Eco. Env. & Cons. 30 (Nov. Suppl. Issue) : 2024; pp. (S239-S244)

ISSN 0971–765X

DOI No. http://doi.org/10.53550/EEC.2024.v30i07s.044

Investigating the Impact of Agricultural Practices on Soil Erosion and Sedimentation in Water Bodies

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(Received 29 April, 2024; Accepted 28 June, 2024)

ABSTRACT

This paper explores the critical analysis of how agricultural operations affect soil erosion and sedimentation in aquatic environments. Despite being essential for human survival, farming frequently unintentionally triggers a decline in the environment, especially when it comes to soil erosion and the sedimentation that follows in aquatic environments. The complex interaction across agricultural practices and several natural occurrences is examined in this article. First, it examines the different agrarian practices-such as tillage, deforestation, and inappropriate land management-that lead to soil deterioration. Due to the disturbance of the soil's foundation and heightened vulnerability to eroding, these activities result in the depletion of rich topsoil and sedimentation of adjacent reservoirs.The link between agricultural practices and their effects on soil erosion and sedimentation in water bodies is examined within this paper. Farming methods frequently cause soil erosion and disturbance, which allows silt to enter adjacent water habitats. Hazards to flooding are raised, habitat damage occurs, and the water's cleanliness is deteriorated. In order to address these problems, the work also covers mitigating techniques including conservation tillage and cover crops. Sustainable handling of water and soil resources depends on a comprehension of these consequences and taking appropriate action.

Key words: *Agricultural practices, Soil erosion, Sedimentation, Water Bodies, Runoff, Soil Quality, Terracing, Terrain, No Tillage, Mitigation, Water Quality.*

Introduction

As long as there has been humanity, soil erosion has existed. It has made society worse and the human search for a better life more difficult. Either natural factors create it, or social development throughout time induces it. Both on- and off-site consequences of the eroded material from soil erosion are harmful to the flora and fauna. Interactions and intra-ecosystem interactions may intensify the consequences.

A diverse of land and methods for managing water that could lessen soil erosion should be investigated in light of the significant soil erosion and the environmental and social effects it has caused. These techniques include tracing, agro-forestation, filter strips, wide and intensive farming, agro-forestation, and area enclosure.

In the United States, 21% of the 15,000,000 hectares (37,000,000 acres) of irrigated land have some degree of soil erosion. Since 1940, researchers have focused mostly on soil erosion caused by irrigation in the Northwestern region of the United States. Annual sediment outputs from furrow-irrigated fields have been recorded in many studies to be greater than 20 t/ha (9 tons/acre), with some fields surpassing 100 t/ha (45 tons/acre). Record high

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sediment production of up to 33 t/ha (15 tons/acre) have been measured using the center-pivot sprinkler system. Irrigation tracts had annual sediment production as high as 4.5 t/ha (2 tons/acre). On slopes smaller than 1%, erosion is rarely severe; on slopes more than 2%, it is frequently excessive. Erosion results in damages off-farm and lowers agricultural output in the fields. (Paul *et al.,*).

The topographical location affects the cropping sequences and rotations used to stop soil degradation and encourage soil regeneration. Water availability is the primary determinant of crop output. In humid environments, radiation, temperature, nutrition, sanitation, erosion, and waterlogging are the main factors limiting agricultural productivity. With 200–500 mm of precipitation, low-input dryland agriculture relies heavily on soil and water conservation measures. The rewards of crop rotation, which preserve high output while conserving assets such as water and soil, have been extensively understood. Conservation of water and soil is essential for long-term sustainable agriculture. Positive collaboration and interaction between government laws, extension services, community development, and research are necessary to guarantee the execution of these practices (Amir *et al.,* 1996).

Water erosion is a serious and constant environmental problem. Rill and in Terrill erosion that are two common forms of water erosion, involve detachment and transport of soil particles from top soil layers, degrading soil quality and reducing the productivity of affected lands. Additionally, excessive sedimentation clogs stream channels and increases values for maintaining water conveyances. Sediment delivered into water bodies may also be a source of contamination, adversely impacting the aquatic biota. Consequently, the need to quantifythe measure of erosion and sediment delivery in a spatially distributed form has become essential at the watershed scale and in the implementation of conservation efforts. Sediment yield from a watershed is an integrated result of all water erosion and transport processes occurring throughout the overall contributing area. The total sediment yield thus depends on both erosion at the various sediment sources such as crop, range, and forest lands, and the efficiency of the system to transport the eroded material out of the watershed

Sediment delivery ratio, the ratio of sediment delivered to the stream or watershed outlet to the total erosion from the contributing areas, is a commonly used indicator of the watershed sediment transport efficiency. The potential for soil erosion varies from watershed to watershed depending on the configuration of the watershed (topography, shape), the soil characteristics, the local climatic conations, and the land use and management practices implemented on the watershed.

It has been endorsed that utilizing erosion models in affiliation with GIS is a successful method for determining the extent and distribution of erosion. Ferro and Porto (2000) analysed erosion and spatially dispersed sediment delivery in a watershed using the trip time concept and USLE. Jain and Kothari (2000) included this method into a GIS. GIS makes it possible to manipulate and display vast amounts of geo-referenced data effectively. Research has shown that using erosion models in affiliation with GIS is an effective way for evaluating the extent and distribution of erosion.

Content

The technique by which dirt is transferred from a particular spot to another by wind, water, or other factors is known as soil erosion, and agricultural practices can have a major influence on it. Deterioration of the environment, decreased soil quality, removal of important topsoil, and water quality issues are all possible outcomes of soil erosion. Agriculture-related activities can affect soil erosion in a few different ways: Tillage, Terracing, Contour farming, Cover crops, etc.

A research investigation was conducted in the vicinity of Soreif, a town located approximately 10 kilometres north-west of Hebron town in the western slopes of the West Bank/Palestine, Central Highland; the precise geographical position is 35.06° East and 31.63° North, with an elevation of 670 m above the level of the ocean. The areas studied covered an area of approximately 40 hectares each. The topography of the location is defined by mountainous terrain and sloping terrain, with levels varying within 10 and 13%. The weather is Mediterranean in nature, with long, hot, and arid summers and pouring winters followed by long, hot, and dry summers. The majority of the moisture falls around October and April, with an average yearly rainfall of 400 to 500 mm. For every kind of plant, two identical micro-catchments of 50 m^2 (5m × 10m) each were built to quantify deposition and surface water discharge. To stop effluent from the surrounding region, cement blocks 20 cm height were placed around each runoff plot. To transfer the runoff water to a 0.7 m^3 tank, plastic piping was utilized. Following each major downpour, the quantity of run-off was assessed after allowing the sediment to settle. During the research period, the study site's rainfall was recorded using a rain gauge. At the conclusion of the winter, soon after getting air-dried, the sediments that had collected at the bottom of each tank were also analysed.

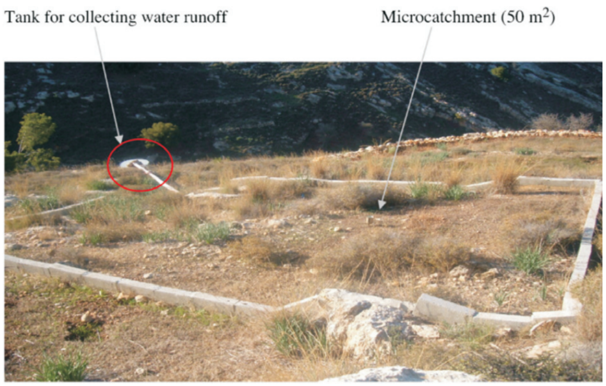


Fig. 1. Microcatchment used to measure runoff and sedimentation.

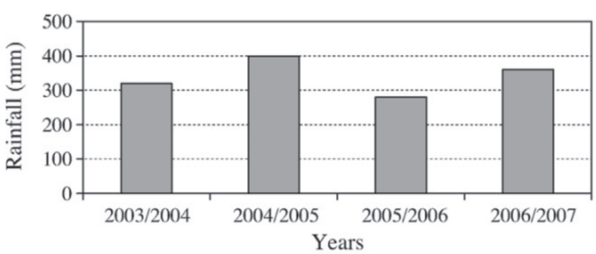


Fig. 2. Annual rainfall (mm) at the study site over four years 2003/2004, 2004/2005, 2005/2006, and 2006/2007.

The following is a summary of the study's findings: There are notable variations in the runoff and soil erosion rates across the five vegetation systems; forestry and indigenous vegetation, which is mostly composed of *S. spinosum*, exhibit the simplest rates of both effluent and soil deterioration. Runoff and soil erosion losses are significantly affected by forest destruction and *S. spinosum* eradication. Deforestation and agricultural practice have a detrimental upshot on soil erosion and elevated runoff because they foster natures that are notabtly more conducive to surface runoff. The deterioration of the landscape is made more likely by human-induced processes like forest loss, the eradication of *S. spinosum* for fuel and other purposes, and the interchangeable use of semi-arid and arid lands for foraging and farming. These events additionally substantially boost the amount of runoff and sedimentation. As a result, careful management of pasture must go hand in hand with the elimination of *S. spinosum* in order to increase countryside production. Thus, maintaining appropriate cover of foliage in forests and rangelands should be taken into account for the preservation of soil and water, and any plowing or brush management ought to be carried out with caution to prevent regressive tendencies in these areas.

No-tillage (NT), sometimes referred to as zero tillage or direct seeding, is a cropping technique that forgoes mechanical seedbed setup in favour of creating a groove strip or tiny hole in the past crop's stubble (20–30 mm wide) for the planting of seeds, with absolutely no additional tilling required. Since NT minimizes soil water erosion and increases soil penetration by water, both of which result in wastage of profitable soil content, it is becoming more and more recognized as a potential aspect of environmentally friendly farming. As a lesser amount of carbon is transferred from soils via erosion of water and the breakdown of organic soil material, the NT may also help attenuate and cope with changes in the environment. To find research articles that look into the outcome of tillage on soil erosion by water, an article search was done using Science Direct, Scientia Agricola, and Google Scholar. There were discovered to be 2,500 studies. It made sense to restrict the hunt to analyses using plot-scale data as it was acknowledged that geographical size affects runoff and soil loss activities. The studies were taken from 282 runoff plots from 14 different countries across the globe. In addition to ecological features (topographical, meteorological, soil, and plot management factors), quantitative measurements of runoff, sediment quantity, and soil depletion were also included into the record.

Between No-Tillage (NT) and Conventional Tillage (CT), the mean runoff rate failed to vary significantly throughout geological and atmospheric variables. In panels with mulch covering, the runoff coefficient was 41% lower under NT than CT, while in exposed soils, there were additionally barely any distinctions between NT & CT. Sediment content and the soil loss response to NT were significantly impacted by site management that exist, which includes topsoil cover, the length of NT application, and the types of agricultural produce planted. Aggregate content in NT was less than CT with regard

Categorical variables used to describe physical and management conditions at experimental sites.

Categorical variable	Level 1	Level 2	Level 3	Level 4
Climate	Tropical	Subtropical	Temperate continental	Temperate maritime
Top-soil texture	Sand (<20% clay)	Loam (20–32% clay)	Clay (>32% clay)	
Mean annual precipitation	Low (<600 mm)	Medium (600–1000 mm)	High (>1000 mm)	
Mean annual temperature.	Low (≤10 °C)	Medium (10–20 °C)	High (>20 °C)	
Altitude	Low (<700 m.a.s.l)	Medium (700–1400 m.a.s.l)	High(>1400 m.a.s.l)	
Top-soil bulk density	Low (≤1.2 g cm^{-3})	Medium (1.2–1.6 g cm^{-3})		
Soil organic carbon content	Low (<1%)	Medium (1–2%)	High (>2%)	
Mean slope gradient	Very gently sloping (1.0–2.0%)	Gently sloping (2.0–5.0%)	Sloping (5.0–10.0%)	Moderately steep (15.0–30.0%)
Slope length	Short (<10 m)	Medium (10–15 m)	Long (>15 m)	
NT treatment duration	Short (<5 years)	Medium (5–10 years)	Long (>10 years)	
Soil surface cover	Crop residue cover	Bare soil (no mulch cover)		
Crop species	Cereals	Legumes	Cereal-legume rotation	Other (tobacco, cotton, canola, oil-seed rape, olives and sunflower).

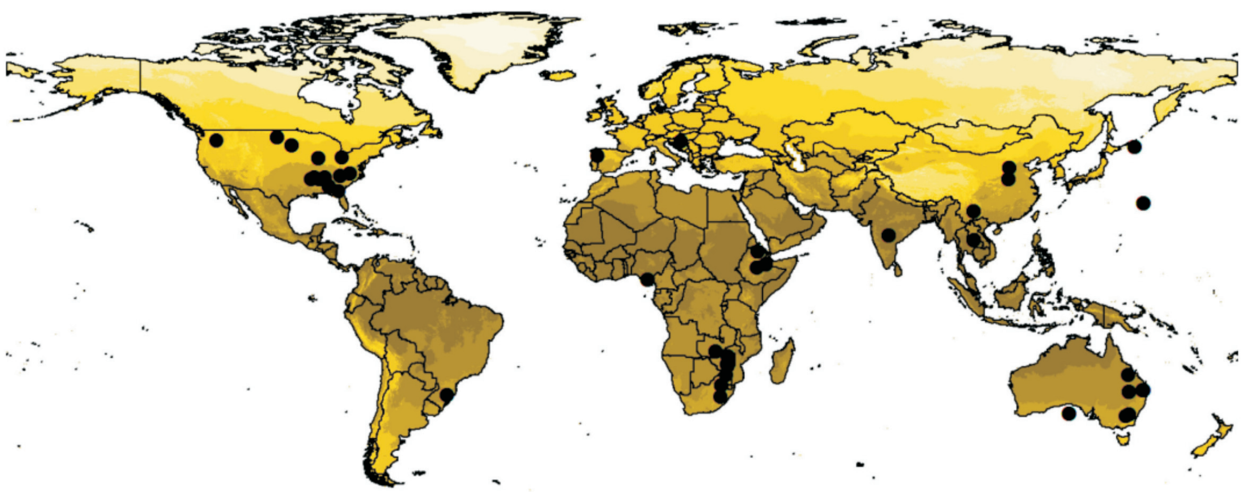


Fig. 1. The global map displaying the study locations from which the data under examination were gathered.

to mulched and bare soils (around 55 and 56%, respectively), while soil loss under NT was 72 and 67% less than CT for both mulched and bare soils, correspondingly. After ploughing being abandoned there was a propensity for effluent to decrease as time passed duration. For moderate intervals (5–10 years), the runoff frequency was 30% lower under NT compared to CT, while it was 39% lesser for extended periods (>10 yrs). This study's primary goals were to evaluate the effects of implementing NT on runoff, silt quantity, and soil losses and to identify soil and environmental elements that may be impacting volatility in NT effectiveness. The study used 282 runoff plots from across the world to compare NT with CT. The outcome showed that soil erosion was reduced in NT compared to CT; nevertheless, overland flow did not vary. Plot length and slope angle increases were correlated with changes in sediment content and soil degradation. Furthermore, the coldest locations with soils that had greater levels of sand along with silt concentration and, consequently, lesser durability of aggregate benefited more from tillage desertion than tropical clay-based climates with solid soil fragments. Furthermore, the influence of tillage abdication on runoff and soil losses was independent of the amount of agricultural waste retained as mulch, indicating the primacy of in-soil processes controlling water penetration and soil separation. Despite present attempts to encourage the use of NT in tropical and subtropical locations, it is expected that the widespread use of NT in cold conditions will be expected to deliver a large drop in soil erosion compared to tropical regions. This is centred on these data. Lastly, the influence of tillage renunciation was observed regardless of mulch existence, suggesting that agricultural leftovers may be shipped for use in other industries, such as the manufacturing of biofuel from biomass (Mazho *et al.,* 2016).

One strategy to lessen or stop the damaging effects of soil erosion is terracing. It's among the first methods for conserving water and soil. Furthermore, it is the method of soil conservation that is applied worldwide the most frequently. Although lowering runoff and degradation of soil is usually the main goal of terracing, it also helps to increase permeability and lower peak water release rates, which raise the humidity of the soil. Using supplementary conservation approaches, such as contouring and seeding, farming for crops (such as strip cropping), and preserving a long-term layer of soil, improves the effectiveness of a terraced system.

Multiple requirements must be applied in order to classify the various kinds of terraces. They are divided into four category based on: 1) their primary purpose; 2) the method of construction; 3) the dimensions of the terrace foundation; and 4) the form.

The terrain is altered by terracing. They thus have a direct impact on local hydrology and, as a result, runoff properties. Terraces also have an indirect impact on the properties and humidity of the soil. Terracing solely affects water erosion; wind erosion is not stopped or lessened by it. Terracing, regardless of the farming technology being employed, allows for a 50% reduction in soil losses.Up to 25% less runoff throughout the period of cultivation meant that greater rainfall was on hand for the crop. Runoff was a total of eight times lower on a hill with flat terraces than it had been on a slope with contour planted crops. They also came to the conclusion that terracing, as opposed to just putting down timber, is significantly more effective in reducing the production of silt. As the forests that were planted grew older, the two together caused a steady decline in the flow of sediment over the course of thirty-five

Fig. 1. The global map displaying the study locations from which the data under examination were gathered.

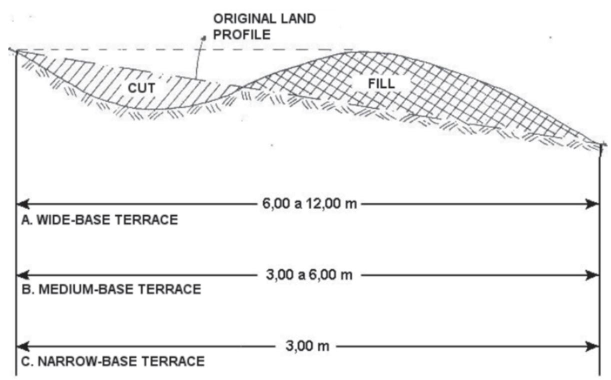
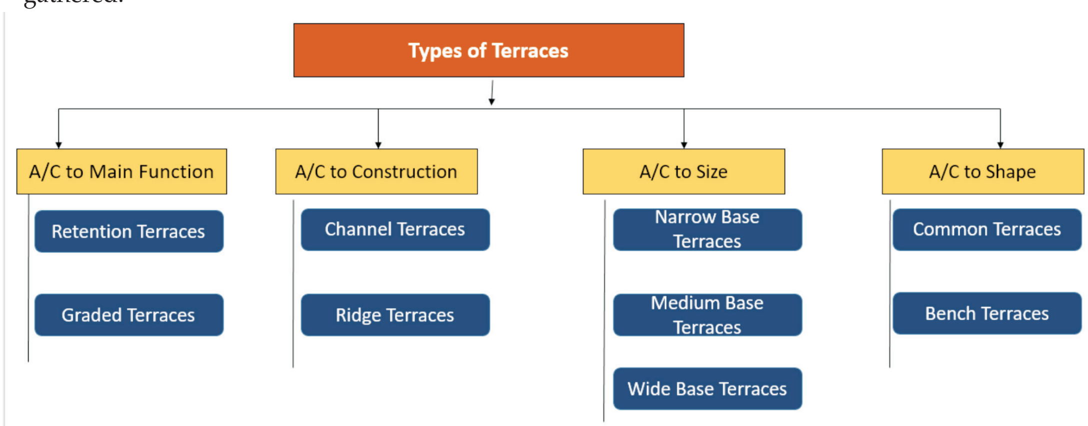


Fig. 1. An illustration of a typical terrace shape that explains the categorization based on various foundation sizes



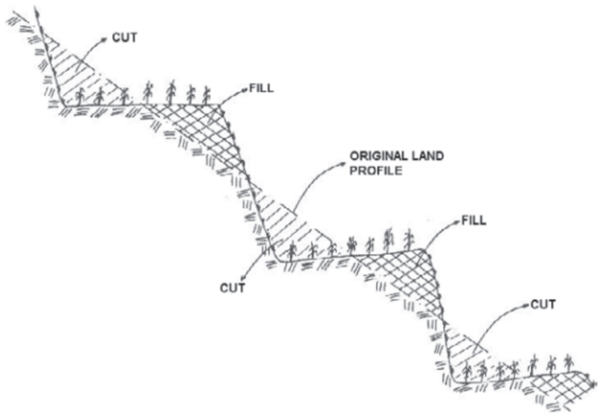


Fig. An illustration of a standard bench terrace

years. The upkeep of the terrace walls is among the most crucial actions that reduce eroding. Terrace destitution might pose a serious danger of significant soil loss. There are some research out on disadvantages of the terrace farming. The upheaval of soil layers, a significant reduction in a soil's fertility through the initial few years, significant soil loss during construction and the initial two years of operation, and an enormous labour and financial commitment required for both building and upkeep. Moreover, they are frequently unstable, unsuitable for sandy and gritty soils, and inadvisable on extremely steep terrain. About 25% of the marginal area is affected by nutrients leakage regarding bench terraces and soil depletion. Bench-terracing changed the properties of the soil horizons, which enhanced runoff and soil erosion. The cumulative impact of water erosion and tillage-induced homogenization might account for the decline in soil integrity on terraces (Dorren *et al.,* 2004).

Conclusion

In summary, the influence of farming methods on soil erosion highlights the necessity of implementing environmentally friendly agricultural approaches to protect soil quality, maintain ecological systems, guarantee food security, and lessen the effects of environmental change. In order to enhance durability and long-term viability in the agricultural sector, controlling soil erosion necessitates a comprehensive strategy that incorporates scientific knowledge, policy interventions, and stakeholder participation. Soil well-being, farming profitability, and ecological sustainability are all negatively impacted by the extensive and pervasive effects of farming operations on soil erosion. The loss of soil rates are greatly accelerated by agricultural techniques such intense tillage, monoculture farming, and inadequate handling of land. The most nutritious layer, the topsoil, is lost, which lowers soil production, decreases the penetration of water capability, and weakens agrarian resilience to environmental stresses. Surface water becomes contaminated with debris, fertilizers, and agricultural compounds due to soil erosion, which also plays a role in deposition in water bodies. Runoff laden with silt can harm the aquatic environment, deteriorate the cleanliness of water, and raise the possibility of eutrophication and algal blooms, thereby endangering both mankind and marine life. It is critical to mitigate sedimentation brought on by agricultural activities in order to protect the sustainability of ecosystems, water purity, and the welfare of society. Prospective generations can benefit from ethical farming and we can lessen the negative impacts of sedimentation on aquatic ecosystems by implementing integrated watershed management approaches and encouraging care of environmental assets. Water treatment plants must incur higher operating expenses because sediment-laden water needs further purification procedures to comply with sanitary water regulations. Furthermore, sedimentation has the potential to jam irrigation lines, which would lower agricultural output and worsen food shortages. Incentives, educational offerings, and legal structures are all very important in encouraging ecological ways of managing land and increasing public understanding of the need of maintaining the integrity of water. To mitigate the effects of agricultural practices on sedimentation in water bodies, politicians, agrarian clients, experts, and the public at large have to cooperate with one another.

Conflict of Interest- None

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