Organic Farming as a Pathway to Sustainable Soil Health, and Environmental Sustainability

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OPEN ACCESS

Keywords

Organic Farming, Sustainable Agriculture, Soil Health, Soil Organic Matter, Integrated Nutrient Management

How to cite this article:

Kumari, N., Sharma, R., Kumar, D. and Tiwari, J. K. 2026. Organic Farming as a Pathway to Sustainable Soil Health, and Environmental Sustainability. *Vigyan Varta* 7 (04): 198-207.

ABSTRACT

Sustainable agricultural development has become a major concern in India, particularly in the context of increasing population pressure, declining soil fertility, and environmental degradation associated with intensive chemical-based farming. Organic farming has emerged as a viable alternative that promotes ecological balance, soil health, and long-term sustainability of agroecosystems. Unlike conventional farming systems that rely heavily on synthetic fertilizers and pesticides, organic farming emphasizes the use of biological inputs such as farmyard manure, compost, green manures, and biofertilizers for maintaining soil fertility and crop productivity. These practices help enhance soil organic matter, stimulate microbial activity, and improve soil structure, which are essential indicators of soil health. Organic agriculture also contributes to biodiversity conservation and reduces the adverse environmental impacts caused by indiscriminate chemical inputs. Furthermore, long-term nutrient management through integrated organic practices can stabilize soil fertility and improve agricultural productivity in an environmentally responsible manner. Therefore, organic farming represents a holistic and sustainable approach that not only restores soil health but also promotes environmental sustainability and the long-term viability of agricultural systems.

INTRODUCTION

Organic farming based on "Nature can provide for everyone's need but not for greed" ……Mahatma Gandhi.

An agricultural approach known as "organic farming" places a strong emphasis on raising livestock and growing crops using natural methods and resources. Its foundation is a philosophy that places an emphasis on biodiversity, ecological equilibrium, and sustainability, with the goal of producing food in a socially and environmentally responsible manner. Organic farming has its roots in prehistoric agricultural techniques where farmers produced crops using natural means. However, the growing use of synthetic pesticides and fertilizers in conventional agriculture prompted the start of the modern organic movement in the early 20th century. The foundation for the organic farming movement was laid by pioneers like **Sir Albert Howard** and **Lady Eve Balfour**, who promoted sustainable practices and soil health. Instead of going against nature, organic farming works in harmony and friendship with the environment, thus it uses unique techniques to get the best results and a sustainable agricultural output. In this manner, a healthy agricultural output is achieved without jeopardizing the health of the local ecosystems or the people who live and work on those fields. Since many ancient agricultural methods are still in use today, adopting organic farming does not imply a return to the past. Organic farming adopts the most effective methods and blends them with cutting-edge scientific methods. The input for an organic farming system should normally be generated on the farm.

The organic movement in India is mainly because of the work of Sir Albert Howard. Sir Albert Howard had formulated and conceptualized most of the views that were later adopted by those individuals who got actively involved in this movement **(Howard 1940)**. Sir Albert Howard is considered to be one of the main founders of the organic movement that came into existence after the industrial revolution. To achieve the objectives of organic farming, farmers have to adopt more practices that can maximize the use of nutrients and energy and minimize crop rotation and diversity of crops; different combinations of livestock and plants; symbiotic nitrogen fixation of legumes; organic manure; and biological control of pests **(Scialabba and Hattam, 2002).**

Organic farming is an agricultural system that seeks to produce food and other products using methods that do not involve synthetic fertilizers, pesticides, genetically modified organisms (GMOs), or artificial chemicals. Instead, it focuses on maintaining ecological balance, enhancing biodiversity, and promoting soil health. Farmers who practice organic farming do not leave their farms totally upon nature, instead, they avail the complete knowledge, methods and material to work with nature. By doing like this, the farmers maintain a balance to grow animal and crop together. Organic farmers do not see every insect as a pest and they don't solve every problem of the farm with the chemical input. Many insects are regarded as farmers' friends and aid in farming. " According to the IFOAM Organic agriculture is a production system that sustains the health of soils, ecosystems, and people,". Instead, then using inputs that have negative impacts, it depends on biological processes, biodiversity, and cycles tailored to local conditions. In order to improve the environment, foster equitable relationships, and improve everyone's quality of life, organic agriculture blends tradition, creativity, and science.

Concept of Organic Farming-

Organic farming includes the concept that the soil, plant, animals, and humans are linked. Concept of organic farming is based on some below mentioned principles:

1. Nature is regarded as the ideal model for agriculture because it functions without synthetic inputs and maintains balance without excessive use of water.
2. Organic farming avoids the exploitation or depletion of soil nutrients and focuses on preserving soil fertility over the long term.
3. In this system, soil is treated as a living system rather than an inert medium for plant growth.
4. The continuous presence of beneficial microorganisms and other soil organisms plays a crucial role in maintaining soil fertility and ecosystem balance.
5. Enhancing biological diversity and sustaining soil productivity are central objectives of organic farming practices.
6. Organic farming emphasizes crop rotation, the use of natural predators, biological methods for pest, disease, and weed control, and the cultivation of resistant crop varieties instead of relying on chemical pesticides.

History of organic farming in India-

India's long and diverse history of organic farming is rooted in traditional farming practices that date back hundreds of years. This is a summary of the development of organic farming in India:

A. Traditional and Ancient Customs:

1. **Indigenous Knowledge:** Sustainable farming methods have a long history in India. Conventional agricultural practices emphasized crop rotation and biodiversity by using natural inputs like compost, cow dung, and green manures. Native American farmers frequently used regional seed varieties and organic pest management techniques.
2. **Ayurveda and Agriculture:** The ancient Indian medical system known as Ayurveda had an impact on agricultural methods. The holistic approach to health extended to agriculture, highlighting the significance of natural fertilizers and soil health.
3. **Vedic era:** ancient texts, including the Vedas and Upanishads, contain references to sustainable farming practices and the importance of respecting nature. These texts highlight the interconnectedness of life and the environment.

B. Colonial Era:

1. **Impact of Colonialism:** During British colonial control, indigenous farming methods declined as traditional practices were frequently substituted by cash crop production. During this time, chemical pesticides and fertilizers were used, further separating agriculture from its organic origins.

C. Post-Independence Period:

1. **Green Revolution:** During the 1960s, high-yielding crop types and chemical insecticides and fertilizers to boost food production. Although it was successful in increasing yields, it also caused health problems, soil depletion, and environmental destruction.
2. **Organic Movement Emergence:** In India, the organic farming movement started to gain momentum in the late 20th century as a reaction to the detrimental effects of chemical agriculture. Researchers, farmers, and activists began promoting sustainable

measures that complemented conventional techniques.

D. 1990s Onward:

1. **Formalization of Organic Farming:** Organic farming gained popularity and awareness in the 1990s. To encourage organic practices and assist farmers making the switch to organic methods, organizations such as the Organic Farming Association of India (OFAI) were founded.

2. **Government Initiatives:** Organic farming's promise for sustainable development was acknowledged by the Indian government. A number of initiatives were started to support organic farming, such as: In order to provide guidelines for organic farming and certification, the National Programme for Organic Production (NPOP) was founded in 2001. In order to encourage organic farming through farmer clusters, the Paramparagat Krishi Vikas Yojana (PKVY) was introduced in 2015.

3. **Certification Systems:** India created an internationally recognized organic certification system under NPOP. This has made it easier for India to export organic goods to international markets.

E. Recent Developments:

1. **Growth of the Organic Sector:** India's organic sector has experienced notable expansion in recent years. The nation's grow to be one of the biggest manufacturers of organic tea, fruits, and spices. As the first totally organic state in India, states like Sikkim have received respect.

2. **Consumer Awareness:** The demand for organic products has been driven by customers' growing knowledge of health and environmental issues. The consumption of organic food is increasing in urban marketplaces.

3. **Innovative Practices:** In order to improve soil health and biodiversity while preserving productivity, farmers are increasingly implementing novel techniques including agroecology, permaculture, and regenerative agriculture.

4. **Digital Platforms:** The rise of digital technology has enabled farmers to access information about organic farming techniques, market their products directly to consumers, and connect with buyers through.

The history of organic farming in India reflects a journey from ancient sustainable practices through colonial influences and modern challenges to a resurgence of interest in organic methods. As awareness grows regarding health and environmental sustainability, organic farming is poised to play an increasingly important role in India's agricultural landscape. The integration of traditional knowledge with modern techniques continues to shape the future of organic agriculture in the country.

The Important Goals of Organic Farming are:

The organic farming furnishes long term benefits to the environment because organic farming has the following aims:

1. Increase the fertility of the soil in the long term.

2. Controlling the disease pest without harming the ecosystem.

3. Ensuring that water is clean and safe.

4. Availing the resources that farmers already have, making them affordable for the farmers to buy the necessary inputs for the farm.

5. Providing nutritional and chemical-free food for human consumption and animal feed, as well as selling high-quality products at good prices.

6. There is a high level of focus in organic livestock farming on the humane treatment and welfare of the animal. This is in the standards for organic farming.

7. Organic farming also focuses on ensuring that there is equity in society. This is through ensuring that those working in the farms are paid fairly and that everyone who consumes the products gets healthy food.

8. Organic farming also seeks to ensure that there is economic sustainability for the farmers. This is through ensuring that there is fair trade for the farmers and that they have a viable income through the premium prices for their products.

Table 1: Rank (on basis of total area) under organic agriculture (Source: Ramesh *et al*., 2010)

Rank (on basis of total area)	Country	Area under organic agriculture (ha)	Percentage of total agriculture land	Number of organic farms
1	Australia	12,294,290	2.8	1550
2	China	2,300,000	0..4	1600
3	Argentina	2,220,489	1.7	1486
4	USA (2005)	1,620,351	0.5	8493
5	Italy	1,148,162	9.0	45,115
6	Uruguay	930,965	6.1	630
7	Spain	926,390	3.7	17,214
8	Brazil	880,000	0.3	15,000
9	Germany	825,539	4.8	17,557
10	UK	604,571	3.8	4485
11	Canada	604,404	0.9	3571
12	France	552,824	2.0	11,640
13	India	528,171	0.3	44,926
		30,418,261	0.65	718,744

Table 2: The status of organic production in India (2013–2014)

Total area under certified organic cultivation	0.72 M ha
Forest and wild area for collection of minor forest produces	3.99 M ha
The total area under organic certification	4.7 M ha
Total production	1.24 million MT
Total quantity exported	177766 MT
Value of total export	1328.61 crores

(Source: APEDA. 2014)

The Principles of Organic Farming-

The principles of organic farming must be understood in order to comprehend the rationale behind organic farming. These guidelines cover the essential objectives and restrictions that are thought to be crucial for producing high-quality food, fiber, and other products in an environmentally sustainable manner. The foundation of organic farming is the dynamic interplay of the soil, plants, animals, humans, ecology, and environment.

The four IFOAM main principles of organic production. (IFOAM, 2005)

1. **The Principle of Health** – Organic agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible.

2. **The Principle of Ecology** – Organic agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them.

3. **The Principle of Fairness** – Organic agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities.

4. **The Principle of Care** – Organic agriculture should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment.

Components of Organic Farming

Different components of organic farming are as follows.

1. **Crop and soil management:** Organic farming promotes crop rotation and the application of organic manure, particularly green manure, to improve soil organic substances. Increased water-holding capacity, improved ion exchange, and decreased soil erosion are some benefits of careful soil management. Another crucial component of organic agricultural systems is the intercropping of legumes and green manuring. It not only aids in weed control but also enhances the chemical and physical characteristics of the soil by lowering soil erosion and nutrient leaching. A mixed cropland, pasture, and livestock system is ideal, if not necessary, for the achievement of sustainable agriculture.

2. **On-farm Waste Recycling:** Due to the rising cost of chemical fertilizers, organic wastes are once again playing a significant part in agricultural fertilizer techniques. In organic farming, composting all organic waste and feedlot or farm yard manure (FYM) is crucial.

3. **Non-chemical Weed Control:** One of the primary issues in organic farming is weed control. Tillage, crop rotation, manure management, the use of cover crops, mulches, and green manuring are some crucial techniques to take into account when preventing weed issues.

4. **Recycling of Domestic and Industrial Waste:** Press mud and molasses from the sugar industry are two industrial byproducts with good manurial value. Only thoroughly decomposed press mud at a rate of 10 tons per hectare should be used. Press mud addition increases microbial activity and soil fertility. When properly decomposed, coir waste can be utilized as manure. If treatment and application techniques are further developed, using sewage and sludge for crop production can become a significant part of organic farming.

5. **Biofertilizers:** Continuous application of inorganic fertilizers has been found to reduce crop production. In order to improve soil health, there is a growing need to combine the provision of nutrients with organic sources. Bio-fertilizers are biologically active products known as microbial inoculates that include active strains of specific microorganisms, such as bacteria, fungi, algae, or a mix of these.

Impact of Organic Farming on Soil Health

Impact on physical properties of soil:

The physical properties of soil include structure, texture, bulk density, porosity, water-holding capacity, etc. (Hillel *et al*., 1982). The positive impact of organic farming on the physical properties of soil, viz., soil structure, water-holding capacity, soil aeration, and soil temperature, is already well-documented (Parthasarathy *et al.,* 2004). Similarly, the beneficial impact of organic farming on the physical properties of soil is noted by (Papadopoulos *et al*., 2014). in the improvement of soil structure, organic matter content, and porosity in the soil. Crop rotation is a significant component of organic farming, which affects the physical properties of the soil in a direct and indirect manner. The accumulation of organic matter in the soil in the lean phase has a direct impact on the modification of the soil structure (Clement *et al*., 1967). The architectural pattern of the root systems of the crops included in the crop rotation is beneficial in the modification of the soil structure (Chan *et al*., 1991). The mulching of the soil surface with organic matter makes the soil soft, pulverized, and humid, which is beneficial in the creation of a

congenial atmosphere in the soil so that the beneficial microbes in the soil maintain the bulk density and porosity in the soil (Lampkin *et al*., 1990). Organic farming increases the organic matter of the soil, which is the primary requirement for improving the health of the soil (Aguiar *et al.*, 2013). Organic matter increases the moisture retention capacity of the soil (Altieri *et al.,* 2005). Organic farming practices like mulching of crop residue and no tillage improve the fertility of the soil, increase crop production, and control soil erosion. Organic residue also increases the organic matter of the soil, which helps to reduce the hydrological response of the soil and increase the repellency of the soil for water, thereby reducing the rate of infiltration (Garcia-Moreno *et al*., 2013). Organic fertilizer applied to the crops provides nutrient to the current crop and the subsequent crop (Jannoura *et al*., 2014). The improvement of the physical properties of the soil due to organic farming has a spatio-temporal dimension. According to (Lotter *et al.,* 2003) organic farming practices are superior to conventional practices in regions where rainfall is extreme due to the higher rate of absorption and lesser amount of runoff of water on the field.

Impact on chemical properties of soil:

Unlike conventional agriculture, organic agriculture uses the natural process to add necessary nutrients to improve quality. Organic agriculture is said to have potential to maintain soil fertility and increase organic carbon in the soil (Pandey *et al.*, 2012). The use of different organic materials such as FYM, vermicompost, green manuring, etc. is useful to maintain sustainability in soil organic carbon along with nutrient supply to plants (Thorne *et al.*, 2004). Using good quality FYM increases total nitrogen and organic matter in the soil, which is "an important substrate of cationic exchange and the warehouse of most of the available nitrogen, phosphorus, and sulphur; the main energy source for microorganisms; and is a key determinant of soil structure" (Ewel *et al.*, 1986). Significant differences and higher values of soil organic carbon, carbon stocks, and carbon sequestration rate were observed in organic management plots than in non-organic management plots (Gattinger *et al.*, 2011). It is undoubtedly an important controlling factor for C:N ratio, total and available N, N mineralization, soil moisture, microbial activity, and soil texture (Agehara *et al.*, 2005). Strikingly, several studies have indicated the availability of more N in organically amended soils than the soil subjected to inorganic fertilization (Chang *et al.*, 200014), owing to the slower rates of mineralization, which eventually reduce the leaching of nitrogen. Organic acids, as well as the humus fraction of the organic matter, have shown efficiency in the release of phosphorus as well as the reduction of its fixation in the soil (Iyamuremye *et al.*, 1996). Nutrient supply through organic sources ensures the availability of micronutrients to the plants (Parthasarathy *et al.*, 2004).

Impact of organic inputs on biological properties of soil:

Though many researchers have limited their scope of soil quality to physical and chemical properties of soil, other researchers have considered soil quality as important and have valued biological parameter as an important aspect of soil quality. The biological parameter needs to be included in the soil quality assessment process (Van Bruggen *et al.*, 2000). Biological properties of soil have been considered very important while assessing soil quality (Abawi *et al.*, 2000) as soil quality is influenced to a great extent by flora and fauna present in the soil. The living part of the soil organic matter present in the soil is called soil microorganisms (Dalal *et al.*, 1998). The

microbial biomass and microbial activities in the soil have been considered to be crucial to ensure the productivity of the soil. To ensure the consistent release of nutrients to the plants, it is important to have a balanced ratio of microbial biomass and microbial activities in the soil (Pandey *et al.*, 2012). Organic farming methods are said to increase microbial biomass and microbial activity by 20-30% and 30-100%, respectively (Stolze *et al.*, 2000). The soil having high organic matter content is said to ensure more microbial activity and more N supplying power compared to the soil having less organic matter content, which is inorganically managed (Gunapala *et al.*, 1998). Besides this, it is also said that the organic matter in the soil possesses the ability to sink CO2 in the atmosphere and thus increase the amount of carbon in the soil, which in turn increases microbial biomass and activity in the soil (Lal *et al.*, 1998) & (Sparling *et al.*, 2003). It is also well documented that the soil, which is inorganically managed, possesses more microbial population and is enriched with various beneficial microorganisms such as arbuscular mycorrhizal fungi, which helps in crop nutrition and reduction of plant diseases (Bethlenfalvay *et al.*, 1992). Arbuscular mycorrhizal fungi are special fungi that form symbiotic association with the root system of the plant (Schussler *et al.*, 2001). This mutual relationship is beneficial to plant as it will be able to absorb more P from the soil, and it will be protected from several diseases (Smith *et al.*, 1997). As organic farming increases microbial activities, competition, parasitism, and predation in the rhizosphere, it reduces the incidence of plant diseases (Knudsen *et al.*, 1995). The application of quality organic inputs will increase the microbial population in the soil (Chowdhury *et al.*, 2000). The application of organic fertilizer increases nodule dry weight, photosynthetic rates, N2 fixation, and an accumulation as well as N concentration in several crops (Jannoura *et al.*, 2014).

CONCLUSION:

The study highlights that organic farming practices significantly improve the physical, chemical, and biological properties of soil, mainly through increased soil organic matter and enhanced microbial activity. These improvements lead to better soil structure, nutrient availability, and overall soil productivity. Additionally, organic farming promotes environmental sustainability by reducing reliance on synthetic inputs, conserving biodiversity, and maintaining ecological balance. The integration of traditional agricultural knowledge with modern scientific approaches has strengthened the effectiveness and applicability of organic farming across diverse farming systems. Continuous refinement of organic practices and their wider adoption can further enhance soil resilience and sustainable agricultural production. Thus, organic farming stands as a holistic approach for sustaining soil health, environmental quality, and long-term agricultural productivity.

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