Soil Management and Conservation: An Approach to Mitigate Soil Contamination

Dr. I. Jagga Rao[1*] and Mr. M. Jitendra[2]

[1]Teaching Associate, Dept. of Soil Science and Agricultural Chemistry
Polytechnic of Seed Technology, J.M. Puram, Gurazala (Md), Palnadu (Dt)-522415
ANGRAU, Lam, Guntur-522 034, A.P, India
[2]Assistant Professor, Dept. of Agronomy, KBR College of Agriculture,
C.S Puram-523112, Affiliated to ANGRAU, Lam, Guntur-522 034, A.P, India

Corresponding Author
Dr. I. Jagga Rao
Email: jaggaraoitrajula@gmail.com

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ABSTRACT

Soil Management and Conservation method as a powerful cure for soil contamination. Microbial activities play an important part in maintaining ecological balance; however, changes in land-use have a direct impact on soil biota, including floral and fauna components. The entry of contaminants into the soil from a variety of sources, including agrochemicals, petrochemicals, landfills, sludge, effluents, and so on, increases the amount of heavy metals in the deposits, deteriorating the soil and polluting the groundwater. Integrating soil management methods to increase biodiversity and reinforce microbial activities improves soil ecology, producing a buffer against harmful pollutants.

INTRODUCTION

Soil is a key component of the terrestrial ecosystem. Loss in the ecosystem represents soil degradation. The soil plays an important role in the health of an ecosystem; nevertheless, human over-exploitation of these ecosystems produces significant deterioration and contamination. Agriculture accounts for 36.5% of the world's land mass (FAOSTAT, 2008). Though human activities may be justified in order to provide greater benefit in other services referred to as development, the consistent degradation of this ecosystem and exposure to various contaminants is not in the best interests of society and is harmful to the environment that supports all life forms.

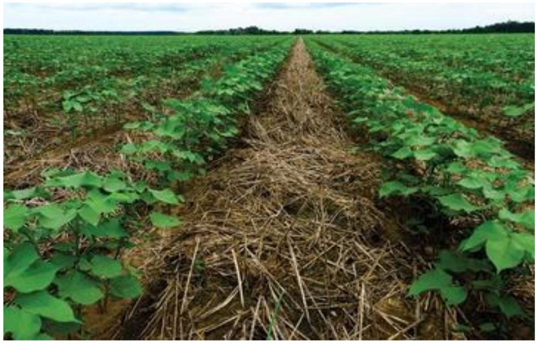
Soil conservation refers to a variety of farming methods and management measures used to reduce soil erosion by avoiding or decreasing soil particle dissociation and water and air flow. It also aids in reducing the loss of the topmost layer of soil and fertility, which can be caused by soil contamination. Understanding the mechanisms and causes that regulate soil erosion is critical for establishing effective control practices and managing soil erosion, ultimately leading to soil conservation.

Crop rotation, cover cropping, windbreak planting, and conservation tillage are examples of conservation practices and management strategies that have been used for millennia. Soil conservation practices are defined as farming operations and soil management strategies that try to reduce soil erosion by avoiding or minimizing soil particle dissociation and transport in air or water (Dabney *et al*., 2012). Soil conservation began with the goal of protecting an ecosystem from agricultural production by employing largely unproven technology that failed to respond to the natural needs of the land. The evolving land degradation trend could only be understood by examining whether the causes were due to natural occurrences or irresponsible use (Tanner, 2012).

1. Soil conservation methods

1.1 Cover cropping and mulching

This method is efficient in preventing topsoil migration by leaving a cover over the soil to reduce soil displacement caused by raindrop impacts on the soil particles. Cover crops and mulching also minimize runoff volume and velocity across the soil. Mulching is the application of organic materials to exposed soil to provide a type of covering over time before decomposition. Straw can be used as mulch, but hay has shown to be the best, and it is critical that it be harvested before the weeds mature. These crops are required to reduce erosion, particularly when the major crops planted do not provide enough residue for more traditional residue management-based erosion control (Keeling *et al*., 2009). Where there is appropriate precipitation, cover crops such as peas can help protect against wind erosion while also adding nitrogen to the soil. The nitrogen generated by these legumes' roots serves as an energy source for microbial metabolic activities, resulting in an active microbial population in the rhizosphere soil.

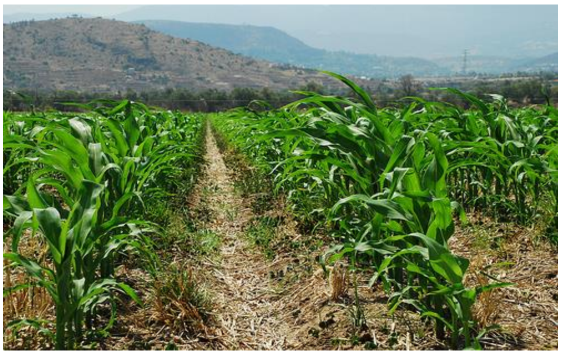


1.2 Crop rotation

Crop rotation is an indigenous and practical method for maintaining agro-ecosystem biodiversity that improves soil health while reducing pest and disease outbreaks (Barbieri *et al.*, 2019). This strategy allows farmers to improve soil structure, increase soil organic matter, and root depth. This occurs when secondary crops are cultivated to improve soil health. Root crops are especially damaging to soil structure because they cause considerable fracturing of soil aggregates during seedbed preparation and harvesting. Therefore, it is recommended that root crops be cultivated once every three years. Corn can be planted the next year after two years of silage, followed by three or more years of fodder. Leguminous crops (such as peas and chickpeas) used in crop rotation help to change soil functional microbial populations. Cover cropping or mulching, as well as zero tillage, should be introduced into the rotation. Crop rotations can improve conditions for the establishment of some soil functional microorganisms. This promotes rich biodiversity within the soil ecosystem since both shallow feeding crops and deep-rooted crops stimulate different species of microorganisms at the same time, resulting in a buildup of microbes with varying traits that colonize the soil. Thus, different crops can create diverse residues and root exudates that promote soil microbial variety and activity, increase soil microbial biomass, and improve C and N cycling (Gurr *et al*., 2016).

1.3 Conservation tillage

This strategy is intended to preserve soil aggregates, organic matter, and crop leftovers (Skaalsveen, 2019). Conservation tillage involves employing less harmful tillage instruments (for example, instead of a mouldboard plow, use a chisel plow), reducing tillage to one turn instead of two, and leaving crop residue on the soil surface to avoid erosion. Traditional agricultural operations are based on plowing and tilling land to prepare a seedbed. However, these practices have been shown to be highly harmful to soil, resulting in the degradation of 24% of worldwide agricultural land (Bai *et al*., 2008). Soil tillage is rapidly being replaced by a new method based on soil conservation and improvement. During conventional tillage, the soil is normally inverted to a depth of less than 20 cm using a mould board plow; however, with conservation tillage, the soil is not disturbed or just little disturbed (Morris *et al*., 2010). This conservation strategy has been found to improve soil structure, minimize soil erosion, improve drainage and water holding capacity, increase soil organic matter, and stimulate microbial and earthworm activity (Abdollahi and Munkholm, 2014).



1.4 Ridges, terraces and contours

The ridges are formed across the wind and consist of tall listed seed beds that are formed over the entire field or trap strips that are perpendicular to the direction of the prevailing wind. The construction of an earthen embankment along a common elevation contour results in an elevated terrace structure that can directly minimize wind erosion by reducing wind speed and intercepting soil particles. Indirect wind erosion control benefits of terraces and the related contour tillage and cropping practices expand overall crop grain and residue productivity by controlling runoff for increased water storage in the soil (Duncan and Burns, 2012). The

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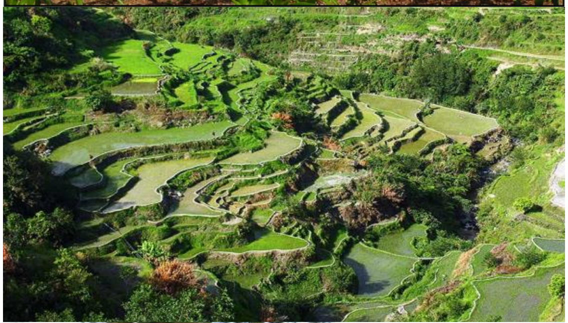
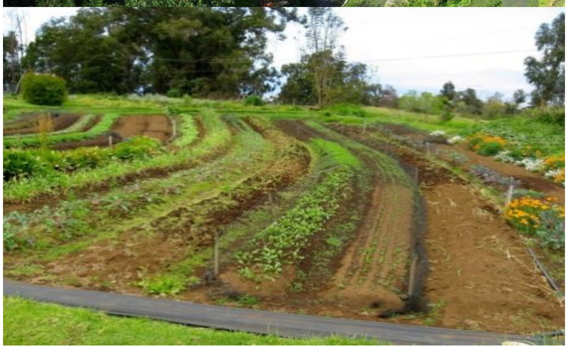
underlying layer of soil becomes relatively less disturbed by the action of erosion hence making room for an increased microbial population within the micro-climate.



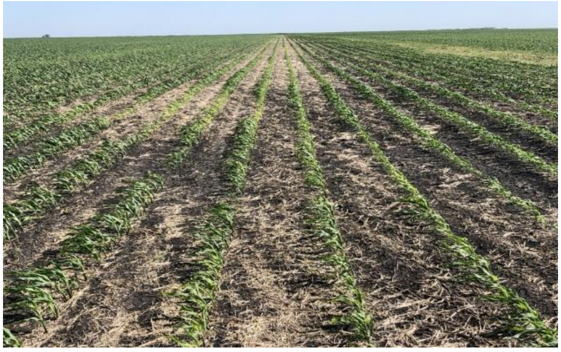


1.5 Strip cropping/planting windbreaks

This is another way to conserve soil and reduce wind erosion. A windbreak acts as a barrier to redirect the flow of air and reduce leeward wind speed (Brandle *et al.*, 2014). However, the availability of irrigation makes this conservation approach beneficial under tough conditions. Crops can be grown in strips perpendicular to the prevailing wind where field orientation is not limited to lower near surface wind speed (Woodruff *et al.*, 2017). This approach allows for a wide range of crop strip widths based on the crop's tolerance to soil erosion or potential to retain soil grains. The gradient of detachment encountered within different soil types is determined by the interplay between soil erosivity and erodibility potential. This emphasizes the usefulness of windbreaks/strip crops in banding soil particles together and reducing dislodgement.

1.6 Residue management

For the majority of crops and climates, this is the best way to control wind erosion. It consists of a variety of tillage practices that use crop residue as a surface cover to avoid soil erosion. Residue management also keeps mulches upright or flat to capture soil grains and trap their movement (Miner *et al*., 2013). Leaving prior crop residue on the soil's surface is helpful because it promotes soil water storage regardless of runoff control contours, increases rain infiltration, and reduces evaporation. The micro-climate here is ideally suited for microbial activity because there is a consistent retrieval of energy from the degrading biomass of residues, which leads to mineralization of organic compounds and breakdown of complex molecules.



CONCLUSION

Land management strategies in agroecosystems influence the structure and function of microbial communities via a variety of mechanisms. Land-use changes also affect soil microbial community structure by altering carbon availability and quality, pH, and nutrient availability. Because the ratio of fungal population to bacterial population is commonly measured as an indicator of microbial community structure, and no-till practices, crop rotations, and the use of cover crops increase the relative proportions of fungi, biological mechanisms regulate carbon and nitrogen exchanges between the land, water, and atmosphere. This demonstrates the relevance of soil management and conservation approaches in increasing microbial activity for soil ecological intensification and buffering the soil to neutralize pollutants. Microbial ecology is essential for assessing the terrestrial carbon cycle and preserving ecosystem equilibrium.

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