maintain top soil and only small volume of water at once is provided by a drip system.

5.8.Avoid Soil Compaction:

People, livestock, and machines all press down on the soil, compacting it into a thick sheet. The distance between soil particles decreases as a result of compaction. As a result, water and air have a hard time reaching the soil. As a result, rather than trampling the dirt, a paving stone route should be built for movement.

5.9.Creation of Windbreakers:

In this method, evergreen trees are planted around gardens or farms to keep the soil away from blowing. Windbreakers shield the plants from wind damage and increase plant protection, efficiency and yield. A crop protected from the wind has much more humidity.

5.10.Groins:

Longshore drift moves sand down the beach, and groins are man-made structures built to catch it. Longshore drift is a transportation method. It entails the transport of eroded material along a coastline. Groins are long, walk-like structures constructed on beaches that stretch perpendicular to the shoreline into the ocean. Longshore currents are blocked by them. When it hits its groin, sand dumps and sediment on the current side of the wall, the long shore current loses its speed. While the sand on the wall upstream is catched, the waves take up sand and gravel on the side downstream again.

5.11.Jetties:

Jetties are obstacles created by people running around the sides of the entrance. The objective of Jetty installation is to hold the Inlet open indefinitely and from shifting locations. This solution requires the establishment of a long system parallel to the sea. They typically consist of stone, cement, steel or wood, and are used to protect sand away from the channel of a ship. On the present side of the jetties, sand should be redistributed across the sand, minimizing erosion further. Erosion continues on the downstream side of the jetties.

5.12.Breakwaters:

Wide piles of rock run parallel to the shore to form breakwaters. Breakwaters are typically used in harbors and artificial marinas to cool the waters. It acts as a wave barrier that enables the beach to grow while avoiding erosion. They dump their sediment load as waves smash into the breakwater. On the other side, every part of the shore not protected by the breakwater begins to erode.

Discussion

Soil erosion is the loosening or washing away of soil particles in valleys, seas, rivers, streams, or distant lands. Human activities such as agriculture and deforestation have exacerbated the issue. Soil erosion is a continuous process that can occur at a slow or rapid pace. It leads to a steady depletion of topsoil, ecological deterioration, and soil collapse, among other things. Soil erosion is primarily caused by increased rainfall rate. The soil is dispersed by the raindrops and swept away into surrounding streams and rivers. Soil depletion in areas with very strong and frequent precipitation is typical. The flowing water erodes a great deal of soil at flood times, creating potholes, rock-cut tanks and other issues.

Soil erosion depletes the top soil for agriculture as the most fertile part of the soil profile. The absence of top soil results in reduced yields and raised production costs. Erosion can lead to erosion, as high soil is lost, rendering it difficult for paddock to expand. Exposure to water and nutrients, low physical and chemical properties of subsoil, higher ripples, water and other nutrients for crop growth, depletion of newly planted crops and silt deposition in lowland areas are the results of erosion on croplands. Erosions can also result in a reduction of water and nutrients stored on the ground.

Conclusion

Erosion of the soil is a natural process that affects any type of the land. Soil erosion is a common physical force of water and wind in agriculture, and is linked to farming activities like tillage and wearing up a top-soil area. There are three specific actions involved in erosion: soil separation, redistribution and absorption, be it due to water, wind or the preparation of land for growing crops. Rich in organic matter, fertility and soil life, top soil either is moved on-site to grow over time or "off-site" is shipped to fill drainage canals. Soil erosion reduces cropland productivity and pollutes local rivers, lakes and streams. Soil erosion may be an unnoticed, slow process, or rapidly, resulting in substantial topsoil loss. The soil compaction, low organic matter, lack of soil composition, poor internal drainage, salinization and acidic conditions are other extreme soil depletion conditions that can speed up the erosion process. By taking all issues into consideration related to soil erosion, it is recommended that proper land management systems is necessary in order to prevent soil erosion. Proper awareness among the small farmer about soil erosion and its prevention must be explore..

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