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The Role of Organic Agriculture in Agricultural Development

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Abstract:

Organic agriculture has the potential to meet the world's food needs while using resources sustainably. This review highlights how organic farming promotes sustainable resource use in food production and development, leading to less pollution and reduced greenhouse gas emissions, ultimately combating climate change. Recent studies indicate that organic farming is well-equipped to feed the current and future population. Organic yields are comparable to conventional yield outperform during droughts, use 45% less energy, and are more efficient. Conventional farming systems generate 40% more greenhouse gases, whereas organic systems are more profitable and enhance soil organic matter, supporting soil biodiversity and creating a sustainable system. Organic agriculture combines environmentally-friendly practices with low external inputs, contributing to food security. To counter the negative impacts of conventional farming, adopting organic practices is crucial, as it not only provides safe food but also has the potential to mitigate climate change through soil carbon sequestration. Organic agriculture is a pathway to sustainable development for humanity.

Keywords: Organic Agriculture, Sustainable development, conventional agriculture, food security, pollution.

Introduction:

The agriculture sector is crucial for ensuring the nation's food and nutritional security. It serves as the primary source of livelihood for over 58% of the population, despite contributing only 14.2% to the national GDP (Department of Agriculture and Cooperation). This situation puts immense pressure on land and results in fragmented land holdings. Additionally, the annual consumption of fertilizers has surged . Fertilizer usage per hectare has also increased from less than 1 kg in 1951-52 to an estimated 135.27 kg in 2009-10 . The intensive use of inorganic fertilizers and pesticides has been a key strategy for boosting crop production, with higher fertilizer consumption indicating agricultural growth .Productivity has increased, but soil fertility depletion is a common issue. The continuous and extensive use of agrochemicals is degrading the environment by reducing soil fertility, polluting water, and significantly contributing to global warming, climate change, and ozone layer depletion. According to the National Bureau of Soil Survey and Land 21.97 million hectares of land are degraded due to acidity and alkalinity/salinity . Indiscriminate fertilizer use directly affects soil health, impacting productivity and mineral composition. Changes in carbon stocks due to agricultural practices, such as clearing primary forests, are also excluded. Deforestation for agricultural land conversion contributes an additional 12% to global GHG emissions. Therefore,

agricultural production practices emit at least one-quarter of global anthropogenic GHG emissions. If food handling and processing activities are included, the agricultural and food sector's share of emissions would be at least one-third of total emissions. Given agriculture's significant contribution to anthropogenic GHG emissions, food production practices can either exacerbate or help solve global warming. Recent studies highlight the significant role of organic agriculture in mitigating and adapting to climate change, primarily based on its potential for soil carbon sequestration.

Organic agriculture offers a unique combination of environmentally-sound practices with low external inputs while contributing to food availability . The objective is to describe the potential of the organic agriculture to provide an alternative way for conventional agricultural practices which leads to a sustainable resource utilization and contributes in mitigating global problems like climate change.

Objectives of the Research:

- Describe the potential of organic agriculture practices to provide an alternative way for conventional agriculture practices which lead to a sustainable architecture development.
- Introduce the concept of Organic agriculture.
- Compare between Organic and Conventional agriculture ways.
- Examine the effects of organic farming on soil fertility, structure, and microbial activity, and how these changes support sustainable crop production.
- Identify the factors influencing the adoption of organic farming practices among farmers, including barriers and incentives.
- Study the social benefits of organic farming, such as improved livelihoods for farmers, community health benefits, and enhanced food security.
- Assess how organic agriculture practices contribute to the sustainable use of natural resources, including soil health, water conservation, and biodiversity.

➢ The Concept of Organic Agriculture:

Many terms are used interchangeably with organic farming, including biological agriculture, ecological agriculture, bio-dynamic, organic-biological agriculture, and natural agriculture. According to the National Organic Standards Board of the US Department of Agriculture (USDA), "organic" is defined as: “An ecological production management system that promotes and enhances biodiversity, biological cycles, and soil biological activity. It is based on the minimal use of off-farm inputs and on management practices that restore, maintain, and enhance ecological harmony” .

The Codex Alimentarius Commission (FAO) describes organic agriculture as “a holistic production management system that avoids the use of synthetic fertilizers, pesticides, and genetically modified organisms, minimizes pollution of air, soil, and water, and optimizes the health and productivity of interdependent communities of plants, animals, and people.” To achieve these goals, organic farmers implement practices such as crop rotations, increased crop diversity, integrating livestock with plants, symbiotic nitrogen fixation using legumes, applying organic manure, and using biological pest control. These strategies aim to maximize the use of local resources.

2. The Role of Organic Agriculture for Agricultural Sustainable development :

When the World Commission on Environment and Development presented their report, Our Common Future, they aimed to resolve conflicts between environmental and development goals by defining sustainable development as: "development which meets the needs of the present without compromising the ability of future generations to meet their own needs" .

An environmentally sustainable system must maintain a stable resource base by avoiding the over-exploitation of renewable resources and environmental sink functions, and by only depleting non-renewable resources if adequate substitutes are invested in. This includes preserving biodiversity, maintaining atmospheric stability, and supporting other ecosystem functions that are not typically considered economic resources

The United Nations report indicated that all case studies focusing on food production within the research showed increases in per hectare productivity of food crops. This finding challenges the widely held belief that organic agriculture cannot enhance agricultural productivity.

3. The Relationship between Organic Agriculture and Sustainable Agricultural Development

Firstly, organic agriculture promotes sustainable resource management. By avoiding synthetic fertilizers and pesticides, organic farming maintains soil fertility, reduces pollution, and enhances ecosystem health. These practices ensure the long-term viability of agricultural lands, which is essential for sustainable agricultural development. Healthy soils and diverse ecosystems are the foundation of resilient farming systems capable of supporting continuous food production without degrading the natural resource base.

Economically, organic farming can be highly beneficial for farmers. It often involves lower input costs since it relies on natural inputs and techniques. Additionally, organic products typically fetch higher prices in the market, leading to better income for farmers. This economic viability can significantly contribute to rural development, improving the livelihoods of small-scale farmers and fostering economic growth within agricultural communities. As farmers become more economically secure, they can invest in better farming practices and technologies, further driving agricultural development.

Globaly, Organic agriculture also plays a crucial role in food security. By enhancing soil health and biodiversity, organic farming systems can improve crop yields and stability. This resilience is particularly important in the face of climate change and extreme weather events, which are becoming increasingly common. Organic farming’s emphasis on diverse cropping systems and soil health makes it better equipped to withstand such challenges, ensuring a stable food supply for communities.

Environmentally , Environment protection is another key benefit of organic agriculture. By reducing reliance on chemical inputs, organic farming lowers greenhouse gas emissions and mitigates climate change. It also preserves natural habitats and promotes biodiversity, contributing to the overall health

of the planet. These environmental benefits are vital for the sustainable development of the agricultural sector, as they help to maintain the natural resources upon which agriculture depends.

Medically, Health benefits derived from organic farming are also significant. Organic agriculture produces food free from synthetic chemicals, which can lead to better public health outcomes and reduced healthcare costs. Healthier communities are more productive, contributing positively to agricultural development. When people consume healthier foods, their overall well-being improves, which can enhance labor productivity and economic growth in agricultural regions.

Lastly, organic agriculture often aligns with traditional farming practices and local knowledge systems. This alignment promotes cultural heritage and community cohesion, adding a social dimension to agricultural development. By preserving and valuing traditional practices, organic farming supports a holistic approach to development that respects cultural values and fosters community solidarity.

1. Main Principles of Organic Farming and Food Processing:

Methodology:

Organic farming differentiates itself from conventional agriculture by upholding values that prioritize human well-being, environmental protection, nature, and animal welfare. These values are embedded in the foundational principles of organic farming as defined by the International Federation of Organic Agriculture Movements (IFOAM). The primary principles (IFOAM, 2002) include:

1. Producing high-quality food in sufficient quantities.
2. Operating within natural cycles and closed systems as much as possible, utilizing local resources.
3. Maintaining and improving soil fertility and sustainability over the long term.
4. Creating a harmonious balance between crop production and animal husbandry.
5. Ensuring high levels of animal welfare.
6. Promoting local and regional production and supply chains.
7. Supporting the development of a production, processing, and distribution chain that is socially and ecologically justifiable.

These principles provide a framework for organic farming to support environmental health and sustainable development, even though the direct mention of sustainable development for mankind is not explicitly stated.

A Comparison between Organic vs. Conventional Agriculture.

A study conducted in California's Central Valley found that tomato yields were similar between organic and conventional farms. However, organic farms exhibited significantly better soil health indicators, such as nitrogen mineralization potential and microbial abundance and diversity, which were three times and significantly higher, respectively, compared to conventional farms. Organic fields also had 28% more organic carbon.

One of the longest-running agricultural trials, the Broadbalk Experiment at Roth Amsted Experimental Station in the UK, compares manure-based fertilizer farming with synthetic chemical fertilizer farming. Results showed slightly higher wheat yields in organically fertilized plots (3.45 tons/hectare) compared to chemically fertilized ones (3.40 tons/hectare). More importantly, soil fertility, measured by soil organic matter and nitrogen levels, increased by 120% in organic plots versus a 20% increase in chemically fertilized plots. The Sustainable Agriculture Farming Systems project at the University of California, Davis, found that organic and low-input systems had yields comparable to conventional systems for crops like tomatoes, safflower, corn, and beans. Initially, organic tomato yields were lower, but they matched and eventually exceeded conventional yields in later years (80 t/ha in organic vs. 68 t/ha in conventional). In South Dakota, studies showed higher average yields for soybeans (3.5%) and wheat (4.8%) in organic systems compared to conventional farming.

A 21-year study by the Institute of Organic Agriculture and the Swiss Federal Research Station for Agro ecology and Agriculture found that organic yields were about 20% lower but used 34% less fertilizer, 53% less energy, and 97% less pesticide compared to conventional methods. Organic soils also supported a larger and more diverse community of organisms.

Research at Iowa State University indicated that initially, organic corn and soybean yields were slightly lower (91.8% and 99.6% of conventional yields, respectively), but in the fourth year, organic yields surpassed conventional ones for both crops. The 30-Year Farming System Trial at the Rodale Institute found that organic corn yields were 31% higher than conventional yields during drought years. These yields were significantly better compared to genetically engineered drought-tolerant varieties, which saw only a 6.7% to 13.3% increase over conventional varieties. Additionally, organic systems tolerated higher weed competition while maintaining equivalent yields, a significant factor given the rise of herbicide-resistant weeds in conventional systems.

In Andhra Pradesh, India, the ETC Organic Cotton Programme reported that organic cotton yields were on par with conventional cotton (232 kg/acre vs. 105 kg/acre), with pest control costs being significantly lower in organic farming (Rs. 220 per acre) compared to conventional farming (Rs. 1624 per acre) (Daniel et al., 2005). A study at Washington State University compared apple yields using organic, conventional, and integrated methods. Organic systems ranked highest in overall sustainability, followed by integrated and then conventional systems.

A survey by the Indian Institute of Soil Science on certified organic farms found that organic farming resulted in 9.2% lower crop productivity compared to conventional farming. However, the average cultivation cost was 11.7% lower in organic farming, with a 22% higher net profit when a 20-40% premium was provided.

Results of Study:

- ✓ Research in California's Central Valley showed that tomato yields were similar between organic and conventional farms. While yields were comparable, organic farms exhibited better soil health indicators, such as significantly higher nitrogen mineralization potential and microbial abundance and diversity. Organic fields also contained 28% more organic carbon.
- ✓ The Broad Balk Experiment in the UK, one of the longest-running agricultural trials, indicated that wheat yields were slightly higher in organically fertilized plots compared to chemically fertilized ones. More significantly, soil fertility, as measured by soil organic matter and nitrogen levels, increased by 120% in organic plots compared to a 20% increase in chemically fertilized plots.
- ✓ Studies from the Sustainable Agriculture Farming Systems project at the University of California, Davis, found that organic and low-input systems had yields comparable to conventional systems across various crops, and sometimes even higher. Notably, organic tomato yields, initially lower, eventually surpassed conventional yields. Similarly, in South Dakota, organic systems yielded higher average yields for soybeans (3.5%) and wheat (4.8%) compared to conventional systems.
- ✓ A 21-year study by the Institute of Organic Agriculture and the Swiss Federal Research Station showed that while organic yields were about 20% lower, the use of fertilizers, energy, and pesticides was reduced by 34%, 53%, and 97%, respectively. Organic soils also supported a larger and more diverse community of organisms.
- ✓ The Rodale Institute's 30-Year Farming System Trial found that organic corn yields were 31% higher than conventional yields during drought years. This is in contrast to genetically engineered drought-tolerant varieties, which showed only a 6.7% to 13.3% yield increase over conventional varieties.
- ✓ A study in Andhra Pradesh, India, reported that organic cotton yields were on par with conventional cotton but with significantly lower pest control costs (Daniel et al., 2005). Additionally, research at Washington State University found that organic apple production ranked highest in overall sustainability when compared to conventional and integrated methods.
- ✓ A survey by the Indian Institute of Soil Science revealed that while organic farming had 9.2% lower crop productivity on average, the cost of cultivation was 11.7% lower, resulting in a 22% higher net profit when a premium of 20-40% was provided. The study also noted improvements in soil quality, indicating enhanced soil health and sustainability.

GENERALLY: These findings underscore that organic agriculture can be a viable alternative to conventional farming, offering benefits such as improved soil health, increased resilience to climate extremes, reduced environmental impact, and potential economic advantages. Despite some challenges, such as initially lower yields and the need for premiums to ensure profitability, organic farming presents a sustainable pathway for agricultural development.

Recommendations:

Organic agriculture focuses on producing food using natural substances and processes. Here are some recommendations for improving in organic farming:

- Compost and Organic Matter: Use compost, cover crops, and green manure to improve soil structure and fertility.
- Crop Rotation: Implement diverse crop rotations to enhance soil health and reduce pest and disease cycles.
- Biological Controls: Introduce beneficial insects and microorganisms to manage pests.
- Cultural Practices: Use intercropping and proper spacing to reduce pest outbreaks.
- Mechanical Controls: Employ traps, barriers, and manual removal to control pests.
- Efficient Irrigation: Use drip irrigation or other water-saving techniques
- Rainwater Harvesting: Collect and use rainwater to reduce dependence on external water sources
- Organic Fertilizers: Use natural fertilizers like compost, manure, and bone meal.
- Leguminous Crops: Plant legumes to fix nitrogen naturally in the soil.
- Hand Weeding: Regular manual weeding to manage weed populations.
- Habitat Conservation: Preserve natural habitats around the farm to encourage beneficial wildlife.
- Understand Certification Requirements: Familiarize yourself with organic certification standards and procedures.
- Record Keeping: Maintain detailed records of farming practices, inputs, and harvests for certification and management purposes.
- Direct Marketing: Sell products directly to consumers through farmers' markets, CSAs (Community Supported Agriculture), or farm stands.
- Value Addition: Offer processed organic products like jams, juices, or dried fruits to increase market value.
- Continuous Learning: Stay updated with the latest organic farming techniques through workshops, courses, and literature.
- Networking: Join organic farming associations and networks for support and knowledge sharing.
- Environmental Stewardship: Prioritize practices that protect the environment and conserve resources.
- Social Responsibility: Ensure fair labor practices and contribute positively to the local community.

Conclusion:

A thorough analysis of various comparative studies on agricultural yields indicates that organic farming often matches or surpasses conventional farming methods. Although some studies report overall lower yields, the economic benefits remain superior due to reduced reliance on external inputs. In addition to yield comparisons, organic practices demonstrate higher soil organic matter, reduced energy consumption, decreased use of external inputs, improved food quality, and the potential to address global challenges such as climate change.

In conclusion, organic agriculture offers numerous advantages over conventional farming. It not only maintains or even improves yield in many cases but also enhances economic viability through lower external input costs. Organic practices promote higher soil organic matter, reduced energy consumption, and improved food quality. Additionally, organic farming has the potential to contribute positively to global issues such as climate change mitigation. Therefore, embracing organic agriculture can lead to more sustainable, environmentally friendly, and economically viable farming systems.

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