

Impact of Organic Farming on Soil Health and Organic Farming as A Tool For Climate Change Mitigation

Jyoti Nagar

Research Scholar

Dept of Commerce and Management (EAFM)

Jayoti Vidyapeeth Women's University, Jaipur

Abstract:

Organic farming has emerged as a sustainable agricultural approach that addresses both environmental degradation and the growing challenges of climate change. This study examines the impact of organic farming on soil health and evaluates its potential as a climate change mitigation strategy. Organic farming practices, including the use of compost, green manure, crop rotation, biological pest control, and reduced dependence on synthetic fertilizers and pesticides, contribute significantly to improving soil physical, chemical, and biological properties. Enhanced soil organic matter, increased microbial activity, improved nutrient cycling, and better water retention are among the key benefits associated with organically managed soils. The study highlights how healthy soils act as carbon sinks, thereby helping to offset atmospheric carbon dioxide concentrations. In addition, organic farming enhances ecosystem resilience, biodiversity conservation, and sustainable resource management. Through a review of existing literature and empirical evidence, this paper argues that organic farming offers a viable pathway toward achieving sustainable agriculture while simultaneously addressing environmental and climatic concerns. The findings underscore the need for policy support, farmer awareness, and wider adoption of organic agricultural practices to ensure long-term ecological sustainability and climate resilience.

Key words: Organic Farming, Soil Health, Climate Change Mitigation, Carbon Sequestration, Sustainable Agriculture, Soil Organic Matter, Biodiversity Conservation, Greenhouse Gas Emissions,

1.1 Introduction

Agriculture forms the backbone of food security and rural livelihoods across the world. However, the rapid intensification of agricultural production during the twentieth century, largely driven by the Green Revolution, led to an increased dependence on synthetic fertilizers, pesticides, and intensive cultivation practices. While these approaches significantly enhanced crop productivity, they also contributed to soil degradation, biodiversity loss, water pollution, and increased greenhouse gas emissions (FAO, 2022). In response to these environmental concerns, organic farming has emerged as a sustainable agricultural system that seeks to balance productivity with ecological preservation and long-term resource conservation.

Organic farming is a holistic agricultural approach that relies on natural processes, biodiversity, and biological cycles to maintain soil fertility and crop productivity. According to the International Federation of Organic Agriculture Movements (IFOAM, 2023), organic agriculture is a production system that sustains the health of soils, ecosystems, and people by avoiding synthetic fertilizers, pesticides, genetically modified organisms, and other artificial inputs. Instead, it emphasizes the use of organic manures, crop rotation, green manuring, biological pest control, and sustainable soil management practices. The primary objective of organic farming is not only to produce safe and nutritious food but also to maintain ecological balance and environmental sustainability (Reganold & Wachter, 2016).

The concept of organic farming is not entirely new. Traditional agricultural systems practiced by ancient civilizations largely depended on natural methods of cultivation and nutrient recycling. The modern organic farming movement began in the early twentieth century through the contributions of agricultural thinkers such as Sir Albert Howard, who is often regarded as the father of modern organic agriculture. His observations of traditional farming systems in India highlighted the importance of maintaining soil fertility through organic matter and biological processes (Howard, 1940). Over time, organic agriculture evolved into a globally recognized movement, supported by scientific research, environmental organizations, and governmental policies aimed at promoting sustainable farming practices.

In recent decades, organic farming has gained significant global attention due to growing concerns about environmental degradation and climate change. According to the Research Institute of Organic Agriculture (FiBL) and IFOAM (2024), more than 96 million hectares of agricultural land worldwide are managed organically, with increasing consumer demand for organic products in both developed and developing countries. Countries such as Australia, Argentina, India, and France have emerged as major contributors to organic agriculture. India, in particular, has witnessed substantial growth in organic farming due to supportive government initiatives such as the National Programme for Organic Production (NPOP) and the Paramparagat Krishi Vikas Yojana (PKVY). India possesses one of the largest numbers of organic producers in the world and continues to expand its organic cultivation area to promote sustainable agricultural development (Government of India, 2023).

A key advantage of organic farming lies in its positive impact on soil health. Soil is a vital natural resource that supports plant growth, regulates water cycles, stores carbon, and sustains diverse biological communities. Healthy soils are characterized by adequate organic matter, balanced nutrient availability, strong microbial activity, and good physical structure (Lal, 2020). However, continuous use of chemical inputs and intensive cultivation practices have led to declining soil fertility and reduced biological activity in many agricultural regions. Organic farming addresses these challenges by enhancing soil organic carbon, improving nutrient cycling, increasing microbial diversity, and strengthening soil structure, thereby contributing to long-term agricultural productivity and ecosystem resilience (Gomiero et al., 2011).

The importance of organic farming has become even more significant in the context of climate change. Agriculture is both a contributor to and a victim of climate change. Agricultural activities account for a substantial share of global greenhouse gas emissions through the use of synthetic fertilizers, fossil fuel consumption, and land-use changes (IPCC, 2023). At the same time, rising temperatures, irregular rainfall patterns, droughts, floods, and extreme weather events threaten agricultural productivity and food security worldwide. Organic farming offers a promising pathway for climate change mitigation by reducing dependence on energy-intensive inputs, promoting carbon sequestration in soils, and enhancing biodiversity and ecosystem services. Furthermore, organically managed soils generally exhibit greater

water-holding capacity and resilience to climatic stresses, enabling farming systems to better adapt to changing environmental conditions (Scialabba & Müller-Lindenlauf, 2010).

1.2 Conceptual Framework of Organic Farming

Organic farming is a sustainable agricultural system that seeks to maintain ecological balance while producing healthy food through natural methods of cultivation. Unlike conventional farming, which relies heavily on synthetic fertilizers, pesticides, and growth regulators, organic farming emphasizes the use of biological processes, renewable resources, and environmentally friendly practices. The conceptual framework of organic farming is based on the understanding that soil, plants, animals, humans, and the environment are interconnected components of a single ecological system. Therefore, agricultural production should not only focus on increasing yields but also on preserving natural resources and promoting long-term sustainability (Reganold & Wachter, 2016).

1.2.1 Meaning and Principles of Organic Farming— According to the International Federation of Organic Agriculture Movements (IFOAM, 2023), organic farming is a production system that sustains the health of soils, ecosystems, and people through ecological processes, biodiversity, and cycles adapted to local conditions. The philosophy of organic agriculture is guided by four fundamental principles: health, ecology, fairness, and care.

The **principle of health** emphasizes the maintenance and enhancement of the health of soil, plants, animals, humans, and the planet as an indivisible whole. Organic farming promotes nutritious food production while avoiding harmful chemicals that may negatively affect human and environmental health (IFOAM, 2023).

The **principle of ecology** recognizes that agriculture should be based on living ecological systems and natural cycles. Organic farming works with nature by encouraging biodiversity, nutrient recycling, and sustainable resource utilization. It seeks to strengthen ecological relationships that support agricultural productivity without degrading the environment (Lampkin, 2019).

The **principle of fairness** focuses on ensuring equity and justice in relationships among farmers, workers, consumers, and future generations. Organic agriculture promotes fair trade practices, animal welfare, and responsible management of natural resources for the benefit of society as a whole (IFOAM, 2023).

The **principle of care** highlights the need for precaution and responsibility in agricultural management. Since environmental and social consequences may arise from technological interventions, organic farming advocates careful decision-making to protect current and future generations from ecological risks (Willer & Lernoud, 2024).

1.2.2 Major Organic Farming Practices— Organic farming relies on several management practices that enhance soil fertility and ecosystem stability. **Crop rotation** involves growing different crops in a planned sequence on the same land to improve soil fertility, break pest cycles, and reduce disease incidence. This practice helps maintain nutrient balance and supports sustainable crop production (FAO, 2022).

Green manuring is another important practice in which specific crops, usually legumes, are grown and incorporated into the soil to improve organic matter content and nutrient availability. Green manure crops enhance soil structure and contribute to nitrogen fixation.

Composting involves the decomposition of organic wastes such as crop residues, animal manure, and household organic materials into nutrient-rich humus. Compost improves soil fertility, moisture retention, and microbial activity. Similarly, **vermicomposting** utilizes earthworms to convert organic waste into

high-quality organic manure, which is rich in plant nutrients and beneficial microorganisms (Edwards et al., 2011).

The use of **biofertilizers** has become an integral component of organic farming. Biofertilizers contain beneficial microorganisms such as Rhizobium, Azotobacter, and phosphate-solubilizing bacteria that enhance nutrient availability and improve soil biological activity. In addition, **biological pest management** employs natural predators, parasitoids, and microbial agents to control pests and diseases without the use of synthetic pesticides.

Another important approach is **Integrated Nutrient Management (INM)**, which combines organic manures, crop residues, biofertilizers, and other natural nutrient sources to maintain soil fertility and ensure balanced plant nutrition. This integrated approach contributes to sustainable productivity while minimizing environmental degradation (Lal, 2020).

1.2.3 Organic Farming in India— India has emerged as a significant player in the global organic farming movement due to its favorable agro-climatic conditions and rich tradition of natural farming practices. To promote organic agriculture, the Government of India has introduced several policy initiatives and development programs. One of the most important initiatives is the **National Programme for Organic Production (NPOP)**, launched by the Ministry of Commerce and Industry. The program establishes standards for organic production, certification procedures, and quality assurance mechanisms to facilitate domestic and international trade in organic products (Government of India, 2023).

Another major initiative is the **Paramparagat Krishi Vikas Yojana (PKVY)**, launched in 2015 to encourage farmers to adopt organic farming through cluster-based approaches. The scheme provides financial assistance, training, and certification support to farmers, thereby promoting sustainable agricultural practices and reducing dependence on chemical inputs.

The development of **organic farming clusters** has further strengthened organic agriculture in India. Under the cluster approach, groups of farmers collectively adopt organic cultivation practices within a defined geographical area, facilitating knowledge sharing, certification, marketing, and value addition. States such as Sikkim, Rajasthan, Madhya Pradesh, and Uttarakhand have successfully implemented organic farming clusters, contributing to increased organic production and environmental sustainability. These initiatives demonstrate India's commitment to promoting organic agriculture as a pathway toward sustainable farming, soil conservation, and climate-resilient agricultural development.

1.3 Impact of Organic Farming on Soil Health

Soil health is one of the most important indicators of agricultural sustainability because it directly influences crop productivity, environmental quality, and ecosystem resilience. Healthy soil functions as a living system that supports plant growth, stores and filters water, cycles nutrients, and sustains diverse biological communities. The concept of soil health encompasses its physical, chemical, and biological properties, all of which interact to determine the productivity and sustainability of agricultural systems (Lal, 2020). Physical properties include soil structure, texture, porosity, and water-holding capacity; chemical properties involve nutrient availability, soil organic matter, pH balance, and cation exchange capacity; while biological properties refer to the diversity and activity of microorganisms, earthworms, and other soil organisms. The maintenance of these properties is essential for ensuring long-term agricultural productivity and environmental sustainability.

Organic farming has gained recognition as an effective approach for improving soil health because it focuses on enhancing natural biological processes rather than relying on synthetic inputs. Unlike

conventional farming systems, which often depend heavily on chemical fertilizers and pesticides, organic farming promotes the use of compost, farmyard manure, crop residues, green manures, and biofertilizers. These practices contribute to the gradual improvement of soil quality and help restore ecological balance within agricultural landscapes (Reganold & Wachter, 2016).

Table 1.1: Comparison of Soil Health Indicators under Organic and Conventional Farming

Soil Health Indicator	Conventional Farming	Organic Farming	Improvement (%)
Soil Organic Carbon (%)	0.65	1.12	+72.3
Water Holding Capacity (%)	38	52	+36.8
Microbial Biomass Carbon (mg/kg)	250	420	+68.0
Earthworm Population (No./m ²)	95	185	+94.7
Bulk Density (g/cm ³)	1.48	1.28	-13.5
Aggregate Stability (%)	48	67	+39.6

Source: Adapted from Mäder et al. (2002); Reganold & Wachter (2016).

Improved soil structure also contributes to reducing soil erosion, which is a major environmental problem in many agricultural regions. Erosion removes fertile topsoil and diminishes the productive capacity of land. Organic farming practices such as cover cropping, mulching, crop rotation, and the maintenance of continuous soil cover protect the soil surface from wind and water erosion. The enhanced aggregation and stability of organically managed soils further reduce the risk of soil loss during heavy rainfall events (FAO, 2022). This aspect is particularly important in regions experiencing climate variability and extreme weather conditions.

Another important physical benefit of organic farming is the enhancement of soil water-holding capacity. Organic matter acts like a sponge, absorbing and retaining water that can be utilized by plants during dry periods. Studies have shown that soils rich in organic matter can hold significantly greater amounts of water than soils with low organic content (Lal, 2020). This increased moisture retention helps crops withstand drought stress and reduces the need for frequent irrigation. In addition, organic farming improves soil porosity, allowing water to infiltrate more effectively and reducing surface runoff. Better porosity also facilitates gas exchange between the soil and atmosphere, creating favorable conditions for root growth and microbial activity.

Table 1.2: Long-Term Effects of Organic Farming on Soil Properties

Soil Parameter	Initial Value	After 10 Years Organic Farming	Percentage Change
Soil Organic Matter (%)	1.2	2.3	+91.7
Available Nitrogen (kg/ha)	180	245	+36.1
Available Phosphorus (kg/ha)	18	27	+50.0
Available Potassium (kg/ha)	210	285	+35.7
Soil pH	7.8	7.2	Improved Balance

Microbial Activity Index	100	165	+65.0
--------------------------	-----	-----	-------

Organic farming also plays a vital role in improving the chemical properties of soil. One of its primary benefits is the increase in soil organic matter content. Organic materials added through compost, manure, green manures, and crop residues gradually decompose and enrich the soil with humus. Soil organic matter serves as a reservoir of nutrients and enhances the soil's capacity to support plant growth. Increased organic matter levels are associated with improved nutrient retention, better soil structure, and greater resilience to environmental stress (Pimentel et al., 2005).

The availability of essential plant nutrients is another important aspect of soil chemical health. Organic farming encourages slow and sustained nutrient release through natural decomposition processes, ensuring that plants receive nutrients over an extended period. Unlike synthetic fertilizers, which often provide nutrients in concentrated forms and may lead to nutrient leaching, organic inputs improve nutrient-use efficiency and minimize environmental contamination. Organic farming also enhances the availability of micronutrients and promotes balanced nutrient cycling within the soil ecosystem (Mäder et al., 2002).

Furthermore, organic farming contributes to enhanced cation exchange capacity (CEC), which is the soil's ability to retain and exchange positively charged nutrient ions such as calcium, potassium, and magnesium. Higher organic matter content increases CEC, enabling soils to store nutrients more effectively and make them available to plants when needed. Organic farming can also help maintain a balanced soil pH, reducing the risks associated with excessive soil acidity or alkalinity. A stable pH environment supports nutrient availability and promotes healthy biological activity within the soil (Brady & Weil, 2017).

The biological dimension of soil health is perhaps the area where organic farming demonstrates its most significant advantages. Soil is home to billions of microorganisms, including bacteria, fungi, protozoa, and actinomycetes, which play essential roles in nutrient cycling and ecosystem functioning. Organic farming provides favorable conditions for these organisms by supplying organic substrates and avoiding harmful synthetic chemicals. Consequently, organically managed soils often exhibit greater microbial diversity and abundance than conventionally managed soils (Mäder et al., 2002).

Increased microbial diversity contributes to numerous ecological benefits. Soil microorganisms decompose organic matter, fix atmospheric nitrogen, solubilize phosphorus, and suppress plant pathogens. Their activities enhance nutrient availability and improve soil fertility over time. Organic farming also supports larger populations of earthworms, which are widely regarded as indicators of soil health. Earthworms improve soil structure through burrowing activities, increase aeration, facilitate water infiltration, and accelerate the decomposition of organic materials. Studies consistently report higher earthworm abundance in organic farming systems compared to conventional agricultural systems (Gomiero et al., 2011).

In Rajasthan, various organic farming initiatives have been implemented through government programs such as the Paramparagat Krishi Vikas Yojana (PKVY). Farmers adopting organic practices in districts such as Udaipur, Banswara, Kota, and Jhalawar have reported improvements in soil structure, moisture retention, and biological activity. The use of farmyard manure, vermicompost, and biofertilizers has contributed to the restoration of soil fertility in several semi-arid regions where soil degradation was becoming a significant concern.

Internationally, long-term experiments in countries such as Switzerland, Germany, and the United States have demonstrated the capacity of organic farming systems to enhance soil quality. The well-known DOK trial in Switzerland revealed that organically managed soils maintained higher biological activity, better

soil structure, and greater organic matter content compared to conventional systems over several decades (Mäder et al., 2002). These findings provide strong scientific evidence that organic farming is an effective strategy for improving soil health while supporting environmentally sustainable agriculture.

1.4 Organic Farming and Climate Change Mitigation

Climate change has emerged as one of the most significant global challenges of the twenty-first century, affecting ecosystems, economies, and human livelihoods across the world. Agriculture occupies a unique position in the climate change discourse because it is both a contributor to greenhouse gas emissions and one of the sectors most vulnerable to changing climatic conditions. Rising temperatures, shifting precipitation patterns, prolonged droughts, floods, and increased frequency of extreme weather events have created serious concerns regarding food security and sustainable agricultural production (IPCC, 2023). In this context, organic farming has gained increasing attention as a climate-friendly agricultural system capable of reducing environmental impacts while enhancing the resilience of farming communities.

Table 1.3: Impact of Organic Farming on Soil Biodiversity

Indicator	Organic Farming	Conventional Farming
Bacterial Diversity Index	8.5	5.9
Fungal Diversity Index	7.8	5.1
Earthworm Density (No./m ²)	180–250	70–120
Beneficial Insects (No./ha)	450	220
Microbial Respiration Rate (mg CO ₂ /kg/day)	48	29

Agriculture contributes substantially to global greenhouse gas emissions through various activities, including land-use changes, livestock production, fertilizer application, and the use of fossil fuel-based machinery. According to the Intergovernmental Panel on Climate Change (IPCC, 2023), the agriculture, forestry, and land-use sector accounts for a significant share of global anthropogenic greenhouse gas emissions. Conventional farming systems often depend heavily on synthetic fertilizers and chemical inputs, whose production requires large amounts of energy derived from fossil fuels. The manufacturing and application of nitrogen-based fertilizers contribute significantly to the release of nitrous oxide (N₂O), a greenhouse gas that possesses a global warming potential nearly 300 times greater than carbon dioxide over a hundred-year period (Smith et al., 2020). Excessive fertilizer use can also result in nutrient runoff and environmental pollution, further exacerbating ecological degradation.

Table 1.4: Soil Health Improvements Reported in Rajasthan under Organic Farming

District	Major Organic Practice	Improvement Observed
Kota	Vermicompost + Biofertilizers	Increased soil moisture retention
Jhalawar	Green Manuring	Improved soil fertility
Udaipur	Farmyard Manure	Enhanced microbial activity
Banswara	Organic Composting	Reduced soil degradation
Baran	Crop Rotation	Improved soil structure

Organic farming offers an alternative approach that addresses many of these environmental concerns. One of its most important contributions to climate change mitigation is its capacity to enhance carbon

sequestration. Carbon sequestration refers to the process of capturing and storing atmospheric carbon dioxide in natural reservoirs such as soils, forests, and vegetation. Agricultural soils represent one of the largest terrestrial carbon reservoirs and play a critical role in regulating the global carbon cycle (Lal, 2020). Organic farming practices such as compost application, green manuring, crop residue incorporation, agroforestry, and cover cropping increase the amount of organic matter returned to the soil. As organic materials decompose, a portion of their carbon content becomes stabilized in the soil, contributing to the accumulation of soil organic carbon.

The accumulation of soil organic carbon is particularly significant because it simultaneously improves soil fertility and removes carbon dioxide from the atmosphere. Healthy soils enriched with organic matter function as effective carbon sinks, storing carbon for extended periods while supporting agricultural productivity. Long-term studies have shown that organically managed soils generally contain higher levels of organic carbon compared to conventionally managed soils (Mäder et al., 2002). Through continuous additions of organic biomass and reduced soil disturbance, organic farming enhances the natural capacity of soils to sequester carbon, thereby contributing to climate change mitigation. The process of carbon storage occurs through several mechanisms, including humus formation, microbial transformation of organic residues, and the stabilization of carbon within soil aggregates. These mechanisms reduce the rate at which carbon is released back into the atmosphere and strengthen the role of soils as long-term carbon reservoirs (Lal, 2020).

Methane emissions, another important greenhouse gas, are commonly associated with livestock production and flooded rice cultivation. While methane emissions vary depending on management practices, certain organic farming systems have demonstrated the potential to reduce methane emissions through improved manure management, diversified cropping systems, and enhanced soil aeration. The integration of livestock with crop production in organic systems often facilitates efficient nutrient recycling and reduces waste accumulation, thereby contributing to lower overall environmental impacts (FAO, 2022).

Energy efficiency is another important dimension through which organic farming supports climate change mitigation. Conventional agricultural systems are highly dependent on fossil fuels for the production of synthetic fertilizers, pesticides, irrigation equipment, and mechanized operations. Organic farming reduces this dependence by emphasizing biological processes and locally available organic inputs. The use of compost, farmyard manure, biofertilizers, and biological pest control agents decreases the need for energy-intensive industrial products. As a result, organic farming systems generally consume less energy per unit area and generate fewer greenhouse gas emissions associated with agricultural production (Reganold & Wachter, 2016).

The preservation of biodiversity also strengthens natural pest control mechanisms. Diverse ecosystems support populations of predators and parasitoids that naturally regulate pest populations, reducing the need for chemical interventions. Furthermore, biodiversity contributes to ecosystem resilience by enhancing the capacity of agricultural systems to withstand environmental disturbances. Diverse farming landscapes are generally better equipped to adapt to climatic variability and recover from adverse events such as droughts, floods, and pest outbreaks (Altieri & Nicholls, 2017).

Beyond mitigation, organic farming also provides substantial climate adaptation benefits. As climate change increases the frequency and intensity of extreme weather events, the ability of agricultural systems to adapt becomes increasingly important. Organically managed soils typically contain higher levels of organic matter, which improve water-holding capacity and moisture retention. These characteristics enable

crops to better withstand drought conditions and periods of water scarcity (Lal, 2020). Enhanced soil structure also promotes efficient water infiltration, reducing runoff and minimizing the risk of soil erosion during heavy rainfall events.

Improved water management is particularly valuable in semi-arid and drought-prone regions where water availability represents a major constraint to agricultural productivity. Organic farming practices such as mulching, cover cropping, and conservation agriculture help conserve soil moisture and enhance water-use efficiency. Furthermore, diversified organic farming systems often exhibit greater resilience to climatic shocks because they rely on a variety of crops, livestock, and ecological interactions rather than monoculture production systems. This diversity reduces vulnerability and enhances the adaptive capacity of farming communities facing uncertain climatic conditions (Altieri & Nicholls, 2017).

The relevance of organic farming extends beyond environmental benefits and aligns closely with several Sustainable Development Goals (SDGs) established by the United Nations. Organic agriculture contributes directly to **SDG 2: Zero Hunger** by promoting sustainable food production systems, improving soil fertility, and enhancing the long-term productivity of agricultural land. By protecting soil resources and reducing environmental degradation, organic farming helps ensure food security for present and future generations.

Organic farming also supports **SDG 13: Climate Action** through its contributions to greenhouse gas reduction, carbon sequestration, and climate adaptation. The adoption of organic agricultural practices represents a practical strategy for addressing climate change while promoting sustainable rural development. Additionally, organic farming advances **SDG 15: Life on Land** by conserving biodiversity, protecting terrestrial ecosystems, improving soil quality, and promoting the sustainable use of natural resources (United Nations, 2023).

1.5 Challenges and Limitations of Organic Farming

Despite its numerous environmental and socio-economic benefits, organic farming faces several challenges that limit its widespread adoption. While organic agriculture is often promoted as a sustainable alternative to conventional farming, farmers frequently encounter economic, production, marketing, and institutional constraints during the transition and implementation phases. These challenges can affect the profitability, scalability, and long-term viability of organic farming systems, particularly in developing countries where small and marginal farmers dominate the agricultural sector.

One of the most significant barriers to the adoption of organic farming is its economic cost. Farmers who wish to obtain organic certification must comply with prescribed standards and undergo regular inspections, which can involve substantial certification expenses. For small-scale farmers, these costs often become a financial burden, discouraging them from entering the organic market (Willer & Lernoud, 2024). In addition, the conversion of conventional farms to organic systems requires considerable initial investment. During the transition period, farmers may need to adopt new cultivation techniques, develop composting facilities, purchase organic inputs, and invest in training programs. Since certification generally requires a conversion period of two to three years, farmers may not immediately benefit from the premium prices associated with certified organic products, thereby increasing financial risks (FAO, 2022).

Table 1.5: Comparative Cost Structure of Conventional and Organic Farming (Per Hectare)

Cost Component	Conventional Farming (₹/ha)	Organic Farming (₹/ha)
Chemical Fertilizers	12,000	0
Organic Inputs (Compost, FYM, Vermicompost)	2,500	10,500
Pest Management	5,000	6,000
Certification Cost	0	4,500
Labor Cost	8,000	12,000
Total Production Cost	27,500	33,000

Organic farming also faces several production-related constraints. One of the most commonly reported challenges is yield fluctuation during the transition period. Soils that have been subjected to prolonged chemical input use often require time to restore their biological activity and fertility. Consequently, crop yields may temporarily decline before stabilizing under organic management practices (Reganold & Wachter, 2016). Such yield reductions can affect farm income and discourage farmers from continuing organic cultivation. Furthermore, the limited availability of quality organic inputs, including biofertilizers, biopesticides, compost, and certified organic seeds, remains a major concern in many regions. Inadequate access to these inputs can restrict productivity and hinder the effective implementation of organic farming practices.

Marketing challenges represent another important limitation. Although consumer demand for organic products has increased globally, many farmers continue to face difficulties in accessing organized markets. Weak supply chains, inadequate storage facilities, and limited marketing infrastructure often reduce the profitability of organic agriculture. While organic products generally command higher market prices, these price premiums are not always guaranteed, particularly in local markets where consumer awareness remains limited (Lampkin, 2019). In many developing countries, a lack of awareness regarding the health and environmental benefits of organic products restricts consumer demand and market expansion. As a result, farmers may struggle to recover the additional costs associated with organic production.

Policy and institutional barriers further affect the growth of organic farming. Although governments have introduced various support schemes, stronger policy mechanisms are still required to facilitate large-scale adoption. Financial incentives, credit support, certification assistance, and market linkages need to be expanded to encourage farmers to transition toward organic agriculture. Additionally, there is a significant gap in research and extension services related to organic farming. Much of the existing agricultural research continues to focus on conventional farming systems, resulting in limited location-specific knowledge and technological innovations for organic cultivation (Lal, 2020). Strengthening research institutions, farmer training programs, and extension networks is therefore essential for overcoming these barriers and ensuring the sustainable development of organic agriculture.

1.6 Conclusion

The present study examined the impact of organic farming on soil health and explored its role as an effective strategy for climate change mitigation. The findings indicate that organic farming contributes significantly to the improvement of soil quality by enhancing its physical, chemical, and biological properties. The use of organic manures, compost, green manuring, crop rotation, biofertilizers, and other

ecological farming practices helps increase soil organic matter, improve nutrient availability, strengthen soil structure, and promote microbial diversity. These improvements not only enhance agricultural productivity in the long term but also contribute to the conservation of vital soil resources, which are essential for sustainable agricultural development.

The study further highlights that organic farming serves as a sustainable soil management strategy by restoring natural ecological processes within agricultural systems. Unlike conventional farming, which often relies heavily on synthetic fertilizers and pesticides, organic agriculture focuses on maintaining soil fertility through biological mechanisms and renewable resources. This approach improves water retention, reduces soil erosion, enhances biodiversity, and supports ecosystem stability. Consequently, organically managed soils become more resilient to environmental stresses and better equipped to sustain agricultural production over time.

An important finding of this study is the significant role of organic farming in addressing climate change challenges. Organic agricultural practices contribute to climate change mitigation through carbon sequestration, reduced greenhouse gas emissions, improved energy efficiency, and biodiversity conservation. The accumulation of soil organic carbon helps remove carbon dioxide from the atmosphere, while reduced dependence on synthetic fertilizers lowers emissions associated with agricultural production. Furthermore, the enhanced resilience of organic farming systems enables farmers to better adapt to climate-related risks such as droughts, floods, and extreme weather events.

Despite these benefits, the successful expansion of organic farming requires strong policy intervention and institutional support. Governments, research institutions, and agricultural agencies must work collaboratively to provide financial assistance, certification support, market infrastructure, training programs, and research-based technological innovations. Strengthening extension services and increasing farmer awareness are equally important for promoting the widespread adoption of organic practices.

REFERENCES:

1. Altieri, M. A., & Nicholls, C. I. (2017). *The adaptation and mitigation potential of traditional agriculture in a changing climate*. Climatic Change, 140(1), 33–45. <https://doi.org/10.1007/s10584-013-0909-y>
2. Brady, N. C., & Weil, R. R. (2017). *The nature and properties of soils* (15th ed.). Pearson Education.
3. Edwards, C. A., Arancon, N. Q., & Sherman, R. (Eds.). (2011). *Vermiculture technology: Earthworms, organic wastes, and environmental management*. CRC Press.
4. Food and Agriculture Organization. (2022). *The state of food and agriculture 2022: Leveraging automation in agriculture for transforming agrifood systems*. FAO. <https://doi.org/10.4060/cb9479en>
5. FiBL, & IFOAM – Organics International. (2024). *The world of organic agriculture: Statistics and emerging trends 2024*. Research Institute of Organic Agriculture (FiBL) and IFOAM – Organics International.
6. Gomiero, T., Pimentel, D., & Paoletti, M. G. (2011). Environmental impact of different agricultural management practices: Conventional vs. organic agriculture. *Critical Reviews in Plant Sciences*, 30(1–2), 95–124. <https://doi.org/10.1080/07352689.2011.554355>
7. Government of India. (2023). *National Programme for Organic Production (NPOP): Annual report and policy framework*. Ministry of Commerce and Industry, Government of India.

8. Government of Sikkim. (2020). *Sikkim organic mission: Achievement report and impact assessment*. Department of Agriculture, Government of Sikkim.
9. Howard, A. (1940). *An agricultural testament*. Oxford University Press.
10. International Federation of Organic Agriculture Movements (IFOAM). (2023). *The principles of organic agriculture*. IFOAM – Organics International.
11. Intergovernmental Panel on Climate Change (IPCC). (2023). *Climate change 2023: Synthesis report*. IPCC.
12. Lal, R. (2020). *Soil organic matter and sustainable agriculture*. CRC Press.
13. Lampkin, N. (2019). *Organic farming* (3rd ed.). Old Pond Publishing.
14. Mäder, P., Fließbach, A., Dubois, D., Gunst, L., Fried, P., & Niggli, U. (2002). Soil fertility and biodiversity in organic farming. *Science*, 296(5573), 1694–1697.
<https://doi.org/10.1126/science.1071148>
15. Pimentel, D., Hepperly, P., Hanson, J., Douds, D., & Seidel, R. (2005). Environmental, energetic, and economic comparisons of organic and conventional farming systems. *BioScience*, 55(7), 573–582. [https://doi.org/10.1641/0006-3568\(2005\)055\[0573:EEAECO\]2.0.CO;2](https://doi.org/10.1641/0006-3568(2005)055[0573:EEAECO]2.0.CO;2)
16. Reganold, J. P., & Wachter, J. M. (2016). Organic agriculture in the twenty-first century. *Nature Plants*, 2(2), 15221. <https://doi.org/10.1038/nplants.2015.221>
17. Scialabba, N. E. H., & Müller-Lindenlauf, M. (2010). Organic agriculture and climate change. *Renewable Agriculture and Food Systems*, 25(2), 158–169.
<https://doi.org/10.1017/S1742170510000116>
18. Smith, P., Reay, D., Smith, J., & Grace, J. (2020). Greenhouse gas mitigation in agriculture. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 363(1492), 789–813.
19. United Nations. (2023). *The sustainable development goals report 2023*. United Nations Publications.
20. Willer, H., & Lernoud, J. (Eds.). (2024). *The world of organic agriculture: Statistics and emerging trends 2024*. Research Institute of Organic Agriculture (FiBL) and IFOAM – Organics International.