

Role of Organic Farming on Soil Health

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Abstract

Soil health is the foundation of diverse ecosystems, fostering life through a complex network of organisms, organic matter, minerals, and water. It sustains crops, forests, and habitats while also impacting air and water quality, climate regulation, and resilience against global challenges like climate change. Protecting soil health is crucial for the planet's sustainability, influencing ecosystems and securing a resilient future for generations to come. Organic farming stands as a sustainable agricultural approach that emphasizes the significance of soil health in nurturing crops and preserving ecosystems. By eschewing synthetic chemicals and employing natural techniques like crop rotation, composting, and biological pest control, organic farming prioritizes soil vitality. It encourages the nurturing of rich, biodiverse soil ecosystems teeming with beneficial microbes, earthworms, and other organisms crucial for soil structure and fertility. This practice fosters a healthier soil structure, increasing its water retention capacity and promoting better nutrient absorption by plants. Moreover, organic farming techniques minimize soil erosion, enhance carbon sequestration, and reduce pollution, contributing to the overall improvement and preservation of soil health for long-term agricultural sustainability.

Introduction

The main economic activity of agriculture is the production of various kinds of crops, fruits, flowers, vegetables, and cattle Rani *et al.* (2023). Soils are a non-renewable resource on which 95% of our food supply depends. Short-sighted chemical fertilizer applications in industrial farming are depleting soils at an alarming rate. Pesticide residues from agricultural intensification are also causing increasing soil contamination which is also an issue of increasing concern because of their toxicity to non-target species. Unsustainable agricultural practices are also a major cause of desertification, a global problem directly affecting over 250 million people and a third of the earth's land surface. It is especially concentrated in developing countries, and leads to food insecurity,

climate change, poverty, and human displacement. Soil, a diverse ecosystem with billions of microorganisms, supports fertility and nutrient cycling. Despite holding twice, the carbon of the atmosphere, a third of global land faces severe degradation, losing 24bn tonnes yearly, impacting farming and leading to EU farmland crises. Shifting towards sustainable land management involves embracing holistic approaches like organic farming, agroecology, and safeguarding natural ecosystems like peatlands and forests. Preserving our soils stands as a pivotal measure in mitigating and adapting to the ongoing climate crisis (IFOAM, 2023). Healthy soil is vital for robust plant growth, thriving within a microorganism-rich ecosystem. Organic farming promotes soil health by favoring compost over synthetic fertilizers, preserving soil vitality and plant well-being. Natural fertilizers deter diseases, contrasting with pesticides/herbicides that disturb soil-crop microorganism interactions. Organic methods, including crop rotation, enrich the soil, aid water retention, and curb erosion. Soil's organic content aids air circulation and water absorption, while low levels lead to erosion and hinder nutrient release. Organic soil management, involving cover crops, mulching, and reduced tillage, helps maintain and enhance organic matter, supplying essential nitrogen, phosphorus, and sulfur for plant nourishment. Adherence to these practices boosts organic matter levels, seen in higher content in organically managed soils compared to conventional ones.

Four key practices emerged as being the most critical for impacting soil health, including:

- ✓ Cover crops
- ✓ Rotation diversity and length
- ✓ Organic amendments
- ✓ Tillage

Cover Crops

Cover crops are plants that are grown to benefit the soil rather than harvest income. They provide protection from soil erosion, nutrient losses,

along with many other agroecosystem benefits. In organic systems, they can be used for weed suppression and are often a critical source of nutrients for cash crops through nitrogen fixation and green manure. Numerous studies highlight cover crops' positive impact on overall soil health, yet limited research directly compares their effects in organic systems. Despite this lack of data obscuring potential trends, it's evident that roll-killed cover crops demonstrate superior weed suppression compared to disking. Further research should delve into the influence of cover crop species, termination methods, and combinations of soil amendments on soil health outcomes. Additionally, understanding the timing of nitrogen release during cover crop decomposition is crucial to prevent either premature nutrient leaching or delayed availability causing nitrogen deficiency stress.

Organic amendments

The use of synthetic nutrients is banned on organic farms, so organic farmers must rely on naturally-occurring fertilizers such as compost and manure for enhancing nutrient content in soils. The use of organic amendments has been shown to increase soil carbon sequestration, which may help to mitigate climate change by locking away carbon that could otherwise act as a greenhouse gas in the atmosphere. However, organic soil amendments can vary dramatically in nutrient content, carbon to nitrogen ratios, and timing of nutrient release, which has led to variability in the impacts of organic soil amendments on soil health.

The variability in organic amendment type and treatment also makes it difficult to compare studies, but this project was able to uncover some general themes. Specifically, combining different organic amendments (such as vermicomposts in combination with manure) is better for soil health than using one type of organic fertilizer alone. Future research should focus on specific regional effects of fertilizer types and rates, and how timing of nutrient release can be synchronized with crop need.

Rotation diversity and length

Crop rotations, the sequence of crops grown on the same land in succession — are a critical component

of maintaining healthy soils. They break pest and weed cycles, help cycle nutrients, and reduce economic risks associated with single cropping strategies. Organic farms tend to have longer crop rotations than their conventional counterparts, which leads to higher on-farm diversity. This study found that most research on crop rotations focuses on the effect of rotation length, rotation complexity and grain versus forage rotations. Diversity in rotations was key to enhancing soil health, especially when it comes to including perennials, such as alfalfa, into the systems to improve soil health indicators including soil carbon, nitrogen and aggregate stability.

Tillage

Tillage serves as a weed control method in some organic farming practices, yet excessive tillage can harm soil structure and result in soil organic carbon depletion. However, there's a growing interest in organic approaches that minimize tillage. Studies in organic systems demonstrate that reducing tillage can enhance soil carbon levels, although the varied definitions of "reduced tillage" pose challenges in identifying broader trends. While organic no-till methods may decrease yields, future research should focus on minimizing tillage without compromising yield. Additionally, shallow non-inversion tillage methods like "vertical tillage" or "strip-tillage" could potentially optimize both yields and soil carbon storage. Further research comparing various tillage methods, spanning from chisel ploughing to shallow inversion tillage, would aid in developing strategies that promote multiple aspects of soil health without hampering crop yields on organic farms.

Conclusion

Healthy soils are imperative in meeting the population's food needs, and organic farming stands as a sustainable approach that prioritizes soil and environmental health while ensuring crop yields and profitability for farmers. Studies indicate that certain farming practices, like growing cover crops, sequester greenhouse gases in the soil, preventing their release into the atmosphere and thereby mitigating contributions to climate change. This symbiotic relationship between organic methods, soil health, and environmental conservation highlights the pivotal role

of sustainable agriculture in securing both food security and environmental stability.

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