

Organic Agriculture in India: A Review of Current Status, Challenges, and Future Prospects

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Received January 24, 2023; Revised March 1, 2023; Accepted March 27, 2023

Cite This Paper in the Following Citation Styles

(a): [1] Roshan Raj Bhujel, Harisha G. Joshi, "Organic Agriculture in India: A Review of Current Status, Challenges, and Future Prospects," *Universal Journal of Agricultural Research*, Vol. 11, No. 2, pp. 306 - 313, 2023. DOI: 10.13189/ujar.2023.110208.

(b): Roshan Raj Bhujel, Harisha G. Joshi (2023). *Organic Agriculture in India: A Review of Current Status, Challenges, and Future Prospects*. *Universal Journal of Agricultural Research*, 11(2), 306 - 313. DOI: 10.13189/ujar.2023.110208.

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Abstract Organic agriculture has gained significant attention as a potential solution to India's food security challenges. This study aims to provide a comprehensive review of the existing literature on organic farming in India and to identify avenues for future research. This study aimed to examine the connection between organic farming practices and increased crop yields and agricultural output and assess the potential impact of organic agriculture on food security in India. The methodology involved a thorough review of relevant literature. The results of this study showed that organic agriculture has the potential to improve food security in India. However, further research is needed to understand this impact fully. The conclusions highlight the importance of long-term evaluations of the viability and scalability of organic farming as a solution to food security in India, as well as research on the economic and social variables impacting the acceptance and effectiveness of organic agricultural practices. This study also emphasizes the need for further studies comparing the outcomes of organic and conventional farming practices. The contribution of this study to the field is that it provides a comprehensive overview of the current state of organic farming in India and identifies areas for future research. The research limitations and implications and the practical and social implications of organic agriculture are also discussed. The limitation of this review is that the availability of data and information on the topic of organic agriculture in India might be limited, which can impact the comprehensiveness of the review and the ability to synthesize the existing literature fully.

Keywords Organic Farming, Sustainable Agriculture, Sustainability, Organic Production, India

1. Introduction

The history of organic farming in India is deeply rooted in traditional farming practices, which have existed for thousands of years. Traditional Indian farming has always emphasized using natural resources and processes to produce crops without harming the environment. In recent years, the organic farming movement has gained momentum in India as people have become more concerned about the harmful effects of conventional farming methods on the environment and human health. The government has also recognized the importance of organic farming and has taken several initiatives to promote it. These include setting up organic farming zones, providing subsidies to farmers for organic inputs, and establishing organic certification programs.

Additionally, several non-governmental organizations have been actively promoting organic farming in India, working to educate farmers about the benefits of sustainable agriculture and providing training on organic farming practices. Despite these efforts, however, organic farming in India still faces numerous challenges, including a lack of infrastructure, limited access to markets, and the high cost of organic inputs. This paper aims to examine the various aspects of organic farming in India, focusing on biofertilizers and vermicomposting, to understand better

the benefits, challenges, and prospects of this sustainable farming practice.

2. Materials and Methods

The researcher conducted this review study intending to identify existing literature on organic farming in India. Scopus, web of science, EBSCO, ProQuest, science direct, Google Scholar, semantic scholar and ResearchGate were used as the databases to locate and identify journal articles with high-impact results. To begin locating and identifying studies, the researcher employed keywords such as "benefits", "significance", "organic farming", and "India", resulting in 16,700 search results. Also, the researcher applied a critical screening procedure emphasizing inclusion/ exclusion criteria to determine relevant articles necessary for this paper. After thoroughly screening paper abstracts and titles, 40 articles were selected. The 40 articles were further examined according to established criteria and restrictions. The inclusion criteria included studies demonstrating a theoretical interpretation of organic farming, exploring the benefits of organic farming, and addressing the benefits of organic farming in India. This led to the exclusion of 12 articles. The remaining 28 articles were processed through full-text analysis and inclusion/exclusion criteria, resulting in 20 being selected for review.

3. Literature

This section entails a review of the literature regarding organic farming in India.

3.1. Definition of Organic Farming

Various studies contend that excessive conventional farming can contribute to contamination of the entire food chain, calling for the adoption of safer and better foods produced through eco-friendly practices that are highly authentic, thus the need for 'organic farming'. The International Federation of Organic Agriculture Movements (IFOAM) defines 'organic farming' as the agricultural process that utilizes ecologically based bio-fertilizers and pest controls abstracted substantially from plant and animal waste and organic manure [1]. In other words, organic farming emphasizes using natural ways to cultivate plants and rear animals, as opposed to conventional farming, which relies mainly on synthetic pesticides and chemical fertilizers. According to Elayaraja [2], organic farming can ensure the production and consumption of eco-friendly and authentic food and products, reflecting go-green farming practices. Dey [3] highlights that organic farming utilizes biological input to uphold and manage soil fertility and ecological equilibrium, alleviating waste and pollution and sustaining people's

health.

3.2. Need for Organic Farming

Sustainability has become a buzzword in every sector globally, with organic farming being a proponent of agriculture. Organic lifestyle is gradually becoming the core concern in the 21st century. Organic farming aims to impact human health and the planet positively. Elayaraja [2] highlight that adopting organic farming is crucial to avoiding chemical-based pesticides and fertilizers. The process emphasizes natural methods to get rid of weeds and pests. At the same time, chemicals could leave residues in foods and products that could have delirious implications for our health and the planet. Also, as Kumari [4] argues, adopting organic farming is suitable for protecting the environment. The bigger global issue of climate change depicts the harm looming on our environment, calling for interventions to ensure nature stays rich and clean, such as organic farming in the agricultural sector. In that light, ecological production practice significantly sustains the proliferation of biodiversity as opposed to conventional production processes. Besides, Karunakaran [5,4] emphasizes that organic farming could enrich the nutritional content of foods and food products instead of conventional farming. A recent study found that organic ingredients contain significantly higher levels of antioxidants and other essential compounds that benefit consumers, such as anti-inflammatory impacts [6]. Moreover, organic farming contributes to the empowerment of local producers and protect their environment from toxic chemical [7]. Demand for organic foods means farmers producing foods organically get to supply and benefit from the market. In that light, procuring organic food products assures that the overall production could not harm the local communities and their surroundings. Nonetheless, organic farming could be suitable for avoiding genetically modified organisms (GMO) products [4,6]. Organic farming uses organic practices rather than GMOs, eliminating the likelihood of contracting health and ecological consequences associated with GMOs. Therefore, organic farming has more to offer to people and the planet. Thus, it should be widely adopted to boost sustainable existence.

3.3. Methods of Organic Farming

Organic farming could be practised in various forms, provided they avoid chemical-based pesticides and fertilizers. Methods of organic farming integrate scientific knowledge of modern technology with the existing traditional farming practices centred on natural bioprocesses. Various studies delve into organic farming methods, mainly focusing on crop rotation and intercropping, integrated pest management, vermicomposting, organic soil fertility (NPK), biological fertilizers, bio-pesticides, organic manure and waste

management, among others [6].

3.3.1. Crop-Rotation and Intercropping

Since organic agriculture relies on soil health and biology, practices like crop rotation, intercropping and mixed cropping could be handy in improving soil life by boosting soil properties and associated bioactivities. Soni [8] refers to crop rotation as cultivating crops in separate farm areas to ensure no single crop would be consecutively planted in a similar area. It is a great practice to conserve and boost soil structure and nutrient levels alongside hindering soil-borne pests. Also, intercropping refers to cultivating multiple crops simultaneously in the same area [9,8]. According to Yadav [10], intercropping allows farmers to cultivate at least a single high-value crop while leveraging crop combinations to suppress weeds and alleviate soil erosion.

3.3.2. Integrated Pest Management (IPM)

Integrated pest management aims at controlling the pest population below the threshold that could lead to economic devastation. Department of Agriculture [11] states that integrated pest management entails holistically incorporating various appropriate control measures, ensuring they are ecologically based, including biological and cultural pest management. Such practices include crop rotation, a planned timeline for planting and harvesting, and the provision of habitats that provide resources for constructive organisms.

3.3.3. Organic Soil Fertility

According to Yadav [10], organic soil fertility entails "the use of natural materials and exploitation of biological processes to provide necessary nutrients to soils". Various techniques that can add and improve soil fertility

organically include using bio-fertilizers, organic manure, and vermicomposting.

3.3.3.1. Bio-Fertilizers

According to Soni [8] and Yadav [10], biofertilizers are "preparations constituting latent cells or living cells of efficient strains of microorganisms that assist crops' uptake of nutrients by their interactions in the rhizosphere when applied through soil or seed." Biofertilizers include various strains of microbes such as fungi, bacteria, and algae. They are vital in catalyzing given microbial processes in the soil that augment the available nutrients in a form that plants readily absorb.

3.3.3.2. Organic Manure

Organic manures refer to natural materials utilized by farmers to supply nutrients for crop plants [3]. Various forms of organic manure exist, including but not limited to green manures, farmyard manures, vermicompost, biological wastes, compost manures and oil cakes. Organic manures are vital in improving the soil's organic matter, boosting the soil's water-holding capacity, and improving drainage.

3.3.3.3. Vermicomposting

Also, vermicomposting is a critical practice that can physically, biologically, and chemically improve soil fertility. Olle [12] and Pathania [9] refer to vermicomposting as "the process that utilizes earthworms to convert organic materials into humus-like material". Various studies consensually find that vermicompost has a higher nutrient profile than traditional compost, rendering it a viable technique to enrich soil nutrient composition, improve productivity and boost soil structure.

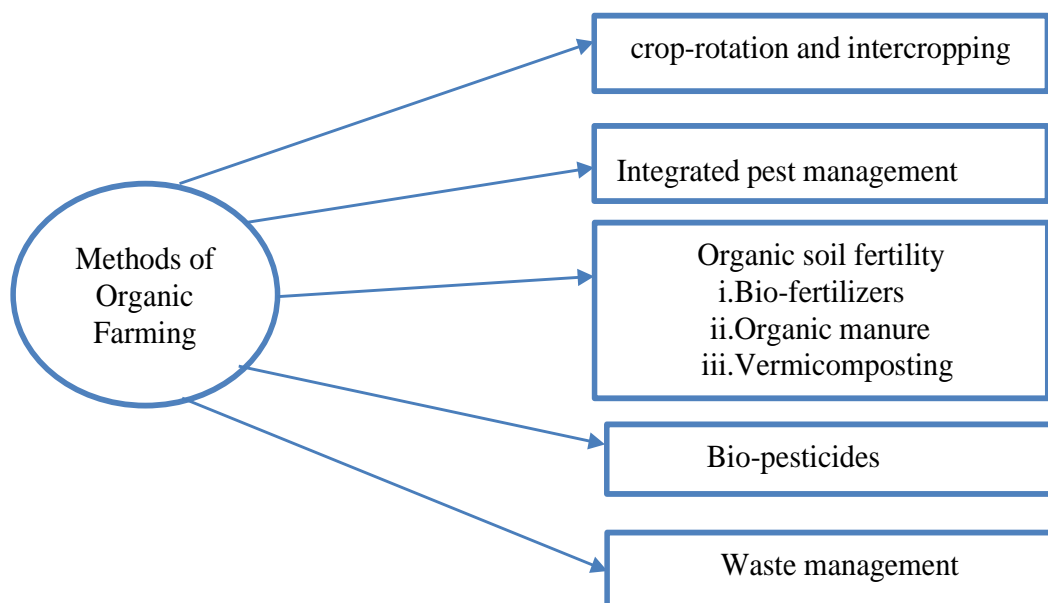


Figure 1. Showing Methods of Organic Farming

3.3.4. Bio-Pesticide

According to Das [1] and Dey [3], biopesticides are biological agents that release toxins detrimental to pests invading plant crops. For instance, secondary metabolites such as alkaloids, terpenoids, phenolics, etc., help fight, repel, and kill fungi, insects, nematodes, and other pests. Some examples of biopesticides are nicotine, pyrethrum, margosa, and neem [3].

3.3.5. Waste Management

Kumari [4] argues that waste management methods such as organic waste recycling and composting are crucial in various soil properties. Organic farming provides a channel to effectively manage household and agricultural waste, often through anaerobic digestion, composting and thermos-chemical treatments, reducing conventional chemical pesticides, fertilizers, and other energy sources. Organic waste management improves biological activities and pore structure, attributing a positive environmental impact.

3.4. Status of Organic Farming in India

Organic farming is steadily gaining popularity globally, with more than 72.3 million hectares of land cultivated organically in 2019 [5]. India is among the leading nations in organic production, with more than 2.3 million hectares of organic production in 2019 [5], an improvement from 41,000 hectares of organic land in 2002 [1]. In 2002, India recorded organic production of 14,000 tonnes, whereby only 85% of it was for export following the establishment of the National Programme for Organic Production (NPOP) in 2001 under the Agricultural and Processed Food Products Export Development Authority (APEDA), of the Ministry of Commerce and Industry [5]. Considering the output was for export, it was a low score, mainly due to various challenges, such as inadequate biomass, discrepancies in government policies to promote organic farming, lack of awareness, inadequate financial support, low yield, etc. [5]. Later in 2005, the Indian government enacted the first organic farming policy, followed by the National Mission for Sustainable Agriculture launching to bolster organic farming [11,13]. The policies, institutions and schemes launched have significantly boosted organic farming in India, rendering growth of various agroecological zones in the country, attributing to large areas under organic certification, including Madhya Pradesh, Rajasthan Maharashtra, Gujarat, Karnataka, Odisha, Sikkim, and Uttar Pradesh, respectively [5].

3.5. Benefits of Organic Farming

3.5.1. Crop Productivity

Various studies have delved into the significance of organic farming on crop productivity, with exclusive attention paid to vermicomposting and bio-fertilizers. According to Cidón [14], vermicomposting positively

correlates with income and crop production. It results from the benefits of vermicomposting, which lowers nitrogen concentration, leading to stabilized production and improved production, boosting income for farmers, and lowering the cost of purchasing and using nitrogen fertilizers [14,15,16]. In that context, vermicomposting enriches the nutrient content organically, which is crucial in boosting crop plant yields, compared to chemical-based fertilizers that leave nitrite residues, often attributed to adverse health concerns for consumers. Also, Kumar [15] stipulates that vermicomposting lowers nutrient leaching activities in nitrogen fertilizers, boosting crop plants' capacity to utilize nutrients essential for production fully. Increased production means that farmers could gain more money from the yields produced organically through sustainable means of production.

Vermicompost is high-quality manure constituting various essential nutrients that crop plants require, including phosphorous, nitrogen, calcium, potassium, magnesium, and micronutrients such as zinc, iron, manganese and copper in adequate amounts that could boost crop productivity [16]. However, Kumar [15] emphasizes that the nutrient content of vermicompost differs from the waste material utilized in vermicompost preparation. Similarly, the type of earthworm species utilized in vermicomposting might impact the quality of vermicompost [15]. Essentially, the nutrient profile of vermicompost is significantly higher compared to traditional compost and lowers reliance on synthetic fertilizer to a substantial extent [7]. Generally, using vermicompost in soil provides sufficient levels of antibiotics, amino acids, enzymes, and hormones that are essential in boosting the growth and development of plants, rendering stable and sustainable crop production.

Microbial inoculants (biofertilizers) entail a necessary element of incorporated nutrient management that improves crop productivity [17]. Recent studies show that biofertilizers play a vital role in regulating the dynamics of organic matter decomposition and the readiness of plant nutrients, including Nitrogen (N), Sulphur (S), and phosphorus (P) [17]. It is because biofertilizers trigger microbial processes in the soil effectively and sustainably, rendering the benefit of use for crop production [7]. Similarly, using beneficial microorganisms as biofertilizers ensures sustainable crop production, reducing dependence on inorganic fertilizers and lowering the environmental implications. Also, biofertilizers can improve crop productivity due to their application to root, seed, and soil to boost microbial activity because of their multiplication, enabling the nutrients to reach target plants and improving their production [18]. In a similar study, Gurjar [16] argues that improved plant growth and development reflect increased crop productivity. Farmers can sustainably realize immense output sufficient for consumption and sale. Conversely, chemical fertilizers can be used to boost crop productivity but could have adverse effects on consumers and the planet.

3.5.2. Product Quality

Crop product quality is a vital aspect to consider when addressing different physiological processes and outcomes in crop plants, such as texture, taste, appearance, nutritional and safety attributes, and texture that influence the value to the consumer and environment. Recent studies show that vermicomposting is linked with improved product quality in process alterations, enhanced durability and storage for a finished product, and improved products' physiological attributes, as anticipated by numerous consumers [15,12]. In that light, vermicomposting calls for progressive experimentation and empirical data to ensure consistent results. Similarly, vermicompost supplies crops with essential nutrients vital for improving the quality of farm produce, as they are readily available for plant uptake, enabling plants to bloom effectively with minimal defects. Vermicomposting is linked with improved nutrient content compared to chemical fertilizers. It improves juice pH, protein and carbohydrate, chlorophyll, and micro and macronutrients [12]. Nonetheless, Olle [12] found that vermicomposting is linked with better consumer health due to its high nutritional content.

Proper growth of plants indicates that they grow to maximum potential, constituting essential aspects that make the products beneficial to consumers and the environment. In comparative studies, biofertilizers are crucial for breaking down complex nutrients, enabling plants to readily access nutrients that ensure optimal growth and development of products [19]. Also, Kanthesh [17] highlight that biofertilizers suppress pathogens that could harm the quality of products, ensuring the latter is safe and healthy for consumption and re-cultivation.

3.6. Organic Farming Challenges in India

However, despite India's widespread acceptance of organic farming, various challenges prevail. This section reviews various critical challenges highlighted in current studies.

3.6.1. Lack of Policy for the Domestic Market and Imports

According to Pathania [9], India's current organic farming policy majors on production for export purposes whilst paying minimal attention to formulating organic farming policy for the domestic market and imports. In that light, there is a high likelihood for consumers and farmers not to differentiate between organic products from conventional products due to the absence of regulation on labelling standards for organic production and logos. Subsequently, fraudulent practices prevent genuine parties from realizing premiums as consumers are willing to pay for organic products.

3.6.2. Declined Crop Yield

Elayaraja's [2] research indicates that farmers transitioning to organic farming often experience reduced

yields in the early stages of production. Additionally, the duration required for crops to become sustainable under organic cultivation is uncertain, resulting in economic unprofitability and increased cultivation costs.

3.6.3. Unavailability of Organic Seeds Upholding Organic Farming

Concurrent fertilizer-sensitive and genetic planting resources and seeds put indigenous varieties on edge, as they are suitable to respond to chemicals and fertilizers [2]. Therefore, it renders significant discrepancies in the availability of quality organic seeds, impeding farmers from adopting organic farming.

Addressing these challenges will require a concerted effort from all stakeholders involved in organic farming in India. This could involve developing policies that support infrastructure and support services for organic farmers, promoting awareness and education about the benefits of organic farming, and investing in research and technology to help farmers adapt to the effects of climate change. For example, the government could encourage the production and distribution of organic seeds by partnering with seed companies and providing subsidies to farmers who use them. Furthermore, promoting the use of organic fertilizers and composting can help reduce the dependence on chemical fertilizers and increase soil fertility, which can enhance crop yields over time. Ultimately, overcoming these challenges will help to ensure the long-term viability and sustainability of organic farming in India.

3.7. Future of Organic Farming in India

India is among the leading nations with vast arable land worldwide, as the net cultivated area accounts for 140.1 million hectares [5]. It is in tandem with the larger agricultural sector that forms the country's primary source of economic livelihood, which accounts for 20-30% of every household income [11]. Despite organic farming being practised in the form of traditional farming in India, the onset of modern techniques and rampant population growth led to the rampant adoption of conventional farming to offset the food problem. However, the growing demand for organic produce is due to increasing awareness of the effects of the chemical on soil health and food quality and safety concerns [13]. India has a robust indigenous farming system, experienced traditional farmers, extensive drylands, and ample rainfall in the northeastern hilly regions, providing a promising opportunity for adopting organic farming. The existing knowledge of traditional farming methods forms a solid foundation for improving modern organic production [5]. India is the largest organic producer globally [11]. Numerous inventions in organic farming, such as 3D printing, incorporating mycorrhizal fungi and nano bio-stimulants and agroecological practices, pose viable opportunities for a better organic farming system in future [20].

4. Discussion

India's agricultural sector is a vital component of its economy, contributing to 30% of its overall revenue [14]. While organic farming has been a traditional practice in India, its contemporary version has recently gained popularity, driven by increasing awareness of food safety and quality. As highlighted in this paper, organic farming has numerous potential benefits for the country, including tapping into the growing demand for organic produce, promoting sustainable food security, maintaining clean and green ecosystems, bolstering social health, and achieving a balance between livelihood and the environment. However, there is controversy in some areas about the effectiveness and practicality of organic farming, which must be addressed to facilitate its widespread adoption in India.

To move the conversation forward, the authors can draw upon the evidence compiled in this paper to suggest a path forward. For example, comparative studies between organic and conventional farming methods in different regions of India can help identify the specific challenges and opportunities faced by organic agriculture. Such studies can also shed light on the potential benefits and drawbacks of switching to organic farming, including the economic and social factors that affect the acceptance and effectiveness of such techniques.

To promote the adoption of organic farming practices in India, there is a need for comprehensive policies and programs, including funding for research and development, infrastructure, and market access. The development of a robust supply chain and infrastructure for organic farming in India is also crucial to support farmers and make their products more accessible to consumers. By addressing the controversies surrounding organic farming and focusing on developing effective policies and programs, India can unlock the full potential of organic agriculture to promote sustainable food security and contribute to the country's economic growth.

While organic farming in India holds great promise for addressing critical issues, such as food security and environmental sustainability, it is not without controversy. Some farmers and stakeholders argue that organic farming is not feasible or practical on a large scale due to the potential for lower crop yields and economic losses. Others have concerns about the higher costs associated with organic farming practices, including the use of organic inputs and certification requirements.

However, the evidence presented in this paper suggests that organic farming can be a viable and profitable option for farmers in India. While it may require more labor and investment upfront, organic farming has been shown to improve soil health, reduce the need for harmful pesticides and fertilizers, and increase crops' nutritional content and quality. Furthermore, organic farming is more resilient to climate change and extreme weather events, making it an increasingly attractive option for farmers in regions prone to droughts or floods.

Moving forward, it will be necessary for policymakers and stakeholders to address the barriers to adopting organic farming in India and develop supportive policies and programs. This could include funding for research and development of organic farming techniques, providing access to organic seeds and inputs, and improving market infrastructure to facilitate the sale and distribution of organic products. Additionally, efforts should be made to educate farmers and consumers about the benefits of organic farming and promote its adoption through extension programs and community outreach. By taking a proactive and collaborative approach, India can realize the full potential of organic farming to address critical issues and create a more sustainable future.

5. Limitations and Suggestions

While the studies reviewed provide valuable insights into the potential of organic farming in India, there are some limitations to be considered. Firstly, most of the studies were conducted in a specific region of India, which may limit the generalizability of the findings to other regions of the country. Additionally, most of the studies only examined the short-term effects of organic farming on food security and related aspects, so more research is needed to fully understand the long-term effects of organic farming.

Moving forward, future research should focus on conducting more comparative studies between organic and conventional farming methods in India and examining the specific challenges and opportunities faced by organic agriculture in different regions and climates of India. This will help to understand better the potential benefits and drawbacks of switching to organic farming in India, as well as the economic and social aspects that affect the acceptance and effectiveness of such techniques.

In terms of policy and practical implications, boosting government support for organic agriculture and expanding access to markets for organic farmers in India could significantly influence the growth of India's organic agricultural industry. Further research is needed to evaluate the long-term effects of organic farming on food security, crop yields, and the economy in India. To support organic farming in India, government policies and programs should be developed to provide funding for research and development, infrastructure, and market access. Developing a robust supply chain and infrastructure for organic farming in India is crucial to support farmers and make their products more accessible to consumers. Collaboration between farmers, researchers, and policymakers is necessary to promote the adoption of organic farming practices and ensure its success in India.

6. Conclusion

India's dependence on agriculture for sustaining

livelihoods and the economy underscores the need to adopt sustainable farming practices that promote social health, environmental conservation, and economic growth. Organic farming, with its natural and biological processes, is crucial for achieving this balance between the environment and livelihood while promoting production and product quality. Despite India's favorable conditions for organic farming, various challenges hinder its nationwide adoption. These challenges, ranging from inadequate policy frameworks to limited access to organic inputs and markets, must be addressed to counter the predicaments. To overcome these barriers, policymakers and stakeholders must take a proactive and collaborative approach. This could include funding for research and development of organic farming techniques, providing access to organic seeds and inputs, and improving market infrastructure to facilitate the sale and distribution of organic products. Additionally, education and outreach efforts can help farmers and consumers understand the benefits of organic farming and promote its adoption through extension programs and community outreach. To achieve a comprehensive and integrated policy framework, policies that support organic farming should aim to create a level playing field for farmers, ensure a fair price for organic produce, and provide incentives for farmers to adopt sustainable practices. Furthermore, policies should prioritize the conservation of biodiversity, natural resources, and traditional knowledge associated with organic farming.

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