



Comparative analysis of Organic and Chemical (Traditional) farming practice in terms of Crop productivity and Environmental impact in rural area of India

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Abstract

Agriculture is the backbone of human society and it is crucial for the survival of human beings. The global agricultural commercial faces an unprecedented challenge: feeding a growing population while remaining environmentally sustainable. The current literature focuses on a comparative examination of organic and chemical farming systems in relation to seed productivity, long-term agricultural sustainability, and environmental implications in rural farming. Organic farming entails growing crops without using chemical fertilizers or pesticides. It uses natural methods such as green manure, whereas chemical farming makes use of chemical fertilizers, synthetic fertilizers, and pesticides to increase crop yields. Organic farming is helpful to biodiversity and environmental protection at the local level, although it produces lower yields than chemical farming, which often produces larger short-term yields. Organic farming focuses on ecosystem services to improve soil composition and biodiversity. The use of natural compost, green manure, and crop rotation has been shown to increase soil fertility and biodiversity. Chemical farming is a method of agriculture that increases greenhouse gas emissions, soil erosion, water pollution through runoff, loss of ecosystem services, and has a detrimental impact on human health. Organic items are more nutritious for health than products that have been treated with chemicals and fertilizers. Organic farming has significant environmental benefits, such as increasing biodiversity, lowering pollution, and mitigating climate change through fewer carbon emissions and increased carbon sequestration. The comparison of organic and chemical farming approaches reveals that organic farming has considerable benefits for soil health and environmental sustainability. In comparison to traditional farming, the upgraded organic farming system had a greater net return and benefit-cost ratio. This study found that organic farming is a better practice than chemical farming since it is more environmentally friendly, soil-friendly, and helpful to human health. The current literature gives great information and an overview of organic and chemical farming in terms of crop yield, soil health, and environmental impact in rural agriculture, as well as support for future examination of organic and chemical farming by the researcher.

Keywords: Agricultural productivity, Conventional farming, Crop yield, Environment friendly, Soil health

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Introduction

Agriculture in rural area is the backbone of the Indian economy which is process of producing food, feed, fiber and other products by the cultivation of crops. Agriculture farming plays a vital role in food security, employment, rural economy, meeting the food demands of the World. Agricultural sector in India has undergone significant structural changes. At present, the issue is whether to continue with the chemical inputs-based intensive technologies or to go back to the traditional environment friendly farming practices like organic farming for sustainable production, income and socio-economic development of the farming community (Krishnia and Rajawat, 2020). Agriculture farming of rural India and supports nearly half of the country's population because they provides livelihood to millions of rural families, major contributor to the economy, ensures food security for the nation and supports agriculture based industries. Agricultural development and equitable distribution of the benefits of economic growth are crucial for the global reduction of poverty and hunger. India is one of the largest agricultural producers in the world. Food crops including; rice, wheat,

millets and cash crops including; sugarcane, cotton, tea, spices, pulses and fruits, vegetables and flowers are grown and cultivated in rural India.

The agricultural sector is the leading contributor to the economy of Uttar Pradesh state. Besides striving to meet the food requirement, the sector has a strong impact on the needs and overall quality of life of the people of Uttar Pradesh. The agricultural production and productivity depends largely on the quality of land and sustainable practices. A balance between efficient and productive agricultural enterprise and environmental protection and sustainability is important to make agriculture sector an economically viable venture. In the recent decade, the achievement of self-sufficiency in food production in various states was accorded high priority in the food policies of the country (Yadav *et al.*, 2013). Early agricultural methods were based on local climate circumstances, but it is practice the same plant is being repeated in the field till the soil loses and its capacity. Agriculture has become more efficient as a result of techniques like crop rotation, irrigation and intercropping. However, the agriculture farming has changed dramatically many countries have shifted to more traditional practices.

Growing populations, economic instability, climate change and corporate incentives to produce larger yields have all played a role in this trend (Sushma, 2020).

Since human evolution, the farming practices concept has been changing with new innovations and connectivity with other continental peoples. The concept has totally changed from its core ideas, which is also favorable in point of meet the current demand form society. In current scenario, ecologist, scientific community, policy makers and economist making special affords to reduce the environmental burden of agricultural production and direct it toward more sustainable practices. To serve the purpose, we have conducted comparative study between organic and chemical farming with special reference to crop productivity and environmental impact in rural area agriculture. India has various types of agriculture due to different climates, soils, and rainfall patterns across states. The main types of agriculture are including; subsistence, intensive, commercial and plantation farming, alongside specific types like shifting cultivation, dryland and mixed farming. Organic agriculture and chemical (conventional) agriculture represent two distinct farming systems that have gained prominence in recent years. With the increasing awareness of sustainable and healthy food production, there has been a growing interest in comparing traditional (chemical) and organic farming systems. Organic farming emphasizes ecological sustainability, biodiversity conservation, and the exclusion of synthetic inputs, whereas cchemical farming relies on modern technologies, synthetic fertilizers, and pesticides to maximize productivity. This comparative analysis provides a comprehensive evaluation of both farming systems, in term of productivity, health and environment impact to sustainable agriculture. Understanding these differences is crucial for future researcher, policymakers, farmers, and consumers making informed decisions about agricultural practices and food choices.

(i) Organic Farming:-Organic farming known as environmentally friendly or ecofriendly farming, involves growing crops without using chemical fertilizers and pesticides (Figure 1). Natural techniques are used in organic farming, such as the usage of compost, vermi compost, and animal manure, mostly cow manure as well as certain powders combined with neem leaves. It is a sustainable farming method that combines nitrogen-fixing cover crops, organic fertilizers made mostly from plant and animal waste, and ecologically based insect management. In addition to using organic seeds, companion planting, biological pest control, and natural soil management, organic agriculture practices primarily concentrate on improving crop yield and soil quality. With major advantages for soil health, crop productivity and quality, and environmental sustainability, organic farming offers a practical and sustainable substitute for traditional agricultural methods. In fact, the use of synthetic fertilizers and chemical pesticides led to environmental damage, which prompted the development of organic farming. In contrast, organic farming avoids artificial chemicals and places an emphasis on natural processes, biodiversity conservation, and ecological balance. Producing enough food to feed the expanding population has been India's biggest challenge since gaining independence. As a result, insecticides, fertilizers, and irrigation water are infused into high-yielding cultivars. Organic farming is vital to the food production process, as well as the quality of life

today, tomorrow, and for future generations, by creating the conditions for sustainable development (Krishnia 2020).

Early in the 19th century, the idea of organic farming was presented. Sir Albert Howard, F.H. King, Rudolf Steiner, and others thought that using animal manure, cover crops, crop rotation, and biologically based pest management improved agricultural system (Pandey & Singh, 2011). Ancient farmers began cultivating using purely natural resources 10,000 years ago, which is when organic or natural farming first emerged (Bhattacharyya and Chakraborty, 2005). Actually, traditional farming methods that developed over the course of a millennium in many villages and farming communities are the origins of organic agriculture. An essential component of organic farming is composting, which increases soil fertility and structure, improves water retention, and fosters the growth of beneficial microorganisms. Organic farming relies on natural inputs and ecological processes, avoiding synthetic chemicals while promoting soil health, biodiversity, and sustainability. Crop rotation, composting, biological pest control, and the use of organic fertilizers are some of the methods used by organic farmers to keep pests and diseases at bay and preserve soil fertility. Healthy soils give crops the nutrients they need, retain water, and support a variety of biological communities that are vital to the balance of ecosystems. To put it another way, organic farming is a novel approach to farming that restores, preserves, and enhances the natural equilibrium. Organic farming is better for the environment. India is now one of the world's leading producers of organic food, having seen tremendous growth in organic agriculture. According to research, organic farming significantly improves India's health by ensuring long-term growth (Dinesh, 2020).

(ii) Chemical farming (Traditional Farming):-Chemical farming is the use of chemical or synthetic fertilizers, insecticides, and genetically modified organisms in huge amounts to boost yields (Figure 1). Chemical farming, commonly known as conventional or industrial farming, is primarily reliant on synthetic fertilizers to increase crop productivity. Due to the use of synthetic chemicals, cutting-edge technologies, and enhanced crop varieties, chemical farming produces greater, more reliable yields and efficiency, but it also degrades soil, reduces biodiversity, pollutes the environment, and may be more detrimental to people and the environment. Conventional farmers, who can produce in greater quantities and satisfy market demands, may benefit from economies of scale and more accessible distribution routes. Production from this form of farming is only good to food security and the economy. Continuous use of chemical inputs alters the natural balance of nutrients and significantly affects soil biodiversity by lowering microbial activity and beneficial species (Shriwas, 2020). Synthetic inputs help farmers control pests, boost crop yields, and reduce post-harvest losses. Globally, chemical farming, which requires vast amounts of inputs, was chosen as a response to world requirements. However, the way the land is managed has resulted in environmental and ecological consequences (Krishnia, 2020).

Historically, conventional or chemical farming in India produced enough food for its own consumption while also producing a surplus for trade. At some point, the demand for personal consumption and raw resources for industries began to rise as the country's and the world's populations increased. The demand for alternate farming methods has begun to emerge, necessitating the resolution of this issue. The

agriculture system began using synthetic chemical fertilizers and pesticides, which is known as conventional or chemical farming (SUSHMA, 2020). Chemical farming systems routinely produce higher yields per hectare in the near term thanks to synthetic fertilizers. However, these inputs frequently result in correspondingly better yields, potentially increasing cost-efficiency per unit of production. Synthetic fertilizers give nutrients that are readily. Cereal crops with the highest yield disparities are wheat, rice, and maize, which are grown chemically. Conventional farming is one of the most popular agricultural methods due to its advantages for both producers and consumers, such as availability and affordability.

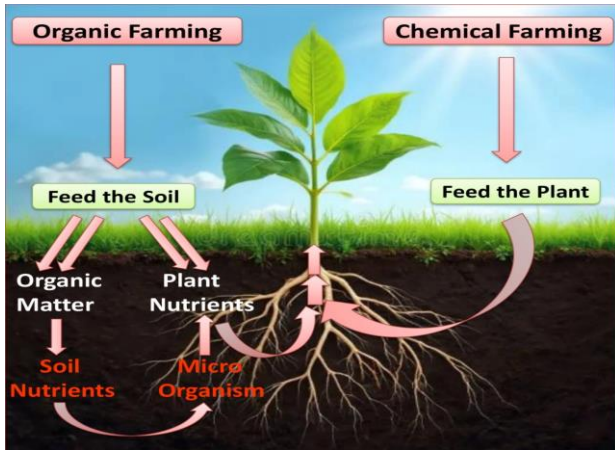


Figure 1: Organic and chemical fertilizers use in organic farming and Chemical farming
Comparative Analysis of Organic and Chemical (Traditional) farming:

- Unlike conventional farming, which frequently heavily relies on chemical fertilizers and pesticides, organic farming practices are recognized for their emphasis on preserving and enhancing soil health. By avoiding synthetic chemicals and pesticides, organic farming uses natural compost, green manure, and crop rotations to minimize soil contamination and degradation, preserving the soil's long-term health and productivity (Clark and Tilman, 2017).
- The advantages of organic farming in terms of biodiversity and nutrient control are well known. Compared to chemical systems, organic farms had higher levels of soil organic matter and nitrogen retention, which enhanced soil fertility and decreased nitrogen losses to the environment. Natural processes like biological nitrogen fixation and organic fertilization are the foundation of organic systems, which lessen the negative environmental effects of industrial pesticides and fertilizers (Pimentel *et al.* (2005).
- Compared to crops grown traditionally (with chemicals), organic crops may have higher concentrations of specific nutrients and antioxidants. Chemical farming frequently uses synthetic pesticides and fertilizers, which can eventually cause soil deterioration. They frequently cause soil compaction, a decrease in organic matter, and a reduction in microbial diversity. Long-term problems with chemical farming include erosion, decreased fertility, and greater susceptibility to pests and illnesses (Tiwari, 2021).
- Organic farming can reduce input costs by developing self-sustaining systems that require less external inputs. However, chemical farming frequently necessitates higher initial expenses for synthetic inputs, apparatus, and technology.

Chemical fertilizers, insecticides, and hybrid seeds can be expensive.

- Converting to organic farming may not always result in higher yields, as it depends on crop production methods, soil conditions, and climate. When switching to organic agriculture, a paradigm shift is required from external input packages that treat issues to preventive management and extensive knowledge inputs (Nemes, 2009).
 - In comparison to conventional farms, organic farms showed higher levels of microbial biomass, enzymatic activity, nutrient content, soil organic matter, and pH balance. The use of natural inputs (compost) in organic farming, which increase soil structure and nutrient cycling, is responsible for these gains (Shriwas, 2020).
 - Long term study was also done by Mader *et al.* (2002), on organic and chemical farming systems, and proof that Organic farms improved long-term soil fertility by increasing microbial biomass and activity, which are required for nutrient cycling and soil regeneration.
 - Chemical farming uses synthetic fertilizers and pesticides, which deplete soil nutrients faster. These chemical inputs provide rapid nutrient release, decreased microbial activity, and soil acidification. Rapid nutrient depletion in chemical systems may need even higher inputs of synthetic fertilizers over time, creating a cycle of soil health decline (Shriwas, 2020).
 - Organic farms may have greater levels of phosphate and nitrogen. In contrast to chemical (traditional) farms that rely on synthetic fertilizers, which frequently experience nutrient depletion due to the quick release and leaching of nutrients, particularly nitrogen, organic soils have a higher nutrient content because they regularly use organic fertilizers, crop residues, and green manures, all of which improve nutrient cycling and retention (Shriwas, 2020).
 - Due to consumer demand for sustainable and healthful options, organic products sometimes fetch higher costs. For farmers, especially small-scale producers, obtaining organic certifications and markets may be difficult. However, traditional farmers may profit from economies of scale and easier distribution channels due to their capacity to meet market demands and produce larger quantities.
 - Synthetic pesticides are frequently used in chemical farming, which can be harmful to human health. During application, farmers and other agricultural workers are exposed to these chemicals, and pesticide residues on crops may have an impact on consumers. Farmers, customers, and nearby ecosystems all gain when pesticide exposure is decreased through organic farming.
- Organic farming reduces exposure to toxic chemicals on farms and food, whereas chemical farming increases the risk of diseases like cancer, allergies, obesity, diabetes, high blood pressure, heart disease, and birth defects.
- Impact on Crop productivity of Organic and Chemical farming:** Organic farming produces lower yields, however recent research indicate that the gap is reducing as organic agricultural practices progress. Organic farming food is frequently credited with superior nutritional content, including higher quantities of antioxidants and vitamins. To achieve these benefits, organic farms must be carefully planned and managed, taking into account aspects such as crop variety, soil type, and local ecological circumstances (Shah and Buddha, 2020, Nemes, 2009). Because organic produce is free of chemical pesticides and fertilizers, it contains less chemical residues, which is an important

consideration for consumers worried about food safety. Organic crops are generally credited with having higher quantities of specific nutrients, antioxidants, vitamins, and minerals (Tully and McAskill, 2020). Conventional farming typically produces higher yields due to the use of synthetic inputs, new technologies, and improved crop types. The ability to more effectively control pests and diseases, combined with access to high-yielding hybrid or genetically modified crop varieties, all contribute to higher seed output. Organic crops may produce more consistent yields in challenging circumstances because they are frequently more resilient to environmental stresses like drought. Due to the extensive use of synthetic fertilizers and pesticides, conventional farming usually produces more crops in the short term, but it can also degrade soil health, which may eventually lower the seed's capacity to produce (Bai et., 2018, Tiwari, 2021).

Chemical farming allows farmers to grow more crops due to its low production costs. Conventional (chemical) farming production contributes to meeting increased food demand. Food production has begun to decline in recent years as a result of numerous natural disasters and global warming. Many farmers have shifted to conventional farming over organic farming as chemical farming makes it possible to grow more crops (Sushma, 2020). Short-term yields per hectare are consistently greater in chemical farming methods. Because synthetic fertilizers offer nutrients that are instantly available, plants can grow more quickly and produce more biomass. The yields from organic farming, however, vary less from season to season. While organic farming improves soil health through crop rotation, cover crops, and composting, chemical farming depends on outside inputs to sustain fertility. Over time, this distinction produces unique patterns of productivity. Through targeted fertilizer applications, chemical systems may promptly rectify nutrient shortfalls, resulting in consistently high yields. On the other hand, persistent chemical use can cause soil deterioration, which lowers the potential for long-term output. All types of food products, including oilseeds, sugarcane, cereals, millets, cotton, pulses, medicinal plants, tea, fruits, spices, dried fruits, vegetables, coffee, and more, were produced in India in 2017–18, totaling over 1.70 Mt of certified organic products. Despite having only 2.59% of the world's total cultivable land, India produced 30% of all organic products (APEDA, 2017, Buragohain, 2020).

Environmental Impact of Organic and Chemical farming:

Organic farming plays a protective role in preserving the environment. An ecological method of agricultural management, organic farming enhances biological cycles and biodiversity. Growth hormones, synthetic chemicals, herbicides, and genetic modification techniques are not used in organic farming. Organic farming improves, maintains, and restores ecological balance (Winter and Davis, 2006). Chemical and organic farming methods have differing effects on the environment and people. Chemical agriculture causes increased greenhouse gas emissions, land erosion, water pollution, and human health, whereas organic farming lowers carbon emissions and restores natural ecosystems for cleaner water and air, all while avoiding dangerous pesticide residues (Sushma, 2020). Organic farming has favorable long-term benefits on the ecosystem because it encourages biodiversity and preserves natural resources, making it environmentally benign. Groundwater pollution is a big concern in many regions of the country due to the widespread use of chemical

fertilizers and pesticides; however, embracing organic agriculture, which restricts the use of pesticides and chemical fertilizers, can help to ameliorate the problem. Furthermore, the absence of chemical inputs produces favorable environments for wildlife.

The constant use of chemical inputs disrupts the natural nutrient balance and has a negative impact on soil biodiversity by lowering microbial activity and beneficial species. Furthermore, chemical farming adds to water pollution through runoff and increases greenhouse gas emissions, causing broader environmental concerns such as climate change and loss of ecosystem services (Shriwas, 2020) The chemical farming system produces soil erosion, water pollution, increased greenhouse gas emissions, severe effects on human health, and a loss in soil productivity. This is due to topsoil erosion caused by wind and water, loss of organic soil matter, lower water holding capacity, and soil degradation. Reduced carbon emissions, agrochemical contamination, and biodiversity conservation are all benefits of organic agricultural methods. Agroforestry and cover crops can improve carbon sequestration and help mitigate climate change by avoiding synthetic fertilizers and pesticides (Das et. al, 2017).

One of the main advantages of organic farming is environmental sustainability. Organic agricultural methods minimize pollution and save water resources by using natural resources instead of artificial chemicals. Additionally, these methods promote biodiversity in terms of crop types and the larger ecological system, which includes soil microbes and beneficial insects (Schrama *et al.*, 2018). Cover cropping promotes carbon sequestration. However, organic farming can require more acreage to produce the same amount of food as conventional methods, which is a topic to consider in terms of environmental effect (Boone et. al, 2019, Singh et., 2020). While conventional agricultural operations have proven to be effective in generating vast quantities of food, their environmental impact is becoming increasingly important. Issues include greenhouse gas emissions from synthetic fertilizers, degradation of water sources due to chemical runoff, and a decline in biodiversity caused by habitat destruction and the usage of monocultures (Tiwari, 2021). Biodiversity in organic and conventional farming systems found that organic farms typically sustain more species diversity, especially soil fauna like microbes and earthworms, which are essential to soil aeration, nutrient cycling, and ecosystem health. Long-term sustainability is increased by organic farming since it promotes soil health and provides ecosystem services like pollination and insect control (Hole *et al.*, 2005).

Organic farming outperforms conventional farming in terms of microbial diversity preservation and enhancement. Chemical farming, while initially beneficial, can cause soil damage over time. Continuous use of synthetic fertilizers can deplete soil organic matter and impair beneficial microbial populations. Organic farms promote habitat variety through hedgerows, cover crops, and low-impact methods, while. Chemical farming systems, while possibly benefiting biodiversity through habitat management practices, typically have lower species diversity due to pesticide use and simpler crop rotations. Chemical farming contributes to greenhouse gas emissions by producing and applying synthetic fertilizers. Organic agriculture helps to lessen the greenhouse effect and reduce global warming by using fewer or no pesticides and inorganic fertilizers. It also helps to conserve biodiversity.

The absence of agrochemicals minimizes the risk of ground water pollution and improves the ecology by providing a suitable habitat for wildlife (Rahmann *et al.*, 2017).

Impact on Sustainable Agriculture of Organic and Chemical farming:-The emphasis on soil health and biodiversity in organic farming helps agricultural systems to be more sustainable in the long term. Organic farmers improve soil structure, water retention, and nutrient cycling by using organic fertilizers, cover crops, and crop rotations. Organic farming has emerged as a sustainable alternative to conventional practices, emphasizing soil fertility and ecosystem health through natural inputs and practices such as crop rotation, composting, green maturing, and the avoidance of synthetic chemicals. These practices increase soil organic matter, improve nutrient cycling, and promote a healthy microbial ecosystem. More and more people believe that organic farming may reverse the negative consequences of conventional agriculture while maintaining long-term sustainability and food security (Shriwas, 2020). Building organic matter, microbial activity, and beneficial soil organisms are top priorities for organic growers. Over time, conventional farming methods, such as the extensive use of chemicals, can deteriorate soil health, resulting in nutrient depletion, soil erosion, and a decline in soil biodiversity. Organic farming encourages biodiversity conservation by avoiding synthetic pesticides and creating habitat for beneficial organisms. Organic farms promote pollinator populations, natural pest foes, and other beneficial insects by reducing chemical inputs and developing diversified landscapes.

Conclusion

The advantages and disadvantages of conventional and organic farming methods are compared, along with how they affect agricultural productivity and the environment. Organic farming prioritizes long-term sustainability, environmental benefits, and lower health concerns connected with pesticide use, while traditional farming excels in production and short-term profitability owing to the use of synthetic inputs and technological technologies. An eco-friendly, more sustainable option that gradually enhances soil health is organic farming. By enhancing food quality, sustainability, and soil health, organic farming has a favorable effect on agriculture. However, obstacles like as lower initial yield and certification issues necessitate appropriate legislative support and farmer education. The decision between the two techniques is influenced by a variety of factors, including market dynamics, resource availability, and personal beliefs. Encouraging sustainable farming techniques and supporting farmers can result in a more resilient and healthier agricultural system that serves the requirements of current and future generations. Although chemical farming currently produces the higher yields required to meet the world's food demands, it also poses environmental problems that could jeopardize the sustainability of agriculture in the long run. Future agricultural growth should prioritize developing farming methods that can attain high production while remaining environmentally sustainable. Biodiversity benefits significantly favor organic agricultural systems, which indicate superior environmental sustainability through improved soil health, reduced pollution, and increased biodiversity. Thus, a comparison analysis of organic and chemical agriculture indicates that organic farming practices are beneficial in boosting sustainability, biodiversity, food quality, and maintaining healthy ecosystems, resulting in

long-term economic viability. Therefore, environmental sustainability must be given top priority when developing and enforcing agricultural regulations, and the long-term financial advantages of organic farming must also be taken into account. This study sheds light on the benefits of organic farming in terms of crop productivity and environmental impact in rural areas; nevertheless, more research is required to fully grasp the long-term benefits of organic systems, particularly yield stabilization. Furthermore, organic farming practices will be critical in encouraging the adoption of sustainable farming practices in rural communities.

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