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ORGANIC FARMING IN PUNJAB: ITS STATUS AND FUTURE PROSPECTS

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ABSTRACT

In India, organic farming encourages environmentally friendly practices by avoiding synthetic pesticides, fertilizers, and GM crops. It uses organic methods like composting, crop rotation, and biological pest management. Even while organic farming still makes up a very small percentage of India's total agricultural landscape, its significance is progressively growing as a result of increased health and environmental consciousness as well as the growing demand for organic produce. About 3.7 million hectares, or 2% of India's total agricultural land, are grown organically as of 2023. With government programs like the National Mission on Sustainable Agriculture (NMSA) and Paramparagat Krishi Vikas Yojana (PKVY), which provide farmers switching to organic practices with financial assistance and training, this field is still growing. Kerala, Uttarakhand, and Sikkim are among the states that have demonstrated leadership in organic farming; Sikkim was the first to obtain 100% organic classification. The lack of infrastructure, marketing avenues, and reasonably priced organic inputs remain major obstacles to the widespread expansion of organic farming, despite these achievements. But with sustained government backing, market demand, and technology developments, organic farming in India has enormous growth potential and is poised to play a significant role in the country's agricultural landscape going forward.

On the other hand, organic farming is becoming a viable substitute for traditional, chemical-intensive agriculture in Punjab. Because of worries about chemical residues, water depletion, and soil health, the state is seeing an increase in interest in organic farming practices despite its historical dependence on high-input farming. Despite its infancy, organic farming has shown promise for both economic and environmental advantages in certain districts through successful

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case studies. Its widespread acceptance depends on ongoing awareness and assistance. As a result, the current state of organic farming in Punjab is highlighted in this review article, and it is crucial to create policies that could remove challenges to organic farming.

Keywords: Organic Farming, Organic Production, Punjab, PKVY, NPOP, PGS, and Kheti Virasat Mission.

INTRODUCTION

Organic farming has been an integral part of agricultural practices in India since ancient times. Its focus is on sustainable agriculture that supports environmental health and ensures the production of safe and nutritious food. The core of organic farming revolves around using natural resources to enhance agricultural productivity, without compromising the health of the ecosystem. It employs organic inputs, such as animal, crop, and aquatic waste, biological materials, and beneficial microorganisms, like biofertilizers and biocontrol agents. These inputs enrich the soil, provide essential nutrients to plants, and protect crops from pests and diseases, ultimately resulting in a more productive and healthier agricultural output.

The practice of organic farming has gained significant attention, especially in the aftermath of the Covid-19 pandemic. During the pandemic, many individuals became more conscious of their health, including the quality of the food they consumed. This heightened awareness led to an increased interest in organic food, which is perceived as healthier and free from harmful chemicals. Additionally, the pandemic exposed the vulnerabilities of conventional farming systems, which often rely heavily on synthetic pesticides, insecticides, and chemical fertilizers. The widespread use of these chemicals has resulted in the contamination of the food chain, leading to concerns about their impact on human health and the environment (Singh, 2019).

The use of chemical inputs in conventional farming has not only deteriorate human health but has also contributed to environmental degradation. For example, excessive use of pesticides and fertilizers has led to the contamination of soil and water resources. This contamination has adversely affected biodiversity, soil health, and the quality of water in many agricultural regions. The depletion of the water table, particularly in states like Punjab, has become a major environmental concern. Moreover, the extensive use of synthetic fertilizers has led to the erosion of soil fertility over time, making the soil less productive in the long run (Gamage et al., 2023).

In response to these challenges, the Indian government and various non-governmental organizations (NGOs) have started promoting organic farming on a larger scale. Several initiatives have been launched to educate farmers about the benefits of organic farming, provide financial support, and encourage the adoption of sustainable practices. Government schemes offer funding for transitioning from conventional to organic farming, training programs, and marketing support

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for organic produce. These efforts aim to reduce the dependency on chemical inputs and encourage farmers to adopt more sustainable, ecologically friendly agricultural practices (Yadav, 2017).

Despite these positive developments, the adoption of organic farming in Punjab faces several hurdles. Punjab, known as the "granary of India," but converted its conventional agriculture in to chemical-intensive agriculture. Transitioning to organic farming in such a region requires overcoming multiple challenges, such as a lack of awareness, limited availability of organic inputs, and the higher cost of organic production compared to conventional methods. Moreover, the state's agricultural infrastructure, which is heavily geared towards conventional farming, poses an additional obstacle. Many farmers are hesitant to adopt organic farming due to the perceived risks and the lower initial returns on investment. So, this review aims to examine the current status of organic farming in Punjab, its challenges and future prospectives.

METHODOLOGY

This review study was carried out with the goal of identifying the current state of research on organic farming in India and Punjab. High-impact results were found and identified using the databases like Scopus, Web of Science, Science Direct, Google Scholar and ResearchGate. The researcher used keywords like "organic farming," "India," "Punjab," "PKVY," "NPOP," "PGS," and "Kheti Virasat Mission" to start finding and identifying papers. This produced 103 search results. Additionally, the researcher used a screening process that focused on inclusion/exclusion criteria to identify relevant publications that were required for this paper. Thirteen articles were chosen after paper titles and abstracts were carefully screened. These articles explored the advantages of organic farming, addressed the advantages of organic farming in India and Punjab, and provided a theoretical interpretation of organic farming. Additionally recent data was collected from the official sites of APEDA, PGS and NPOP and Annual report 2022-2023 by the National Centre Organic and Natural Farming.

LITERATURE SURVEY

Definitions:

By IFOAM: International Federation of Organic Agriculture Movements

“Organic Agriculture is a production system that sustains the health of soils, ecosystems, and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic Agriculture combines tradition, innovation, and science to benefit the shared environment and promote fair relationships and good quality of life for all involved”

By FAO: Food and Agriculture Organization

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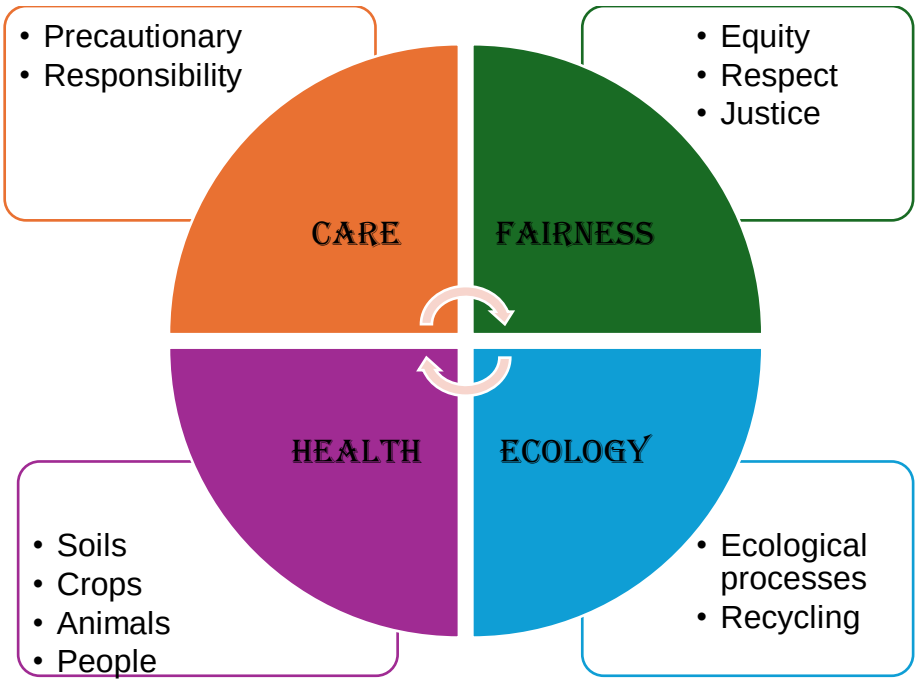
"Organic agriculture is an integrated production management system that promotes and enhances agroecosystem health, including biodiversity, biological cycles and soil biological activity. It emphasizes the use of natural inputs (i.e. mineral and products derived from plants) and the renunciation of synthetic fertilizers and pesticides"

Principles:

It has four principles i.e. Principle of health, ecology, fairness and care that mainly prioritizes the health

of the entire ecosystem, avoiding harmful chemicals. It works with natural cycles and protects the environment. Fairness ensures equitable relationships throughout the food system, from farmers to consumers. Finally, the principle of care emphasizes a precautionary and responsible approach, considering the long-term well-being of both people and the planet.



Critical Survey

Status of organic farming at Global level:

The 2021 FiBL and IFOAM survey reveals that organic farming is a global phenomenon, practiced in 187 countries across the globe. While still a small fraction of overall agricultural land (1.5%) is under the organic farming. In terms of area, 72.3 million hectares under the organic farming globally of total agricultural land. Oceania holds the largest share, followed by Europe and

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Australia leads in terms of total organic land area. This land is worked up on by 3.1 million organic producers worldwide. Asia has the highest number of producers, followed by Africa. India has the highest number of organic producers globally. The Global organic market reached 106.4 billion Euros in 2021. United States holds the largest market share. Denmark has the highest per capita organic consumption (Department of Agriculture and Farmer Welfare).

Status of Organic farming in India:

India possesses immense potential in organic farming, driven by a confluence of factors. Its diverse agro-climatic zones, ranging from the Himalayan foothills to the coastal plains, offer a fertile ground for cultivating a wide array of organic products. This diversity translates into a rich tapestry of crops, from aromatic spices and fragrant teas to succulent fruits and nutritious millets, all of which can be produced organically.

India currently holds a prominent position in the global organic farming landscape. According to the latest data, India ranks first globally in terms of the number of organic producers. Additionally, India ranks among the top countries in terms of organic agricultural land area, showcasing its significant contribution to the global organic food market. India produced approximately 3.6 million metric tons of certified organic products in 2023-2024, encompassing a diverse range of food items and non-food products like organic cotton fiber. Maharashtra leads in organic production followed by Madhya Pradesh, Rajasthan, Karnataka, and Gujarat. Fiber crops constitute the largest category of organic production, followed by oilseeds, sugar crops, cereals, millets, medicinal and aromatic plants, spices, fruits, vegetables, pulses, tea, and coffee.

In 2023-2024, India's organic farming extended across 7.3 million hectares. Madhya Pradesh led in terms of land dedicated to organic farming, followed by Maharashtra, Rajasthan, Gujarat, Odisha, Sikkim, Uttar Pradesh, Uttarakhand, Kerala, Karnataka, and Andhra Pradesh. Organic products from India are exported to many countries, including the USA, countries within the European Union, Canada, Great Britain, Sri Lanka, Switzerland, Vietnam, Australia, Thailand, New Zealand, Japan, and the Republic of Korea. In the financial year 2023-2024, 2.61 lakh metric tons was exported to these countries (Ministry of Food Processing Industries)

Status of Organic farming in Punjab:

Area and Production:

In Punjab, NPOP records that the total area registered under organic farming is 11,089.41 hectare out of which 1009.40 hectare is for organic area and 10,080.01 hectare is for conversion area (APEDA 2023-2024). Punjab ranks 29th position out of total 31 states and union territories of India under NPOP scheme. Madhya Pradesh ranks 1st in terms of total area (11,48,236.07 hectare) under organic farming followed by Maharashtra i.e. 10,01,080.32 hectare. For the wild collections, state

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wise organic area in the Punjab is 63879.73 hectare and it ranked at seventh place out of total nineteen states (APEDA 2023-2024) (Fig. 1 and Fig. 2). Under NPOP scheme, state wise organic farm production in the year 2023-2024 is 6801.79 metric tons for Punjab and at 20th position out of total 27 states. State wise organic production from wild area is 281.33 metric tons and Punjab is at 9th position out of 14 states (Fig. 3 and 4).

Methods of Organic farming:

There are various methods for practising organic farming like crop rotation and intercropping, integrated pest management, organic soil fertility, biofertilizers, organic fertiliser, vermi-compositing, bio-pesticide. Among all these methods, production of organic fertilizers and biofertilizers is very important for maintaining sustainability in the agriculture. Organic fertilizers, biofertilizers, and liquid biofertilizers play crucial roles in organic farming by enhancing soil fertility and promoting sustainable agricultural practices. Organic fertilizers, such as compost and manure, enrich the soil with essential nutrients and improve its structure. Biofertilizers, consisting of beneficial microorganisms, help fix nitrogen and enhance nutrient uptake, reducing the need for synthetic inputs. Liquid biofertilizers, in particular, offer a quick and efficient way to deliver beneficial microbes to plants, boosting their growth and disease resistance. Together, these natural inputs support plant health, increase crop yield, and contribute to environmentally friendly farming practices. Punjab produces 416.9 MT biofertilizers in the year 2022-2023 and overall production of the country was 325582.282 MT. Production of organic fertilisers at Punjab level is 7407.066 MT and 76413125.55 MT at national level. Similarly, production of liquid based biofertilizers is 2367.80 MT in Punjab and overall was 556979.045 MT (Annual report 2022-2023 by the National Centre Organic and Natural Farming) (Fig. 5,6,7).

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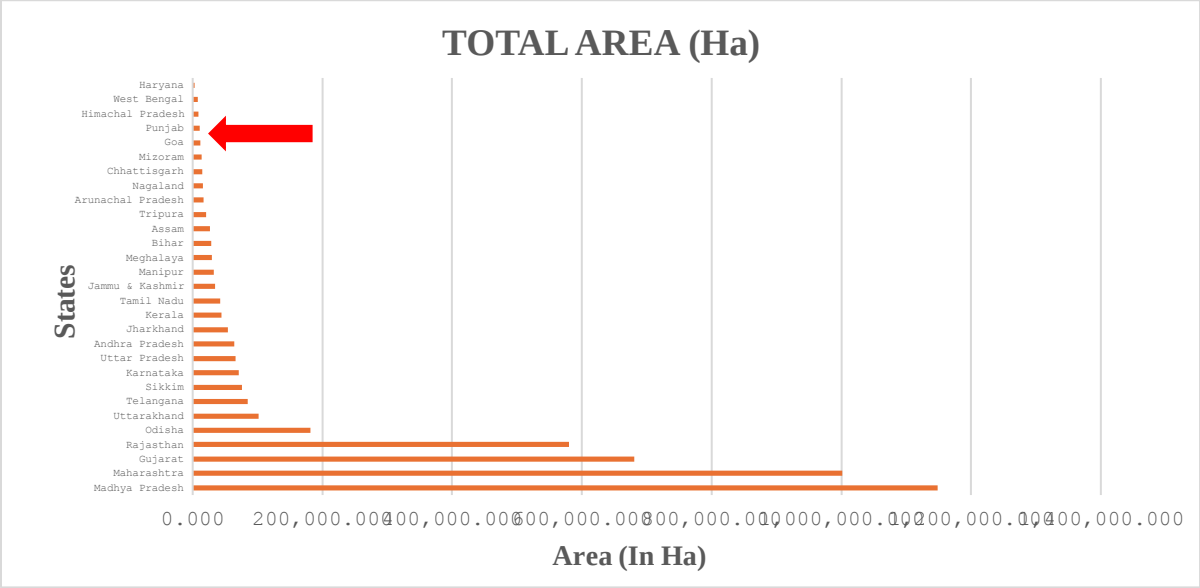
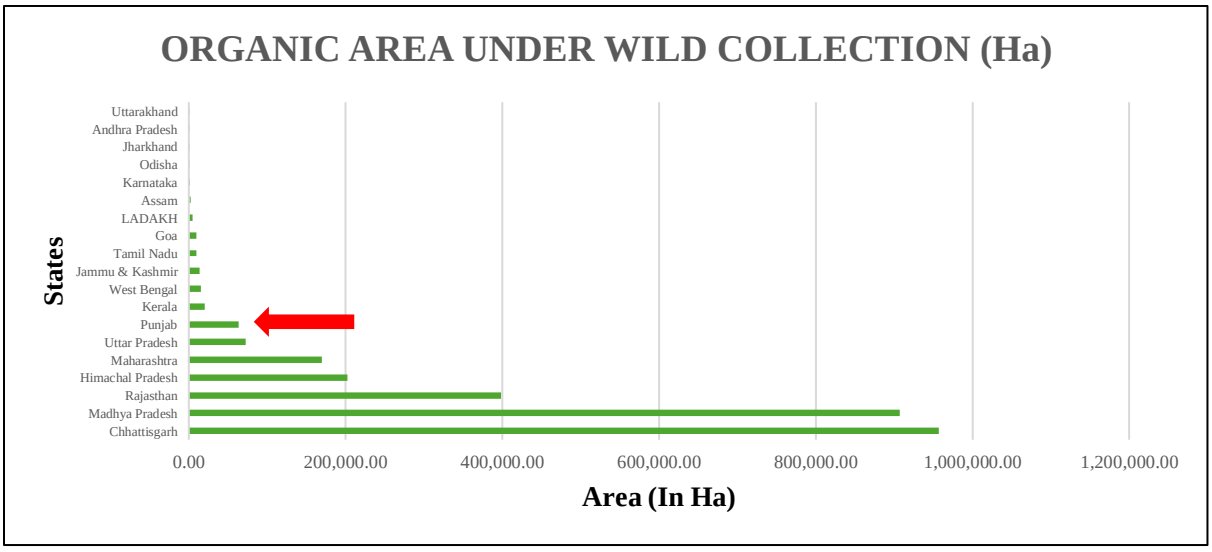
Fig. 1: State wise total area from cultivated area (organic area and converted area) in hectare



Source: APEDA: https://npop.apeda.gov.in/organic-certification-data-under-npop-2023-24

Fig. 2: State wise total area from organic area under wild collection in hectare



Source: APEDA: https://npop.apeda.gov.in/organic-certification-data-under-npop-2023-24

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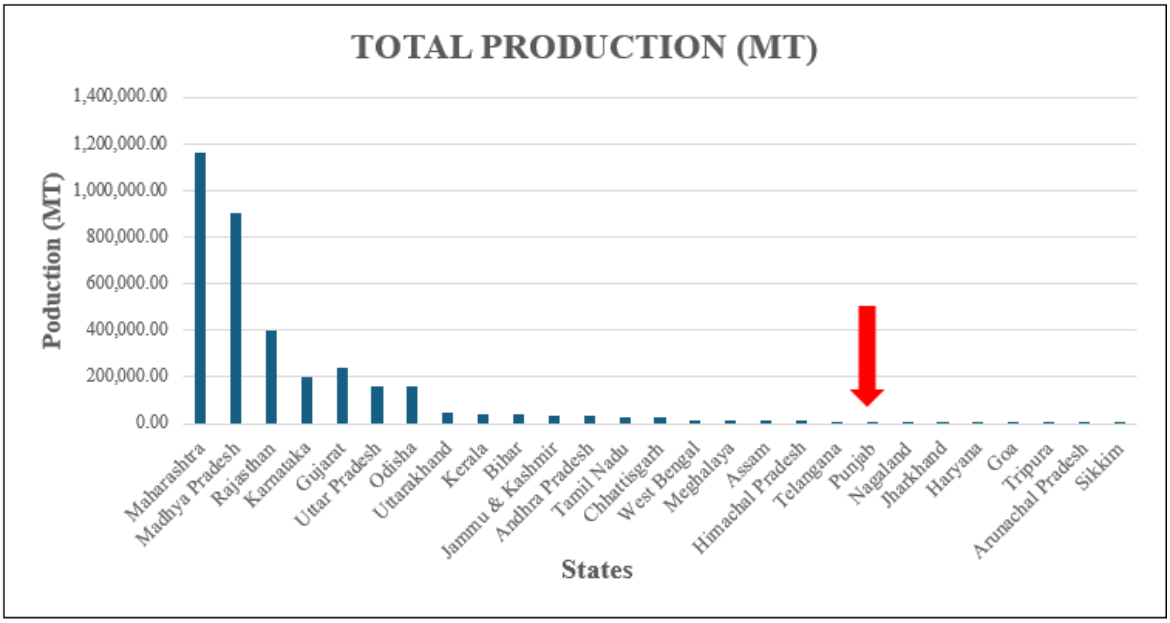
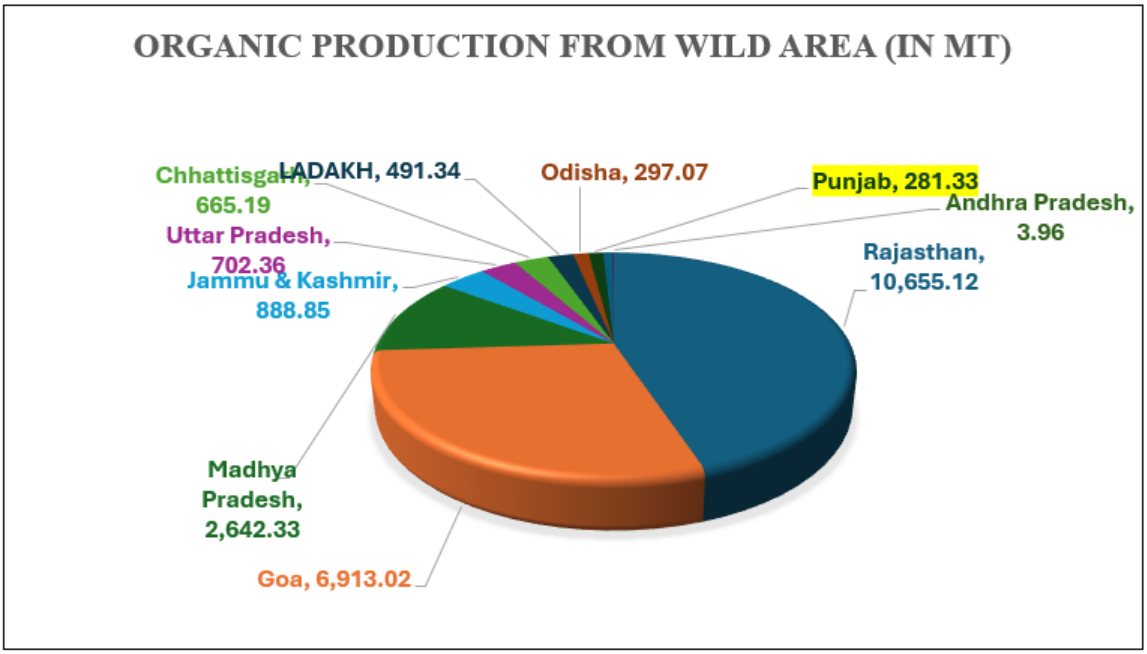
Fig. 3: State wise total production from cultivated area (organic area and converted area) in metric tons



Source: APEDA: https://npop.apeda.gov.in/organic-certification-data-under-npop-2023-24

Fig. 4: State wise organic production from wild area (organic area and converted area) in metric tons



Source: APEDA: https://npop.apeda.gov.in/organic-certification-data-under-npop-2023-24

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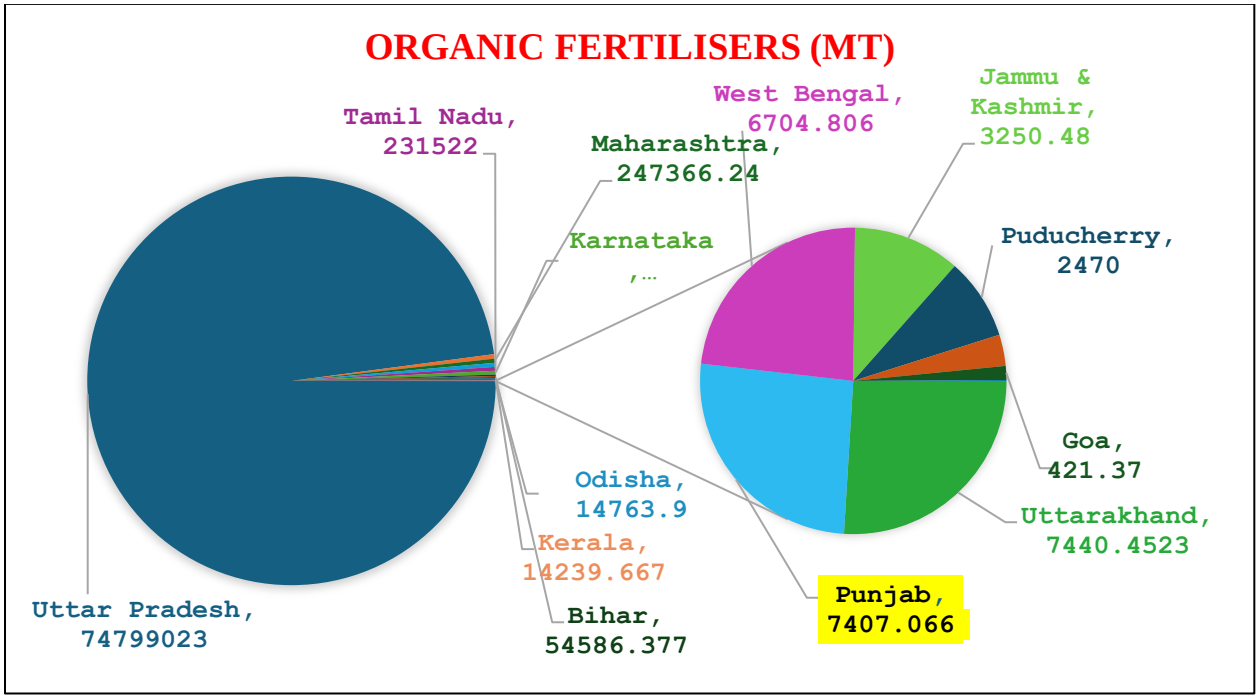
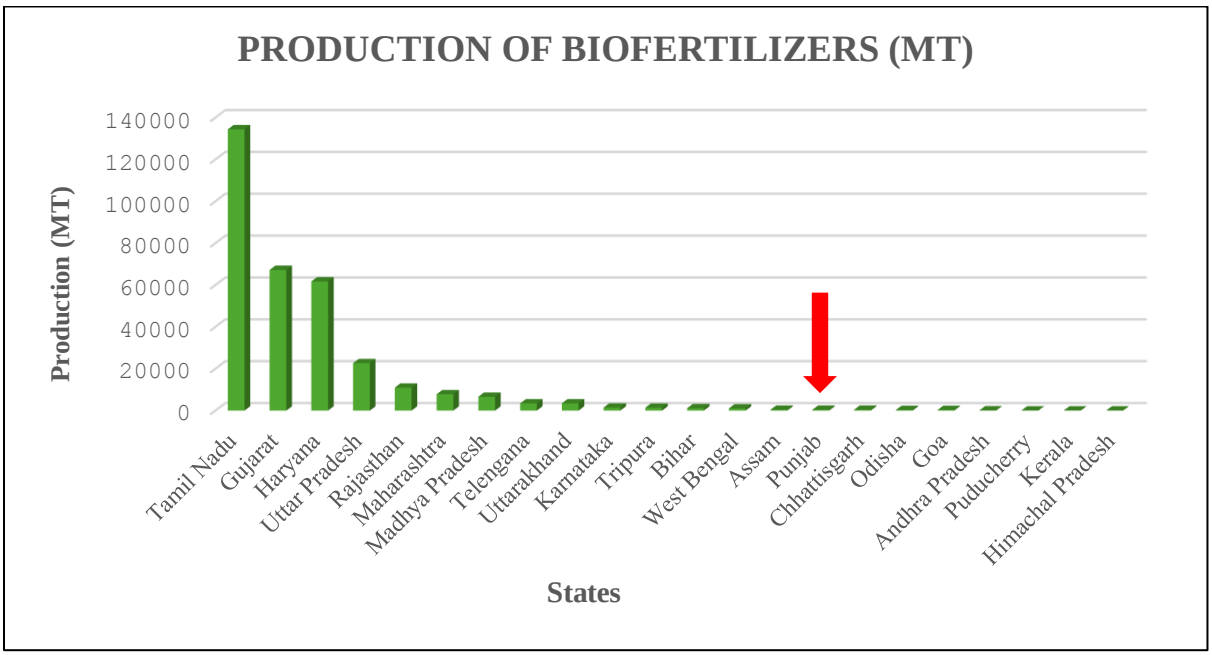
Fig. 5: State wise production of organic fertilizers in metric tons



Source: Annual Report 2022-23, NCONF

Fig. 6: State wise production of biofertilizers in metric tons



Source: Annual Report 2022-23, NCONF

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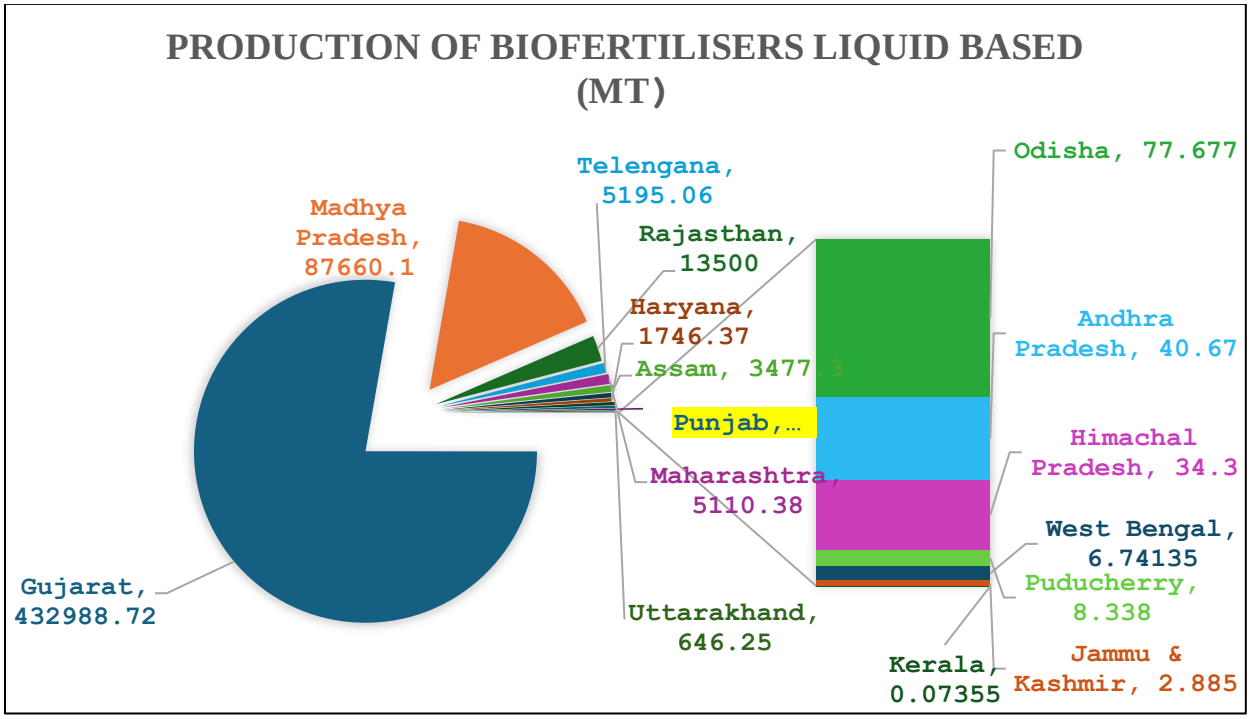
Fig. 7: State wise production of liquid based biofertilizers in metric tons



Source: Annual Report 2022-23, NCONF

Organic Crops:

Table 1: Major organic crops of Punjab

Sr. No.	Type	Products
1	Cereals:	Wheat, Barley, Oats, Maize (Corn), Paddy (Rice), Basmati (Rice), Jowar (Sorghum) and Bajra (Millet)
2	Vegetables	Potato, Radish, Carrots, Onion, Turnip, Cauliflower (Gobhi), Cabbage, Chukandar (Beetroot), Garlic, Okra (Bhindi), Brinjal (Eggplant), Tomato, Kakdi (Cucumber), Kheera (Cucumber), Lobiya (Beans), Gawar, Kaddu, Lauki, pettah, ram tori, palak, methi, turnip
3	Spices	Chilli, turmeric, coriander, ajwain, methi, saunf,

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4	Pulses	Masoor (Red Lentil), Black Gram, Green Gram, Arhar (Pigeon Pea), Urad (Black Gram), Cowpea, soybean
5	Oil seed	Mustard, Groundnut, Soybean, Castor Sunflower, Taramira, Alsi (Flaxseed)
6	Fiber	Cotton
7	Fruit	Jamun, guava, peach, kinnow, malta, ber, amla

Source: https://www.ofai.org/wp-content/uploads/2012/11/Organic-Farmers-and-Farms-of-Punjab.pdf

Schemes for Promoting Organic Farming:

To encourage organic farming in the nation, the government is putting the Parampragat Krishi Vikas Yojana (PKVY) and Mission Organic Value Chain Development for North Eastern Region (MOVCDNER) schemes into action (Debnath et al., 2024). These programs include provisions for farmer training and capacity building. For three years, each farmer receives Rs 7,500 in cash aid under PKVY to enhance their potential. In contrast, MOVCDNER offers financial support for training, handholding, and certification in the amount of Rs 10,000 each farmer for three years (Manida and Nedumaran, 2021). The Department of Agriculture and Farmers Welfare's (DA&FW) subordinate office, the National Centre for Organic and Natural Farming (NCONF), Ghaziabad, raises awareness of organic and natural farming through the Javik Kheti Samelan, field demonstrations and farmer trainings.

Paramparagat Krishi Vikas Yojana (PKVY): The scheme promotes cluster based organic farming with PGS certification. Cluster formation, training, certification and marketing are supported under the scheme. Assistance of Rs.50,000 per ha for 3 years is provided out of which 62% i.e., Rs. 31,000 is given as incentive to a farmer towards organic inputs. The scheme promotes Participatory Guarantee System (PGS) form of organic certification that is built on mutual trust, locally relevant and mandates the involvement of producers and consumers in the process of certification. PGS – India operates outside the framework of "Third Party Certification". Funding pattern under the scheme is in the ratio of 60:40 by the Central and State Governments respectively. In case of North Eastern and Himalayan States, Central Assistance is provided in the ratio of 90:10 (Centre: State) and for Union Territories, the assistance is 100% Under the PKVY Scheme 200 clusters have been sanctioned during the period 2017-18 to 2019-20 and 100 clusters during the period 2018-19 to 2020-21. During this period a total of 6000 numbers of farmers adopted organic under PKVY in the State of Punjab. From 2018-19 to 2020-21, total 1864.94 lakhs were released under this scheme but only 298.38 lakhs were utilised in Punjab.

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Other Initiatives at state level:

Punjab Agro:

Punjab Agro plays a crucial role in promoting organic farming in the state. It provides crucial support to farmers transitioning to organic practices by offering subsidies on organic inputs like fertilizers and pesticides. It also organizes training programs and workshops to educate farmers on organic farming techniques, including soil health management, pest control, and crop rotation. Furthermore, Punjab Agro facilitates market linkages for organic produce by connecting farmers with buyers, processors, and exporters. By providing financial and technical assistance, as well as creating market access, Punjab Agro encourages the adoption of organic farming practices, contributing to sustainable agriculture and improved livelihoods for farmers in the state.

Kheti Virasat mission:

Kheti Virasat Mission (KVM) is a not-for-profit, civil society action group working on organic farming issues since 1998. It was registered as a trust in March 2005. Its mission is to return ecological stability to Punjab through sustainable agricultural practices. KVM has a strong grassroots presence among the farmers of Punjab. Its outreach, training and awareness programmes have influenced the conversion of 20 farms to natural/organic farming, another 200 are under conversion process and over 500 have taken a step forward by growing organically for self-consumption. KVM has two distinct functioning bodies: Vatavaran Panchayats and Environmental Health Action Group (EHAG). EHAG is a forum for physicians, medical professionals and experts of life sciences to take up issues of environmental health. Over the last few years, KVM has set up several village-level participatory forums called Vatavaran Panchayats (comprised mostly of farmers) seeking local holistic ecological solutions. They also run organic farmers market by the name of Kudrati Kisaan Haat (weekly market) and Kudrati Kissan Hut in Faridkot, Jalandhar, Bathinda, Ludhiana, Batala, Gurdaspur, Barnala, Mukatsar, Kotkapura, Amritsar and Sangrur.

Certification System:

At present in India two types of certification system exists namely

1) **Third Party certification (NPOP)**

This system is governed by APEDA, Ministry of Commerce which is mainly focused for export purpose. This third-party certification bears high fees and more documentation as a result small and marginal farmers are not able to offer for certification. In Punjab, there are 367 farmers that have registered for the National Programme for Organic Production (NPOP) in TraceNet under third party certification. But in India, 16.02 lakh farmers have registered in TraceNet under third party certification of the NPOP. For

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the certification purpose there are different certification agencies that issue certificates to them In India and currently there are total 37 accredited certification agencies but in Punjab there are only two certification agencies like MS Agroland Services Private Limited and Krushi Certification Private Limited

2) Participatory Guarantee System (PGS):

This is a quality assurance initiative that is locally relevant, emphasize the participation of stakeholders, including producers and consumers and operate outside the frame of third-party certification. PGS India system is based on participatory approach, a shared vision, transparency and trust. In addition, it gives PGS movement a national recognition and institutional structure. In Punjab total 150 such groups are registered from the 16 districts. Major regional groups are Punjab state seed certification authority, Kheti Virasat mission, Divya yog mandir trust, Rs eventech Pvt Ltd, Noida, Damdaar Maati Jaivik Prasaar Sansthan. District Ferozpur has maximum registered number (50) followed by Patiala (22), Gurdaspur (20), Sangrur (15), Mansa (09), Moga (06), Mukatsar (06), Rupnagar (05), Amritsar (04), Bathinda (04), Ludhiana (03), Jalandhar (02), Barnala (01), Fazilka (01), Faridkot (01), Hoshiarpur (01). However, districts like Fathehgarh sahib, Sahibzada Ajit Singh Nagar, Pathankot, Shahid Bhagat Singh Nagar, Taran Taran, Malerkotla (https://www.pgsindia-ncof.gov.in/)

Technical innovations in Organic farming:

Precision agriculture, which uses sensors, drones, GPS, and Internet of Things (IoT) devices to optimize irrigation, crop management, and resource utilization, has spread throughout Punjab in recent decades. To help smallholder farmers in Punjab and increase water efficiency, for instance, Kinnow orchards have piloted IoT-based data-driven irrigation techniques (Bhakar et al., 2019). Modern equipment is now accessible to smallholders due to the evolution of mechanization, which has produced smaller, more inexpensive machines and the growth of hire-in/hire-out markets.

Drones, or unmanned aerial vehicles (UAVs), are progressively being explored for use in organic farming in Punjab, offering significant potential to enhance sustainability and productivity. In organic systems, drones can be equipped with multispectral and hyperspectral sensors to keep check on crop health, detect early signs of pest or disease outbreaks, and assess soil fertility, all of which are crucial for timely, non-chemical involvements. This technology enables farmers for targeted management practices that align with organic principles and decrease the need for broad-spectrum treatments (Mozhiarasi, 2021; Katekar and Cheruku, 2022). Drones also support biodiversity-friendly agriculture by plotting weed infestations and monitoring ecological features, helping farmers maintain compliance with organic certification standards and promote environmental stewardship (Mohidem et al., 2021). However, several challenges hinder widespread adoption in Punjab. The high initial cost of drones, limited flight time, and the need

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for technical expertise to interpret aerial data can be barriers, especially for smallholder organic farmers. Despite these challenges, as drone technology becomes more affordable and accessible, it holds promise for transforming organic farming in Punjab by enabling precision, sustainability, and improved crop management.

Farmers now have easier access to timely information for market opportunities and decision-making because to the growing usage of mobile technologies and ICT-based solutions for knowledge dissemination. But for these systems to work, they need to be localized and presented in the native tongues (Sharma et al., 2021). Despite these developments, Punjab, still confronts major obstacles to the adoption of new technologies. Many farmers remain hesitant to adopt precision agriculture due to lack of understanding, financial constraints, and practical implementation issues. Therefore, technological advancements have the potential to further revolutionize Punjabi agriculture, but their full benefits will only be realized if institutional and socioeconomic barriers are removed, awareness is raised, and equitable access to contemporary equipment and information is guaranteed (Walia et al., 2025).

The economic viability and comparative profitability of organic and conventional farming in Punjab:

These factors are influenced by a complex interplay of yield, input costs, market dynamics, and sustainability factors. Conventional farming in Punjab, consistently delivers higher yields-studies report wheat yields 11-45% greater than those from organic systems (Singh and Grover, 2011). This yield advantage is largely due to the use of chemical fertilizers and pesticides, which, while boosting productivity, also raise concerns about environmental degradation and long-term soil health (Priya and Singh, 2023). Organic farming, on the other hand, relies on natural inputs such as farmyard manure, green manuring, and biopesticides. This results in lower expenses for fertilizers and pesticides but higher costs for labour and irrigation, as organic systems are more management and labour-intensive (Walia et al., 2025).

Despite lower yields, organic farming can be more money-making under certain market conditions. Premium prices for organic produce and reduced input costs often pay off for the yield gap, leading to higher net returns per acre for organic farmers. One study found net returns of ₹21,895/acre for organic wheat compared to ₹16,700/acre for conventional wheat, with the price premium offsetting lower productivity (Singh and Grover, 2011). However, this profitability is highly sensitive to market demand and the scale of organic production. If organic farming expands and price premiums decline, the economic advantage may diminish. Additionally, organic farming faces challenges such as labour-intensive operations, lack of marketing facilities, and weed control, which can limit its adoption and profitability

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From a sustainability perspective, organic farming offers clear environmental and social benefits, including improved soil fertility, reduced chemical runoff, and better system stability (Priya and Singh, 2023). However, conventional farming remains more economically viable in the short term, especially in the absence of strong market support for organic products. The long-term profitability and viability of organic farming in Punjab will depend on continued consumer demand, supportive policies, and investments in market infrastructure and farmer education (Singh and Mahajan, 2017).

Therefore, conventional farming currently offers higher yields and short-term economic viability in Punjab, organic farming can be more profitable for smallholders when price premiums and lower input costs are realized. The future of organic farming's economic success will depend on sustained market demand, policy incentives, and the development of efficient marketing and support systems.

Farmers' perspectives:

Farmers in Punjab are typically aware of the environmental and health benefits of organic farming, such as increased soil fertility and lower chemical use. Many organic farmers are inspired by concerns about soil health, environmental sustainability, and human well-being, and the majority report satisfaction despite lower output levels. For instance, 62% of surveyed organic farmers indicated satisfaction with organic operations, owing to perceived gains in soil and human health (Aulakh et al. 2017; Walia et al., 2025)

However, considerable challenges persist. The most frequently stated barriers are organic farming's labor-intensive nature, a lack of effective marketing facilities, and insect and weed management challenges. 36% of farmers identified labor requirements as a major barrier, while 31.5% cited poor market infrastructure as a major issue (Aulakh et al. 2017; Walia et al., 2025). Reduced yields and poorer incomes relative to conventional farming discourage further adoption, particularly among small and marginal farmers (Gill et al., 2023).

The captivation of organic methods is further limited by farmer's grievances of inadequate government assistance in marketing, technical guidance, and certification procedures (Singh and Kaur., 2022). Despite these challenges, a lot of farmers believed that better biopesticides, easier access to markets, and labor-saving technology could increase Punjab's organic farming industry's sustainability and profitability.

Social perspectives:

The adoption of organic farming in Punjab is heavily influenced by societal viewpoints, with perceived social benefits, education, and community attitudes playing key roles. According to studies, farmers that are younger, better educated, and engage in diverse crops are more likely to

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use organic practices; these farmers are frequently driven by environmental concerns as well as a desire for social recognition in their communities (Singh and Kaur., 2022). Many farmers express satisfaction with organic farming because of its perceived beneficial effects on soil and human health, and social benefits-such as better health, environmental stewardship, and community well-being are the important motivators (Aulakh et al., 2009).

However, there are still social impediments that can suppress excitement and hinder adoption rates, such as a lack of marketing infrastructure, limited government assistance, and inadequate technical guidance. Local networks and peer pressure are also crucial; farmers are more likely to switch to organic farming if they see their neighbours adopting successful practices or if farm associations support them (Singh and Kaur., 2022). Notwithstanding these obstacles, Punjab is becoming more conscious of the social and environmental benefits of organic farming, which suggests that institutional support, expanding community networks, and boosting information access could all help to encourage its uptake.

Case studies for organic farming models in Punjab:

Gurpreet Singh from Bathinda:

Gurpreet Singh adopts organic farming in 2009, when he decided to take up the mantle of his family's agricultural legacy. He cultivates a variety of crops on their 35-acre land, including Paddy, potatoes, mung beans, and mustard. Growing customer awareness of the value of nutritious, pesticide-free vegetables is one of the factors propelling his commitment to organic farming. He also noted that the market for organic products is promising since consumers are ready to pay more for them. Organizations like Krishi Vigyan Kendra Bathinda and Punjab Agricultural University have helped and mentored him along the way. Notably, he was honored by ICAR in Hyderabad in December 2022 for his outstanding efforts, which were acknowledged on a state and national level. His accomplishments extend beyond awards; he was notably conferred with the 'Best Farmer' Award during the International Conference ICSCI 2022, a testament to his exceptional dedication. He is passionate about educating fellow farmers about the importance of abandoning crop burning practices and implementing innovative methods to combat the depletion of water resources in Punjab. His journey from conventional farming to a champion of organic, eco-friendly methods serve as an inspiration for farmers across the region and beyond. He was also honoured with the 'Best Farmer' Award at the International Conference ICSCI 2022. He is dedicated to educate other farmers about the significance of leaving crop burning practices and implementing creative solutions to prevent water shortage in Punjab. His transformation from conventional farming to organic, eco-friendly methods serves as an inspiration for farmers across the region and beyond (Source: Apni kheti).

Bhagwant Singh from Mohali:

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He is a graduate and owns 27 acres of land, as well as an 8-acre land on lease. Bhagwant Singh, at the age of 20, was inspired by several progressive farmers. He began learning about modern technology, plant diseases and their treatments, new improved varieties, and modern machinery by attending kisan melas, KVK visits, and with the assistance of PAU. He recently began organic farming on his 2-acre plot of land. He cultivated sugarcane and maize without using any chemicals. He uses cow dung and poultry waste as manure. In addition, neem extract is used to control insects and pests. During the peak season, he produces an average of 150-200 kg of jaggery every day. He is aware that chemical fertilizers are detrimental to both livestock and humans. It also damages the soil and groundwater quality. In an interview he said that "to boost productivity in the evolving agriculture industry, new technology, varieties, and sustainable approaches must be adopted. Soil fertility is deteriorating at a faster rate; thus, we must use organic agricultural techniques to preserve the quality of the soil for future generations. Organic food provides more nutritional content compared to conventionally grown crops. Sustainable farming is crucial for meeting future food, fiber, and fodder needs" (Source: Just agriculture).

Dilbir Foundation, Amritsar:

Gunbir Singh, a visionary from Amritsar and the driving force behind the Dilbir Foundation, has become a beacon of sustainable agriculture in Punjab. Disturbed by loss of five closed ones to cancer because of the toxic chemicals used in the food. Also, the deteriorating health of the soil and rising farmer distress, he took it upon himself to promote organic farming as a viable and healthier alternative. Through the foundation, Gunbir initiated widespread awareness campaigns, training sessions, and hands-on support for farmers, emphasizing the long-term benefits of organic farming. His relentless efforts have inspired over 20,000 farmers to transition to organic practices, reviving traditional methods while incorporating modern techniques for better yield and sustainability. The Dilbir Foundation also facilitates market linkages, helping farmers earn fair prices for their produce. Gunbir's mission is not just about healthier crops, but about restoring dignity, economic stability, and environmental balance to Punjab's agrarian communities. His work stands as a powerful example of grassroots change driven by purpose and persistence (Source: the better India).

Bangla Natural Food Farm, Fazilka:

Inder Singh Sidhu, an 89-year-old farmer from Punjab, runs Bangla Natural Food Farm—so named because the region of Fazilka was historically referred to as "Bangla." Rejecting the harmful pesticides introduced during the Green Revolution, Sidhu embraced traditional organic methods, using farm-made compost, sour buttermilk sprays, neem, and other eco-friendly alternatives. His farm is renowned for cultivating the ancient "Bansi" wheat variety, over 2,500 years old and known for its high nutritional value and long-lasting fresh dough. Alongside wheat, the family grows

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garlic, onions, turmeric, pulses, vegetables, and maintains a mixed fruit orchard on around 7 acres. Sidhu remains active in farm operations and is supported by his son and daughter-in-law, who also processes products like vermicelli, guava juice, and garlic powder for home use. The farm spans 50 acres, with one plot organically cultivated for 30 years and the rest leased to other farmers. Certified by the Kheti Virasat Mission, the farm also aims to become an agritourism spot, offering visitors a glimpse into heritage and sustainable natural farming practices (Source: Apni Kheti).

City Fresh, Ropar:

Amandeep Singh, a progressive farmer from Ropar in Punjab, embarked on his agricultural journey in 2011, initially cultivating garlic before diversifying into coriander, cauliflower, turnip, spinach, radish, and fenugreek sold at local markets. In 2013, he innovated by introducing a nethouse for capsicum cultivation, followed by successful trials of broccoli in 2014 and seedless cucumber. With a diploma in Mechanical Engineering (2014), Amandeep embraced multi-cropping—growing up to six different crops simultaneously-to hedge against market fluctuations. By 2016–17, he expanded into baby corn and enhanced his marketing acumen by launching his own retail outlet, "City Fresh," styled like a European fruit-and-vegetable store, offering largely organic, pesticide-free produce. His emphasis on self-marketing and crop rotation fostered soil health and built consumer trust. Amandeep now serves around 150 regular customers, supplies Chandigarh (including McDonald's), and has plans for a seed nursery and a "Future Agri Punjab Farms" initiative to bring stability and innovation to family farming in the region (Source: Krishi Jagran)

Sandhu Farm, Shri Muktsar Sahib:

Balwinder Singh Sandhu, a progressive farmer from Shri Muktsar Sahib District, Punjab, transitioned to natural farming in 2011 after being inspired by Manmohan Singh, a fellow farmer known for his commitment to organic practices. Initially growing crops like cotton, mustard, and paddy, Balwinder shifted focus to vegetable cultivation, starting with chili. Seeking to improve his farming techniques, he visited Gujarat, where he learned about seedless cucumber, strawberry, and melon cultivation.

For the past four years, Balwinder has been practicing pure natural farming on 2 acres, minimizing the use of insecticides and pesticides. His main crop, chili, has provided strong financial returns, earning around Rs. 500,000 from 2 acres. He also sells his produce at a roadside-on-farm market and has expanded into chili powder processing. His diversified crops now include strawberry, cucumber, tomato, pumpkin, capsicum, wheat, paddy, and cotton. With good profits, Balwinder plans to expand natural farming practices across more land in the future. (Source: Apni Kheti)

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There are numerous success stories emerging from Punjab, where farmers are increasingly adopting organic farming practices on their land. These farmers have shifted away from conventional methods and embraced sustainable farming techniques, resulting in improved soil health, higher crop yields, and reduced dependence on harmful chemicals. Many have seen significant economic benefits, with some even securing premium prices for their organic produce. By focusing on crop diversification, eco-friendly pest management, and natural fertilizers, these farmers are not only enhancing their livelihoods but also contributing to environmental conservation and promoting a healthier food system.

Organic Farming in Punjab: Challenges:

Organic farming faces many difficulties that can affect its effectiveness and rate of acceptance, despite the fact that it has many benefits for sustainability, environmental preservation, and health. This section examines the various difficulties faced by organic farmers, elucidating the intrinsic intricacies of the practice as well as the outside variables that affect its implementation.

1: Use of Biofertilizers:

Biofertilizers have numerous agronomic and environmental advantages, but using them in organic farming presents a number of serious. In order to maintain balanced soil fertility, these organic inputs-such as compost, manure, and bone meal-need to be carefully managed because their nutrient contents might vary greatly and may not contain the same proportion of nutrients that plants require (Pandey et al., 2024). The uneven performance of biofertilizers in field settings is one of the main problems since environmental variables including soil type, pH, moisture, and temperature, as well as interactions with natural soil microorganisms, can greatly affect how successful they are (Pandey et al., 2024). This fluctuation frequently results in erratic crop reactions and may deter farmers from widely implementing biofertilizers. Furthermore, formulation and storage provide significant challenges; biofertilizers contain living microorganisms that are susceptible to storage conditions, which can lead to a short shelf life and decreased viability if improperly managed. Their usage is made more difficult by the selection of carrier materials and the requirement for cautious handling both during application and transportation (Fadiji et al., 2024). Furthermore, another issue is the market's supply of organic fertilizers. Because of its lower nutritional concentration than synthetic fertilizers, it is needed in bulk and may be related to handling and transportation.

2. Pest Management:

Organic farming faces several significant challenges in pest management due to its reliance on ecological processes and the prohibition of most synthetic pesticides. One of the primary difficulties is the limited availability and effectiveness of pest control options. Organic farmers

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must depend on cultural practices, biological control agents, and a small number of approved natural pesticides, many of which have short residual effects and require frequent application, making them less reliable than conventional chemical pesticides (El-Shafie, H., 2019).

Moreover, the effectiveness of these methods can be highly variable, influenced by local environmental conditions, pest species, and farm management practices Organic pest management is also more labour-intensive, requiring regular monitoring, manual interventions, and a deep understanding of ecological interactions, which can increase costs and demand greater expertise from farmers (Costa et al.,2019). Overall, while organic farming promotes biodiversity and ecosystem health, pest management remains a complex and resource-intensive aspect, requiring ongoing innovation, education, and support to ensure both productivity and sustainability.

3. Market supply chain

The market supply chain for organic farming is severely constrained, which limits the industry's capacity to expand and become profitable. Furthermore, it might be challenging for organic farmers to maintain a steady supply because of unpredictable production brought on by things like pest assaults and reduced yields (Sedghy et al., 2024). Due to a lack of access to appropriate market platforms and a lack of consumer knowledge regarding organic products, marketing inefficiencies are also common. As a result, farmers have fewer options to sell their products at premium prices and a smaller market reach. In contrast to traditional retail channels, which frequently involve wider price spreads and less market power for producers, supply chains with fewer intermediaries, such as direct sales from producer to consumer, tend to be more cost-effective and provide higher returns to farmers. Furthermore, obstacles to certification, inadequate market infrastructure, problems with traceability, and inconsistent output all contribute to organic farming's narrow market supply chains (Vigano et al., 2022; Chitra et al.,2023).

4. Yield gaps

Depending on crop variety, environment, and management techniques, the yield gap between organic and conventional farming is usually between 18% and 35%. Organic farming routinely generates lower yields than conventional farming (Tshotsho et al. 2024). Reduced nutrient availability from using slow-release organic fertilizers, more difficulty controlling weeds and pests without the use of synthetic chemicals, and less intensive soil use because organic rotations frequently involve more legumes and fallow periods are the main causes of lower yields in organic systems. Furthermore, although some studies reveal comparable or even higher stability in specific circumstances, organic farming may show more production variability from year to year (Pandey et al., 2024). The lower productivity of organic farming means that more land is needed to produce the same amount of food, which can have serious consequences for land use and sustainability, even though it delivers environmental benefits like better soil quality and biodiversity. Overall, the

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data indicates that, despite its benefits for the environment, organic farming typically produces lower agricultural yields than conventional agriculture.

5. Farmer trainings:

A major challenge in organic farming is the lack of adequate farmer training and technical guidance. Many farmers struggle to adopt organic practices due to insufficient awareness, limited access to hands-on training, and inadequate support from extension services (Singh et al., 2025). Without proper training, farmers find it difficult to manage soil fertility, pest control, and the preparation of organic inputs, which are more complex than conventional methods (Karen, A. C., 2023). Studies show that intensive, practical training programs can significantly improve farmer's knowledge, perceptions, and willingness to experiment with organic techniques (Ayyadurai et al., 2024). However, the effectiveness of these programs depends on their accessibility and relevance to local conditions. Persistent gaps in training contribute to low adoption rates, higher input costs, and lower initial yields, making the transition to organic farming risky and less attractive for many (Han et al., 2022). Addressing these training challenges is essential for the sustainable growth of organic agriculture.

Future Prospectives:

The future of organic farming in Punjab, is becoming an increasingly important topic as the agricultural landscape evolves. Punjab, often called the "Granary of India," has long relied on traditional farming methods that involve extensive use of chemical fertilizers and pesticides, leading to a range of environmental and health challenges. However, organic farming, which emphasizes sustainability, ecological balance, and soil health, is emerging as a viable alternative that could address these issues while providing economic benefits to farmers. The prospects for organic farming in Punjab are promising, yet several challenges must be overcome to realize its full potential. How organic farming will play a pivotal role in addressing these issues are as follow

- **Environmental concerns:** One of the key driving factors behind the potential growth of organic farming in Punjab is the growing environmental concerns associated with conventional farming practices. The extensive use of chemical inputs over decades has led to significant soil degradation, reduced soil fertility, and a depletion of the state's groundwater resources. The traditional farming system has resulted in a cycle of diminishing returns, with yields often requiring increasing amounts of synthetic fertilizers and pesticides. Organic farming presents a solution to these problems by avoiding harmful chemicals and promoting the use of organic manure, crop rotations, and composting, all of which improve soil health and fertility over time. By adopting organic practices, Punjab's farmers could restore the ecological balance, protect soil health, and contribute to long-term environmental sustainability (Dhiman, 2020).

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- **Sustainable use of water resources:** In addition to environmental concerns, the depletion of water resources is another pressing issue in Punjab. The state has been grappling with a severe groundwater crisis, with water levels steadily declining due to over-extraction for irrigation. Organic farming practices, which typically rely on more efficient irrigation methods and foster soil health, can contribute to better water management and conservation. Organic farming tends to improve the soil's water retention capacity, reducing the need for excessive irrigation. This makes organic farming not only an environmentally sustainable choice but also a water-conserving one, which is essential for the future of agriculture in the region (Parizad and Bera, 2023).
- **Higher consumer demand:** The rise in consumer demand for organic products both in India and globally is another factor that makes organic farming a promising option for Punjab's farmers. As consumers become more health-conscious and aware of the environmental impacts of their food choices, the demand for organic products is steadily increasing. Organic food is viewed as healthier, free from synthetic pesticides, and environmentally friendly, which has resulted in a shift in consumer preferences. This growing demand for organic produce, both domestically and in international markets, presents a significant opportunity for Punjab's agricultural sector. The state has the potential to become a major supplier of organic food, particularly to markets in Europe, the United States, and the Middle East, where organic produce fetches higher prices. As a result, farmers can benefit from premium prices, improving their profitability compared to conventional farming (Roos et al., 2018).
- **Technical skills:** Highly priced products: Transitioning from conventional to organic farming is not without its challenges. One of the primary hurdles is the transition period, during which farmers may experience a temporary reduction in yields as they move away from synthetic fertilizers and pesticides. This adjustment period can be financially challenging, particularly for small-scale farmers who rely on high yields to maintain their livelihoods. Additionally, the lack of comprehensive knowledge about organic farming practices remains a significant barrier. Many farmers in Punjab have limited experience with organic farming techniques, and there is a need for extensive training programs to educate them about soil health management, pest control, and crop rotation strategies. This knowledge gap can be addressed through farmer training programs, workshops, and the establishment of organic farming extension services that provide hands-on guidance and support (Maas et al., 2020).
- **Market Supply Chain:** Another challenge that organic farming in Punjab faces is the lack of adequate infrastructure to support the organic supply chain. While there is growing demand for organic products, the absence of well-developed marketing channels, processing units, and logistics networks can hinder the growth of the sector. Farmers need

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access to local and international markets, and to reach these markets, they require access to quality certification, transportation, and distribution systems. Establishing better infrastructure to connect organic farmers with consumers will be essential for the long-term success of organic farming in the state (Chitra et al., 2023).

- **Certification process:** The certification process itself is another obstacle for farmers. Organic certification can be a costly and time-consuming process, especially for small farmers who may lack the resources to navigate the certification system. While the Indian government and private entities offer support, the complexity of certification, combined with the associated costs, can discourage some farmers from transitioning to organic farming. Simplifying the certification process and providing financial support to smallholders could help accelerate the adoption of organic practices (Khadda, 2021).

DISCUSSION

Punjab, known for its intensive agricultural practices, faces challenges such as soil degradation and water pollution. Organic farming offers a sustainable alternative by emphasizing natural methods and minimizing the use of synthetic inputs. However, transitioning to organic farming presents challenges for Punjab's farmers. High initial investment costs for organic inputs, limited market access, and a lack of awareness and training among farmers are significant hurdles. Additionally, the competitive advantage of conventional farming with its higher yields and lower production costs poses a significant challenge to the adoption of organic practices.

Despite these challenges, organic farming presents several opportunities for Punjab. Organic produce commands premium prices in the market, offering improved returns to farmers. Moreover, organic farming practices enhance soil health, improve water retention, and reduce soil erosion. By minimizing the use of synthetic fertilizers and pesticides, organic farming reduces the environmental impact, protecting water bodies and air quality. Furthermore, organic produce is free from harmful chemical residues, ensuring safer and healthier food for consumers. Organic farming can also provide opportunities for farmers to diversify their income through value-added products like organic processed foods.

Government as well as non-government agencies has been taking steps to promote organic farming through subsidies, training programs, and market linkages. However, further efforts are crucial to address the challenges and encourage wider adoption of organic farming practices. By providing adequate support, fostering awareness, and improving market access, Punjab can transition towards a more sustainable and environmentally friendly agricultural model that benefits both farmers and the environment.

CONCLUSION

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In conclusion, organic farming in Punjab holds significant promise for the future, but its widespread adoption will depend on overcoming challenges related to knowledge gaps, infrastructure, certification, and market access. With the right policies, training programs, technological support, and infrastructure development, organic farming can become a sustainable and profitable alternative for Punjab's farmers. The region has the potential to lead the way in organic agriculture, contributing to environmental sustainability, improving farmer incomes, and meeting the growing demand for organic produce in both domestic and international markets. With continued support from government, private sector investments, and farmer-led initiatives, organic farming could play a key role in shaping the future of agriculture in Punjab.

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