International Journal of Scientific Research & Engineering Trends
Volume 9, Issue 5, Sept-Oct-2023, ISSN (Online): 2395-566X

Soil Health and Agroecology: Techniques, Impacts on the Quality of Soil, and Carbon Segregation

Darshika Sharma, Zehra Husaini, Shayma Saifi
Department of Biosciences,
Shri Ram College, Muzaffarnagar

Abstract- Soil health is critical to sustainable agriculture, ecosystem stability, and climate change mitigation. Regenerative agriculture, which includes a variety of activities targeted at enhancing soil health, has the potential to reduce deterioration and increase output. This research looks at several regenerative farming approaches, their effects on soil quality, and their function in carbon sequestration. We focus on case studies of effective implementation, the mechanisms by which these practices improve soil health, and the broader implications for food security and environmental sustainability.

Index Terms- Agroecology, Carbon Segregation, Soil health, Regenerative Agriculture

I. INTRODUCTION

Agricultural practices have historically contributed to soil deterioration, resulting in lower production, reduced biodiversity, and higher greenhouse gas emissions.

Traditional farming practices sometimes prioritize immediate returns above long-term soil health, resulting in soil compaction, nutrient depletion, and erosion. In response, regenerative agriculture has arisen as a comprehensive strategy to restoring and improving soil health through a variety of sustainable approaches[1].

Understanding the relationship between these activities and soil quality is critical, especially in light of climate change, where carbon sequestration can help reduce atmospheric CO2 levels. This study aims to chronicle diverse regenerative farming approaches and assess their impact on soil quality and carbon storage [2].

II. REGENERATIVE AGRICULTURE TECHNIQUES

Regenerative agriculture encompasses a variety of approaches aimed at improving soil health. Here are some major techniques:

1. Cover Cropping
Cover crops, including legumes and grasses, are sown between primary crops to minimize soil erosion, control weeds, and enhance soil structure. They add organic matter to the soil and increase microbial activity, which is essential for nutrient cycling [3].

2. Reduced Tillage
Reducing or eliminating tillage reduces soil disturbance while maintaining soil structure and microbial integrity. This method improves water retention, reduces erosion, and boosts soil organic carbon levels [4].

3. Crop Rotation
Crop rotation is the process of alternating different types of crops within a given region over successive seasons. This method can boost soil fertility, disrupt pest and disease cycles, and increase overall biodiversity in the agroecosystem.

4. Agroforestry
Integrating trees into agricultural landscapes can benefit soil health by increasing organic matter inputs, improving water penetration, and increasing biodiversity [5]. Trees also contribute to carbon storage, making agroforestry a valuable tool in carbon sequestration initiatives.

5. Composting and Organic Amendments
Adding compost and organic matter to soil increases nutrients while improving soil structure and microbial dynamics [6]. This approach boosts soil organic carbon and enhances water retention while minimizing the demand for synthetic fertilizers.

III. EFFECTS ON SOIL QUALITY

Studies have demonstrated that regenerative agricultural approaches significantly increase soil quality [7].

1. Structure of Soil
Cover cropping and decreased tillage practices promote soil aggregation, resulting in better aeration and water infiltration.

Healthy soil structure promotes root growth and strengthens soil resilience to drought and flooding.

2. Nutrient Required

Regenerative practices, particularly the use of cover crops and compost, improve the nutrient content of soil [8]. Leguminous cover crops fix nitrogen from the atmosphere, while compost boosts the availability of key nutrients, lowering the need for synthetic fertilizers and encouraging healthier crop growth.

3. Microbial Diversity

Improved soil health promotes a diversified microbial community, which is necessary for the cycling of nutrients and disease suppression. Regenerative methods generate and providing a conducive environment for beneficial bacteria improves overall soil resilience.

IV. CARBON SEGREGATION

One of the most significant advantages of regenerative farming is its potential for carbon sequestration [9]. Healthy soils may store a considerable amount of carbon, helping to mitigate the effects of climate change. Soil organic matter is a significant carbon sink, and measures such as cover cropping and minimal tillage aid in its accumulation. As organic matter decomposes, it produces stable organic molecules that store carbon over time.

1. Case Study

Numerous case studies worldwide demonstrate the effectiveness of regenerative agriculture in improving soil health and carbon sequestration. Farmers in the Midwest region of the United States, for example, have reported considerable increases in organic matter in the soil levels after implementing cover cropping and reduced tillage practices.

V. CONCLUSION

Regenerative agriculture is a potential alternatives for improving soil health and increasing carbon sequestration. Farmers can increase soil structure, nutrient availability, and microbial diversity by using methods like cover cropping, decreased tillage, crop rotation, agroforestry, and the application of organic amendments. The advantages go beyond soil health, helping to boost agricultural output, biodiversity, and environmental mitigation. Future study should concentrate on measuring the long-term advantages of regenerative farming and determining its scalability across other agricultural systems.

REFERENCES

1. Baruah, R. (2024). Restoring Soil Health of Degraded Lands Through Eco-Friendly Nutrient Management Practices in Regenerative Agriculture. In Regenerative Agriculture for Sustainable Food Systems (pp. 237-269). Singapore: Springer Nature Singapore.
2. Biswas, S., Singh, S., & Bera, A. (2024). Regenerative Nutrient Management Practices for Enhancing Plant Nutrition and Soil Health. In Regenerative Agriculture for Sustainable Food Systems (pp. 303-339). Singapore: Springer Nature Singapore.
3. Daverkosen, L., & Holzknecht, A. (2021). Relating the impacts of regenerative farming practices to soil health and carbon sequestration on Gotland, Sweden.
4. Khangura, R., Ferris, D., Wagg, C., & Bowyer, J. (2023). Regenerative agriculture—A literature review on the practices and mechanisms used to improve soil health. Sustainability, 15(3), 2338.
5. McCauley, K., & Barlow, K. (2023). Regenerative agriculture: increasing plant diversity and soil carbon sequestration on agricultural landscapes. SURG Journal, 15(1).
6. Schreefel, L., Schulte, R. P., De Boer, I. J. M., Schrijver, A. P., & Van Zanten, H. H. E. (2020). Regenerative agriculture–the soil is the base. Global Food Security, 26, 100404.
7. Sher, A., Li, H., Hamid, Y., Nasir, B., & Zhang, J. (2024). Importance of regenerative agriculture: climate, soil health, biodiversity and its socioecological impact. Discover Sustainability, 5(1), 1-23.
8. Tan, S. S., & Kuebbing, S. E. (2023). A synthesis of the effect of regenerative agriculture on soil carbon sequestration in Southeast Asian croplands. Agriculture, Ecosystems & Environment, 349, 108450.
9. Vamshi, M., Jagadeesan, R., Lamani, H. D., Rout, S., VijayKumar, R., Jagadesh, M., & Sachan, K. (2024). The Revolutionary Impact of Regenerative Agriculture on Ecosystem Restoration and Land Vitality: A Review. Journal of Geography, Environment and Earth Science International, 28(4), 1-14.