ENHANCING SOIL RECLAMATION FOR SUSTAINABLE AGRICULTURE: THE ROLE OF ORGANIC AMENDMENTS

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***Abstract*- Soil reclamation is a vital practice in sustainable agriculture and land management, aimed at restoring deteriorated or contaminated soils to a usable condition. This article explores the importance of soil reclamation and its challenges, with a particular focus on the role of organic amendments in enhancing soil properties and productivity. Various definitions of soil reclamation are discussed, highlighting its goal of restoring soil to a state suitable for specific uses, while also ensuring long-term sustainability. Furthermore, the article examines a wide range of organic amendments available for soil reclamation, sourced from agriculture, forestry and urban waste streams. These organic materials not only aid in sustainable waste management but also improve soil fertility, making them invaluable in restoring damaged or degraded lands.**

The effects of organic amendments on soil properties, such as increased organic matter content and enhanced microbial activity, are discussed in detail. The use of biofertilizers as a specific form of organic amendment is highlighted for their role in promoting nutrient availability to plants and reducing the reliance on chemical fertilizers.

***Keywords*:Soil reclamation, Organic amendments, Sustainable agriculture, Soil restoration, Environmental conservation**

INTRODUCTION

In order to restore deteriorated or contaminated soil to a usable condition for productive use, soil reclamation is a crucial activity in sustainable agriculture and land management. In this chapter, we look at how soil restoration can increase agricultural output by strengthening soil physical features and their associated benefits. Knowing what soil reclamation is, where it comes from and why it's important will help you design more efficient techniques for doing it.

Soil reclamation, sometimes referred to as soil remediation or rehabilitation, entails a variety of approaches and treatments to slow down soil deterioration and improve its fertility, structure and health. It is essential in restoring soil ecosystems and ensuring they can continue to foster robust plant development and responsible farming practices.

Soil reclamation is a long-standing solution to the soil degradation brought on by human activities such unsustainable farming, tree cutting, industrialization and pollution. Several methods of soil reclamation have emerged in response to the pressing need to improve agricultural output by revitalizing unhealthy soils.

The growth, quantity and quality of crops are all dependent on the soil's health and fertility. Soil reclamation immediately improves soil physical qualities, such as texture, structure, water retention capacity and nutrient availability, all of which are crucial to plant growth and productivity.

Soil reclamation, in which the soil's physical qualities are restored, has many advantages. These include an improved ability to hold water and nutrients, deeper root penetration and more active soil microbes. Better plant growth and agricultural output are the results of these enhancements' effects on soil aeration, water infiltration and nutrient availability.

While critically important, reclaiming degraded soil is not without its difficulties. Soil types, weather patterns and the level of soil deterioration can all affect how effective restoration initiatives are. A comprehensive knowledge of soil physical qualities and the mechanisms by which particular treatments, such as organic amendments, can improve soil health is essential for implementing efficient reclamation techniques **(Rahman, et. al., 2020).**

Sustainable options for soil reclamation have emerged in the form of organic treatments, including organic supplements like compost, animal manure, green manure and biochar. These amendments can boost the soil's health and productivity by enhancing its physical qualities, structure, nutrient availability and microbial activity.

With a focus on the function of organic treatments in enhancing soil physical qualities, this chapter seeks to provide a thorough grasp of soil reclamation and its significance in agricultural productivity. This study helps to sustainable agriculture and environmental conservation by examining the mechanisms by which organic additions improve soil health and addressing the issues associated with soil reclamation.

OBJECTIVE OF THE STUDY

- To investigate the role of organic amendments in soil reclamation and their impact on enhancing soil properties and agricultural productivity**.**

SOIL RECLAMATION AND ITS IMPORTANCE

Restoring deteriorated or contaminated soil to a usable condition for a wide range of purposes, including agriculture, is the primary goal of soil reclamation, a basic practice in sustainable land management. It's crucial for preventing further soil deterioration, maintaining agricultural productivity and protecting natural resources. The importance of soil reclamation in reviving soil ecosystems and increasing agricultural output is discussed in this chapter. Soil reclamation is a multidimensional subject and by carefully examining definitions supplied by many authors, we can acquire a better grasp of its significance for sustainable land use.

Definition of Soil Reclamation

1. In the words of the Soil Science Society of America, "Soil reclamation is the process of restoring a degraded soil to a condition that is suitable for a specific use."

This concept highlights the idea that the goal of soil reclamation is to return deteriorated soils to a usable condition. This could be for agricultural, forestry, or some other use. The purpose is to restore the damaged soil to a state that is consistent with the target.

2. United States Department of Agriculture: "Soil reclamation is the process of restoring a degraded soil to a condition that is productive and sustainable."

Productivity and long-term viability are two major concerns. Soil reclamation aims to restore the soil's ability to produce while also making sure that the rehabilitated soil will be able to do so indefinitely and without further degrading.

3. An explanation of soil reclamation is provided by the International Union of Soil Sciences: "Soil reclamation is the process of restoring a degraded soil to a condition that is similar to its original condition."

This definition emphasizes the need of restoring soil to a condition as close as possible to its natural, undisturbed form. The goal is to bring back the soil's original composition and balance, which may have been disturbed by human activity.

4. "The process of returning land to a productive state after it has been disturbed by human activity," to quote the United Nations Environment Programme.

This concept expands the field to include not only soil reclamation but also the restoration of land. Human activity is singled out as the root cause of land degradation and efforts to restore the land's productivity are prioritized.

5. World Bank: "The process of restoring degraded land to a condition that is suitable for plant growth and other beneficial uses."

This concept emphasizes the multiple character of soil reclamation by noting that restoration efforts should allow for not only plant growth but also other beneficial uses, which may have ecological, social, or economic implications.

6. According to the EPA, soil restoration is "the process of improving the physical, chemical and biological properties of soil that has been damaged by human activities."

By encompassing the physical, chemical and biological aspects of soil health, this definition highlights the all-encompassing character of soil reclamation. Human actions have caused damage and efforts are being made to reverse that damage through various interventions.

7. As defined by the International Soil Reference and Information Centre, "the process of returning a degraded or disturbed soil to a condition that is similar to its original condition."

This definition emphasizes the importance of returning the soil to its natural and sustainable state, which is consistent with the idea of restoring the soil to a state comparable to its undisturbed condition.

8. National Research Council: "The process of making land suitable for a specific use, such as agriculture, forestry, or recreation."

This concept emphasizes the flexible character of soil reclamation, which allows the restoration process to be adapted to meet the needs of a wide variety of end uses, including agriculture, forestry and recreation.

9. As defined by the United Nations' Food and Agriculture Organization, "the process of restoring the productivity and sustainability of degraded land."

As such, it is crucial that the reclaimed land be capable of supporting productive usage in the long run without further degradation if its productivity and sustainability are to be restored.

10. As defined by the Natural Resources Conservation Service, "the process of managing land to improve its long-term health and productivity."

This definition implies a long-term, sustainable strategy to soil reclamation since it goes beyond simple restoration to encompass continuous land management activities that protect and enhance the land's health and productivity.

11. Soil rehabilitation, as defined by the American Society of Agronomy, "restores water infiltration, nutrient cycling and erosion control."

Restoring the soil's capacity to absorb and retain water, cycle nutrients and prevent erosion are all examples of the ecosystem services that are at the heart of this term. The idea is to bring back these key services to promote sustainable land use.

12. The Nature Conservancy: "The process of making land suitable for human use while minimizing negative environmental impacts."

This definition emphasizes the necessity for sustainable practices that take into account both human needs and environmental protection. In order to address the needs of human land use, soil reclamation should be done with the least amount of environmental damage.

13. The Soil Association defines sustainable land management as "the process of creating a more sustainable future for our planet by restoring degraded land."

This concept places greater emphasis on soil reclamation's broader implications, painting it as a preventative step to create a sustainable future by rehabilitating deteriorated land and protecting scarce natural resources.

In conclusion, the principles of soil reclamation, as reaffirmed by these new definitions, are as follows: restoration must be adapted to individual land use objectives; productivity and sustainability must be restored; long-term land management must be taken into account; and natural soil functions must be restored. In addition, they stress the significance of recognizing soil restoration as an active step toward a more sustainable future, one that must take into account both human needs and environmental conservation.Collectively, these criteria stress that soil reclamation is all about bringing once-degraded soils back to a state where they may once again be productive, sustainable and environmentally balanced. Restoring soil health entails a variety of actions to undo the effects of human activity and restore it to a condition that is either conducive to the achievement of targeted land-use goals or to a more natural state.

CHALLENGES IN SOIL RECLAMATION

In order to successfully recover degraded soils, soil reclamation is a difficult process including a number of obstacles. These difficulties may differ based on the nature of the degraded land and the surrounding ecosystem. Some typical difficulties encountered during soil reclamation include:

1. The severity of soil deterioration varies greatly; it might range from moderate to severe soil degradation. Restoring highly degraded soils can be difficult and time-consuming because of the possible loss of vital nutrients, organic matter and soil structure.
2. Degraded soils may include heavy metals, industrial chemicals, pesticides and other pollutants due to contamination. Human health, plant growth and ecological stability can all be jeopardized by contaminants that hang around in the soil for a long time. Soil contamination remediation calls both specific methods and the cautious management of toxic materials.
3. Degraded soils typically have lower organic matter content as a result of erosion and poor land management. Soil fertility, water retention and nutrient cycling are all negatively affected by low organic matter concentration. It may take some time for organic amendments like compost and manure to fully restore organic matter after being added to a soil.
4. Soil deterioration can cause nutritional imbalances, which manifest as either an abundance of one nutrient or a lack of another. To revive soil productivity and promote robust plant growth, nutrient imbalances must be corrected. To solve nutrient problems successfully, soil testing and careful nutrient management are required.
5. soil compaction is a widespread issue in degraded soils, especially those that have been compacted by the use of heavy machinery or by the weight of many people walking on them. Water infiltration and root penetration are both impeded by the lack of pore space in compacted soils. Soil aeration and root growth can be enhanced by breaking up compacted layers through deep plowing or subsoiling.
6. Soil reclamation relies heavily on water, thus it's important to know how to manage that water. Soils that have been reclaimed should be able to both retain water and drain it away effectively. Planning and implementing suitable drainage systems and irrigation practices are essential for resolving waterlogging and drought-prone environments.
7. Soil restoration can be expensive because of the time and materials needed to complete the project. Particularly difficult is the availability of resources for small-scale farmers and communities with low financial capabilities.
8. Long-Term Viability: It is crucial to ensure the long-term viability of recovered soils. Maintaining the advances brought about by reclamation initiatives requires constant monitoring, adaptive management and the use of sustainable land management methods.
9. Changing weather patterns, higher temperatures and shifts in precipitation are just a few ways in which climate change might affect efforts to rehabilitate degraded soil. Because of this, soil moisture, nutrient availability and crop viability may all be impacted.

10. Public education and involvement are crucial to the success of any soil reclamation operation. In order to secure community buy-in and ensure long-term commitment, it is essential to raise knowledge about the importance of soil reclamation and its advantages.
11. Soil reclamation's success can only be judged and its progress monitored. Indicators must be defined, data must be collected and the efficacy of reclamation efforts must be evaluated, all of which can be difficult tasks.
12. In locations where property rights are uncertain or in dispute, land tenure and ownership difficulties might hinder soil restoration initiatives. Sustainable land usage and investment in reclamation programs require definite land tenure systems.
13. Soil restoration calls for policy and institutional backing on a variety of scales, from the neighborhood to the nation. Soil reclamation efforts can't be successful without strong leadership and cooperation from a variety of parties.

Soil reclamation is a complex and multifaceted problem that calls for a multifaceted and integrated strategy that incorporates scientific knowledge, community involvement, financial backing and good land management techniques. Unlocking the potential of soil reclamation for sustainable agriculture and environmental conservation would require concerted efforts from governments, NGOs, researchers and local communities **(Ukhurebor, et. al., 2022).**

ORGANIC AMENDMENTS AVAILABLE FOR SOIL RECLAMATION

Agriculture, forestry and urban areas are only few of the many potential origins of the organic supplements utilized in soil reclamation. Livestock manure from a variety of animals (cattle, hogs, poultry) is the most common type of agricultural waste (fresh, composted, solid fractions from anaerobic digesters). Crop leftovers (such as straw and bean stalks) and spent mushroom compost are two further examples of agriculturally generated amendments. Wood chips, shavings and deinking sludges are only some of the organic amendments that can be found in a forest. Forest and lumber residuals were traditionally burned in beehive or silo burners, resulting in wood ash. As a result, there is now rawer product accessible for land application as a result of the elimination of this technique in Canada due to air quality concerns (**Charmley et al., 2006**)

Biosolids (also known as sewage sludge or municipal sludge) from wastewater treatment plants and the biodegradable portion of municipal solid waste (MSW) resulting from municipal, commercial, institutional, or recreational activities, such as food and kitchen waste, leaf and yard waste and paper, are examples of organic amendments from urban waste streams **(Cogger et al., 2006**). Organic by-products for land application are produced by the food processing sector (vegetables, cereals, meat, fish) but are currently underutilized in reclamation (**Charmley et al., 2006**)

The chemical, physical and biological properties of agricultural and forest byproducts were described by **Edwards and Someshwar (2000).** Most organic amendments produced in metropolitan areas (biosolids, food industry by-products) have historically been disposed of in landfills. The shortage of landfill space, however, has become an environmental and social issue in many cities, thus many of these materials are now land applied instead. About 60% of biosolids produced in North America are recycled through land application, according to research by **Cogger et al. (2006**). Metro Vancouver spread biosolids with a dry weight of 15,000 tons over British Columbia in 2005 (**Wallace et al., 2009**). Fertilization of damaged rangelands and pastures, primarily in the semiarid southern interior of the province, accounted for 10%, while mine reclamation accounted for 78%.

Soil remediation is aided by organic amendments from a variety of industries, such as agriculture, forestry and urban waste streams (**Charmley et al., 2006**; **Cogger et al., 2006**; **Edwards and Someshwar, 2000**; **Wallace et al., 2009**). Utilizing these organic resources not only helps in sustainable waste management but also enhances soil fertility and aids successful land restoration initiatives, especially in areas damaged by degradation or mining activities.

ORGANIC AMENDMENT EFFECTS ON SOIL PROPERTIES

Soil qualities are affected in numerous ways, both directly and indirectly, by organic amendments. The organic additions' intrinsic features have direct effects, while their influence on soil physical, biological and chemical properties has indirect consequences. The use of biosolids in the reclamation of mine spoils is a great illustration of the effectiveness of organic amendments for this purpose, as three interrelated components all work together to achieve the desired results. First, unlike readily available inorganic forms of nitrogen, the nitrogen in biosolids is in a slow-release organic form, lowering the danger of leaching or runoff. The high organic carbon content of biosolids provides a quick source of energy, which in turn increases microbial activity in the soil. The loss of topsoil and soil compaction are two of the main causes of poor soil physical characteristics and adding organic matter is one way to improve the situation.

One of the most crucial soil properties, organic matter is essential to soil quality and function (**Gregorich et al., 1994**). Soil organic carbon levels rise almost immediately after applying organic amendments and the rise is often proportionate to the amount of carbon added (**Chantigny et al., 1999**). Changes in soil organic carbon after low or moderate application rates may not be easily measured or identifiable in soils with high background levels of organic carbon or considerable variability (**Viaud et al., 2011**). The intrinsic quality of organic amendments determines both their breakdown rate and the soil's ability to retain organic carbon over time (**Lashermes et al., 2009**). These amendments contain organic carbon that was previously produced by plants during photosynthesis. Organic additions can range widely in chemical and physical properties, depending on the source vegetation (trees vs. annual crops, for example). In addition, the qualities of the organic additions are affected by the subsequent fate and modification of plant carbon after harvest. Cereal straw, for instance, can be land-applied in either its fresh or decomposed state after being worked into the soil or used as a component of manure. Long-term gains in soil organic matter can be larger with composted plant materials than with fresh plant materials because of the way composting alters the characteristics of labile carbon forms **(Lashermes et al., 2009).**

In sum, organic additions have a profound effect on soil qualities via multiple channels. The organic matter content of soil is increased, which is important for soil health. Soil organic carbon retention over the long term is affected by the decomposition and transformation of organic additions. In order to make educated decisions concerning soil reclamation and restoration procedures, an understanding of these consequences is crucial.

USE OF ORGANIC AMENDMENTS IN SOIL RECLAMATION

Soil reclamation resilience, as defined by **Hobbs (1999**), is an ecosystem's capacity to bounce back or "snap back" after being disrupted (**Cooke and Johnson, 2002**). Resilience in ecological restoration can be as basic as allowing land to recover through primary succession after a disturbance. Nature may restore itself through natural succession, as stressed by **Bradshaw (1997)**, resulting in healthy soils. However, extreme conditions such as soil physical restrictions, nutrient deprivation and toxicity can hinder plant growth in disturbed soils, resulting in a lengthened natural succession.

If natural recovery is expected to be too slow, organic amendments can be used to speed up the process and increase the resilience of degraded or disturbed soils. The harsh conditions that these supplements assist plants overcome are detrimental to their growth and output. For instance, agricultural, oil and gas, mining and forestry activities can all lead to soil degradation.

Soil productivity can be negatively impacted by erosion (**Eck, 1987**; **Tanaka and Aase, 1989**; **Larney et al., 1995a**), hence topsoil removal studies are routinely conducted in degraded agricultural areas. The mechanical removal of progressively deeper layers of topsoil began in 1990 as part of a series of soil productivity studies in Alberta. Soil productivity was restored with a single application of nitrogen and phosphorus fertilizer, 5 centimeters of topsoil, or 75 milligrams per square meter (wet weight) of feedlot manure after the topsoil was removed (**Larney et al., 1995a**).

The research showed that organic additions, notably manure, significantly increased crop yields on previously degraded soils. **Larney et al. (2009)** found that after 16 years of monitoring, manure was more effective at restoring production than topsoil or fertilizer. Manure applied at a low rate (75 Mg ha—1 wet wt.) at the start of the trial led to substantial yield responses 16 years later. Because more root mass and straw residue were returned to the soil, the beneficial effect of manure continued long after the initial nutrient addition response had subsided.In conclusion, organic additions are an effective way to boost degraded soils' resilience, speeding up the reclamation process and encouraging long-term land regeneration.

CONCLUSION

In conclusion, land degradation causes problems including soil erosion, pollution and biodiversity loss, but these problems can be rectified through soil reclamation and restoration. Soil fertility, structure and biological activity can all be enhanced through these efforts and organic amendments play a crucial role by doing so in a way that is both environmentally benign and sustainable.

Organic additives play a crucial part in rehabilitating soil. They raise the level of organic matter in soil, which benefits the soil's health and productivity. Since organic nitrogen is released gradually, it causes less pollution through leaching and runoff. Soil with a high organic carbon content provides microorganisms with a ready source of energy, increasing their activity and the soil's ability to recycle nutrients. Additionally, organic amendments boost crop productivity and effectively recover deteriorated soils, particularly in eroded agricultural settings.

Biofertilizers, a specific form of organic amendment, bring helpful bacteria to the soil, boosting nutrient availability to plants and stimulating crop growth. Biofertilizers aid in environmental sustainability and pollution prevention by decreasing the need of chemical fertilizers.

Soil reclamation that makes use of organic, inorganic and biofertilizers has also been found to be effective. Using all of these amendments together boosts crop output and improves soil health.

Successful soil reclamation requires knowledge of the site's unique requirements and the application of appropriate organic amendments. Restoring natural production and overcoming specific constraints at various sites may need individualized strategies.

Although organic modifications have shown great promise, they are not a panacea for every problem. To avoid overburdening the soil and generating unforeseen results, careful thought must be given to the types and quantities of amendments applied.

Furthermore, constant improvement of soil reclamation procedures and identification of the most effective combinations of organic amendments for different soil types and environmental conditions require ongoing research and monitoring. Soil can be effectively reclaimed and restored with the help of organic additions like biofertilizers and the combined application of organic, inorganic and biofertilizers. They aid in sustainable agriculture, biodiversity preservation and environmental defense by improving soil health, fertility and resilience. Organic additions have played and will continue to play a crucial part in nourishing Earth's soil and assuring a greener and more sustainable future, especially with careful application and ongoing study.

REFERENCES:

1. Bardgett, R. D., Lovell, R. D., Hobbs, P. J., & Jarvis, S. C. (1999). Seasonal changes in soil microbial communities along a fertility gradient of temperate grasslands. *Soil Biology and Biochemistry*, *31*(7), 1021-1030.
2. Bradshaw, A. (1997). Restoration of mined lands—using natural processes. *Ecological engineering*, *8*(4), 255-269.
3. Chantigny, M. H., Angers, D. A., Prévost, D., Simard, R. R., &Chalifour, F. P. (1999). Dynamics of soluble organic C and C mineralization in cultivated soils with varying N fertilization. *Soil Biology and Biochemistry*, *31*(4), 543-550.
4. Charmley, E., Nelson, D., &Zvomuya, F. (2006). Nutrient cycling in the vegetable processing industry: utilization of potato by-products. *Canadian Journal of Soil Science*, *86*(4), 621-629.
5. Cogger, C. G., Forge, T. A., &Neilsen, G. H. (2006). Biosolids recycling: Nitrogen management and soil ecology. *Canadian Journal of Soil Science*, *86*(4), 613-620.
6. Cooke, J. A., & Johnson, M. S. (2002). Ecological restoration of land with particular reference to the mining of metals and industrial minerals: A review of theory and practice. *Environmental Reviews*, *10*(1), 41-71.
7. Eck, H. V. (1987). Characteristics of Exposed Subsoil—At Exposure and 23 Years Later 1. *Agronomy Journal*, *79*(6), 1067-1073.
8. Edwards, J. H., &Someshwar, A. V. (2000). Chemical, physical and biological characteristics of agricultural and forest by-products for land application. *Land application of agricultural, industrial and municipal by-products*, *6*, 1-62.
9. Gregorich, E. G., Carter, M. R., Angers, D. A., Monreal, C., &Ellert, B. H. (1994). Towards a minimum data set to assess soil organic matter quality in agricultural soils. *Canadian journal of soil science*, *74*(4), 367-385.
10. Larney, F. J., Izaurralde, R. C., Jansen, H. H., Olson, B. M., Solberg, E. D., Lindwall, C. W., &Nyborg, M. (1995). Soil erosion—crop productivity relationships for six Alberta soils. *Journal of soil and water conservation*, *50*(1), 87-91.
11. Larney, F. J., Janzen, H. H., Olson, B. M., & Olson, A. F. (2009). Erosion–productivity–soil amendment relationships for wheat over 16 years. *Soil and Tillage Research*, *103*(1), 73-83.
12. Lashermes, G., Nicolardot, B., Parnaudeau, V., Thuriès, L., Chaussod, R., Guillotin, M. L., ... &Houot, S. (2009). Indicator of potential residual carbon in soils after exogenous organic matter application. *European Journal of Soil Science*, *60*(2), 297-310.
13. Pennock, D., Bedard-Haughn, A., &Viaud, V. (2011). Chernozemic soils of Canada: genesis, distribution and classification. *Canadian Journal of Soil Science*, *91*(5), 719-747.
14. Rahman, G. M., Rahman, M. M., Alam, M. S., Kamal, M. Z., Mashuk, H. A., Datta, R., & Meena, R. S. (2020). Biochar and organic amendments for sustainable soil carbon and soil health. *Carbon and nitrogen cycling in soil*, 45-85.
15. Tanaka, D. L., & Aase, J. K. (1989). Influence of topsoil removal and fertilizer application on spring wheat yields. *Soil Science Society of America Journal*, *53*(1), 228-232.
16. Ukhurebor, K. E., Aigbe, U. O., Onyancha, R. B., Ndunagu, J. N., Osibote, O. A., Emegha, J. O., ... &Darmokoesoemo, H. (2022). An Overview of the Emergence and Challenges of Land Reclamation: Issues and Prospect. *Applied and Environmental Soil Science*, *2022*, 1-14.
17. Wallace, D. F. (2009). *This is water: Some thoughts, delivered on a significant occasion, about living a compassionate life*. Hachette UK.