

REVIEW ARTICLE

Challenges and Opportunities of Bangladesh Agriculture Sector: The Role of Chemical Fertilizer and Scope of Organic Farming

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Abstract

Agriculture is the base of Bangladesh's economy, supporting livelihoods and ensuring food demand for its growing population. However, this sector is facing some challenges including soil and environmental degradation due to heavy reliance on chemical fertilizer. This paper will explore the critical role of chemical fertilizer to boost the yield of crops and to ensure food security. Simultaneously, it highlights the crying need for organic farming to ensure the long-term preservation of soil and environmental quality, including the limitations of organic farming in Bangladesh. Key opportunities are identified to improve the agriculture sector, including the implementation of balanced fertilizer management, promotion of government policies and creating awareness among the producers. The paper emphasizes the need for an integrated approach that combines the use of chemical fertilizer with organic farming to ensure the long-term sustainability of the environment in Bangladesh.

Keywords: Bangladesh's agriculture, conventional farming, organic farming, chemical fertilizer, sustainable agriculture, soil health

Introduction

Agriculture is a cornerstone of Bangladesh's economy, promoting food security, providing employment and improving the livelihoods of the nation (BBS, 2023). The fields of Bangladesh are more than soil and crops; they are the base of nations survival and success. Agriculture contributes 11.60% of total GDP (BER, 2024), along with employment sources of more than 40% of total employment (ADB, 2023). About 1.25 million individuals are directly employed by it, while 12 million rural dwellers indirectly benefit from it (Chowhan et al., 2024). Because of the nation's large proportion of impoverished and vulnerable populations, high population density, susceptibility to climate change and dependency on agriculture, food security is crucial for social stability. Additionally, at the national level, 0.82% of households are severely food insecure and 21.92% have moderate or severe food insecurity (BBS, 2023). It has been reported from long-term integrated nutritional management experiments that fertilizer accounted for 35% of the total rice yield in transplanted *aman* season and 50% of the total rice yield in *boro* season (Naher et al., 2015). However, Bangladesh has significantly developed food security over the last two decades by increasing food production, especially rice production through the increased use of chemical fertilizer and better irrigation management strategies (Shahabuddin, 2016). High population pressure significantly contributed to increases in the use fertilizer in densely populated areas. More specifically, a 1% increment in population pressure increases fertilizer use by 0.118% (Xiang et al., 2020). It is expected that the population of Bangladesh will exceed

200 million in 2050 with a population density of 1355 km², amplifying the dependency on chemical fertilizers for crop production (Karim et al., 2024). Nonetheless, long-term fertilization has detrimental effects on the environment such as soil salinity, heavy metal accumulation, eutrophication, nitrate accumulation, greenhouse gas emissions, and biomagnification. The excessive use of chemical fertilizers has also given rise to many interrelated problems including soil, water, and air pollution. In response, organic farming is a viable alternative to protect the ecosystem from long-term degradation. Organic farming, with its emphasis on the use of natural inputs and sustainable practices, offers the potential to mitigate the adverse effects of extensive use of chemical fertilizer. This review examines the role of chemical fertilizers in Bangladesh's agri sector, exploring the impact and emerging opportunities for organic farming. By analysing the current use and trends of agriculture, this review aims to provide insights into the challenges and opportunities of climate resilience farming in Bangladesh.

Materials and Methods

This review was conducted by systematically searching of academic databases based on keywords like organic farming problems and prospects, chemical fertilizer, including Google Scholar, ResearchGate, ScienceDirect, and PubMed, along with different national and international sources like the Bangladesh Bureau of Statistics (BBS), Bangladesh Economic Review (BER), Food and Agriculture Organization (FAO), and International Federation of Organic Agriculture Movements (IFOAM). Keywords such as chemical fertilizers in Bangladesh, organic farming in Bangladesh, challenges of organic farming and the role of synthetic fertilizers in food security were used to identify relevant literature. The study used statistical tools to compare the consumption pattern of chemical fertilizers with grain production trends. Environmental and economic impacts of fertilizer use assessed through existing literature.

Results and discussion

Present status of chemical fertilizer consumption and grain production

There are several factors to increase fertilizer consumption in Bangladesh. First of all, the green revolution in the 1980s, facilitated by high-yielding crop varieties, especially rice and wheat, drove fertilizer consumption remarkably. Additionally, in 1995, authorities started to provide free fertilizer among the producers along with subsidies, which further exacerbated the issue. Furthermore, the widespread fertilizer industry increment and retailer network increased the accessibility of fertilizer to the producers, which ultimately enhanced fertilizer utilization in our country. However, the government's favorable policies regarding fertilizer allocation and price regulation, along with the supply of fertilizer-responsive HYV rice to the nation in the mid-1960s, caused the demand for fertilizer to go up from 875.179 to 6825.55 metric tons (BARC, 2018; BER, 2024) between 1980-81 and 2022-23 (up to February 2023). According to BARC (2018) and BER (2024), the use of urea, Triple Super Phosphate (TSP), Muriate of Potash (MoP) and Diammonium Phosphate (DAP) fertilizers increased by 559.776 to 2286.00, 215.061 to 674.00, 452.04 to 826.00 and 417.36 to 1427 metric tons, respectively, between 1980-81 and 2022-23. The widespread accessibility of inputs that increase crop output and the rapid advancement in growing technologies over the years have made Bangladeshi agriculture more reliant on chemical fertilizers to boost agricultural productivity. In Bangladesh, fertilizer is one of the essential components of soil nutrients and is crucial to crop productivity. Increasing urbanization and population growth have caused Bangladesh to lose 0.08 million hectares of arable land annually and expanding agricultural land use will not boost the yields of food crops (BBS, 2018). As a result, increasing land utilization by undertaking the implementation of innovations that boost production, such as fertilizer, is essential to attaining food sufficiency.

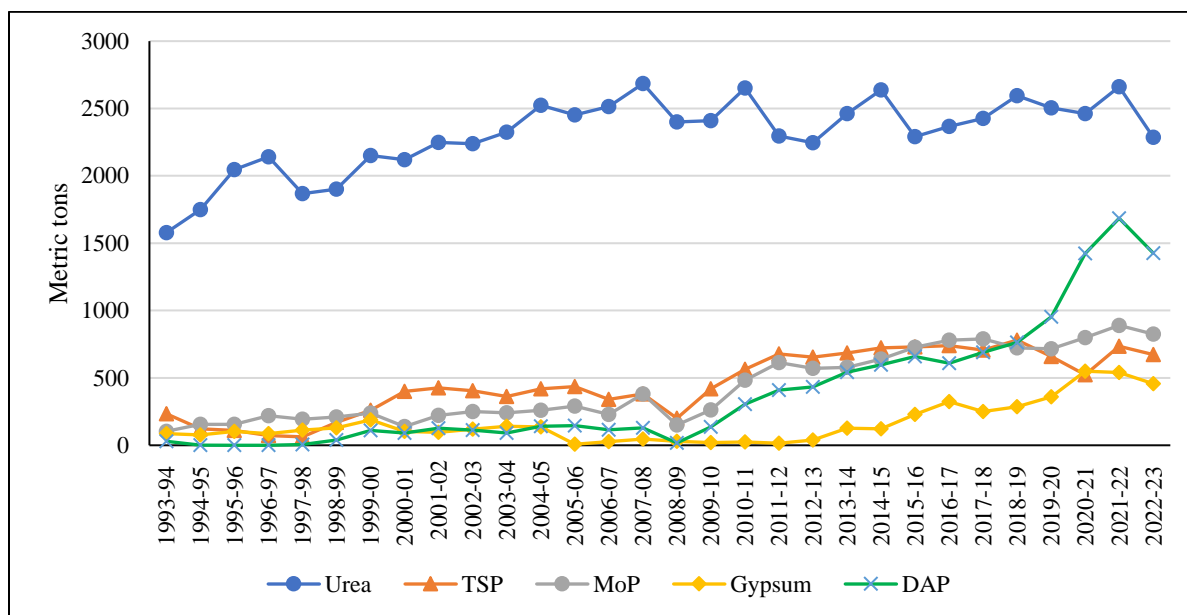


Figure 1: Major fertilizer consumption outlook in Bangladesh

Chemical fertilizers have played a significant role in increasing the major food grains (rice, wheat) production over the years, which play a critical role in ensuring food security in Bangladesh (BBS, 2023). Since their introduction, they are assisted crop production by increasing soil fertility and meeting the nutritional demand of crops. Rice production has experienced a significant growth from 250.87 lakh metric tons to 391.02 lakh metric tons from 1992-93 to 2022-23 farming year; wheat production reached 16.70 lakh metric tons from 11.71 lakh metric tons for the same period, whereas production of maize witnessed 1.49 lakh metric tons from 64.32 lakh metric tons during the period (Table 1).

Table 1. 23-year food grains production in Bangladesh

Market Year	Production (Lakh metric tons)			Market Year	Production (Lakh metric tons)		
	Rice	Wheat	Maize		Rice	Wheat	Maize
2000-01	250.87	16.70	1.49	2012-13	338.33	12.55	21.78
2001-02	243.00	16.06	1.52	2013-14	343.74	13.02	25.16
2002-03	251.88	15.07	1.75	2014-15	347.10	13.48	23.61
2003-04	261.90	12.53	2.41	2015-16	347.10	13.48	27.59
2004-05	251.57	9.76	3.56	2016-17	338.06	13.12	35.78
2005-06	256.53	7.35	5.22	2017-18	362.79	11.53	38.93
2006-07	273.18	7.25	8.99	2018-19	373.63	11.48	46.99
2007-08	289.31	8.44	13.46	2019-20	386.95	12.46	54.02
2008-09	313.17	8.44	7.30	2020-21	376.08	10.85	56.63
2009-10	322.57	9.69	8.87	2021-22	391.80	10.86	56.30
2010-11	335.41	9.72	15.52	2022-23	391.02	11.71	64.32
2011-12	338.90	9.95	19.54	2023-24	434.22	12.29	66.95

Source: (BER, 2005, 2013, 2019 and 2024)

Exploring the roots of fertilizer dependence in Bangladesh

Population pressure

Bangladesh, with a total population of over 165 million and an area of approximately 147570 square kilometers, is the eighth most populated country in the world (Wikipedia, 2024). This immense population density exerts extreme pressure on the country’s agriculture sector to produce sufficient food. With limited arable land, farmers are forced to adopt intensive cropping systems, often planning two to three crops annually on the same plot of land. As a result, soil fertility is depleting rapidly, making the use of chemical fertilizer crucial for replenishing nutrients and sustaining high yields. Additionally, government subsidies and the accessibility of chemical fertilizers have made them a more cost-effective and readily available solution for farmers.

Staple food

Rice and wheat are the primary food sources in Bangladesh. Rice alone supplies almost 70% of the caloric demand for the population (Bin Rahman and Zhang, 2023), with *Aus*, *Aman*, and *Boro* seasons. Wheat, though less dominant, plays a vital role in diversifying the food supply. Bangladesh has adopted high-yielding crop cultivars to meet the demands of its growing population, which require intensive nutrient replenishment. Chemical fertilizers such as urea, triple superphosphate, and muriate of potash are widely used to supply nitrogen, phosphorus, and potassium, respectively, ensuring optimal crop production. This heavy reliance on synthetic fertilizers has become a key strategy to ensure food security in the nation.

Quick and visible result

Chemical fertilizers have an immense impact on crop growth and development, which increase crop yields within a shorter period compared to organic practices. These fertilizers provide essential nutrients for crops, especially staple crops like rice and wheat, where farmers aim to maximize output to meet both their family’s and country’s high food demand. As a result, the need for immediate yield improvement and the pressure to sustain multiple cropping systems have made chemical fertilizers the preferred choice for producers.

Government subsidies and support

The widespread consumption of synthetic agrochemicals in Bangladesh is largely driven by government policies that make them accessible and affordable for farmers. Subsidized pricing, especially for urea, significantly reduces costs, enabling even smallholder farmers to afford fertilizers. Additionally, an extensive distribution network ensures the chemical fertilizers are readily available in rural areas. During the green revolution, the authorities actively promoted chemical fertilizers through campaigns, training programs, and financial incentives to boost agricultural productivity. This long-term support increases the adaptations of synthetic fertilizers to sustain high land for food security.

Table 2. Govt. subsidy for chemical fertilizer for different farming year in Bangladesh

Farming year	Subsidy (Crore)
2005-06 ^a	1,095
2009-10 ^b	4,009
2020-21 ^b	7,717
2021-22 ^c	14,941
2022-23 ^d	16,000
2023-24 ^d	24,000

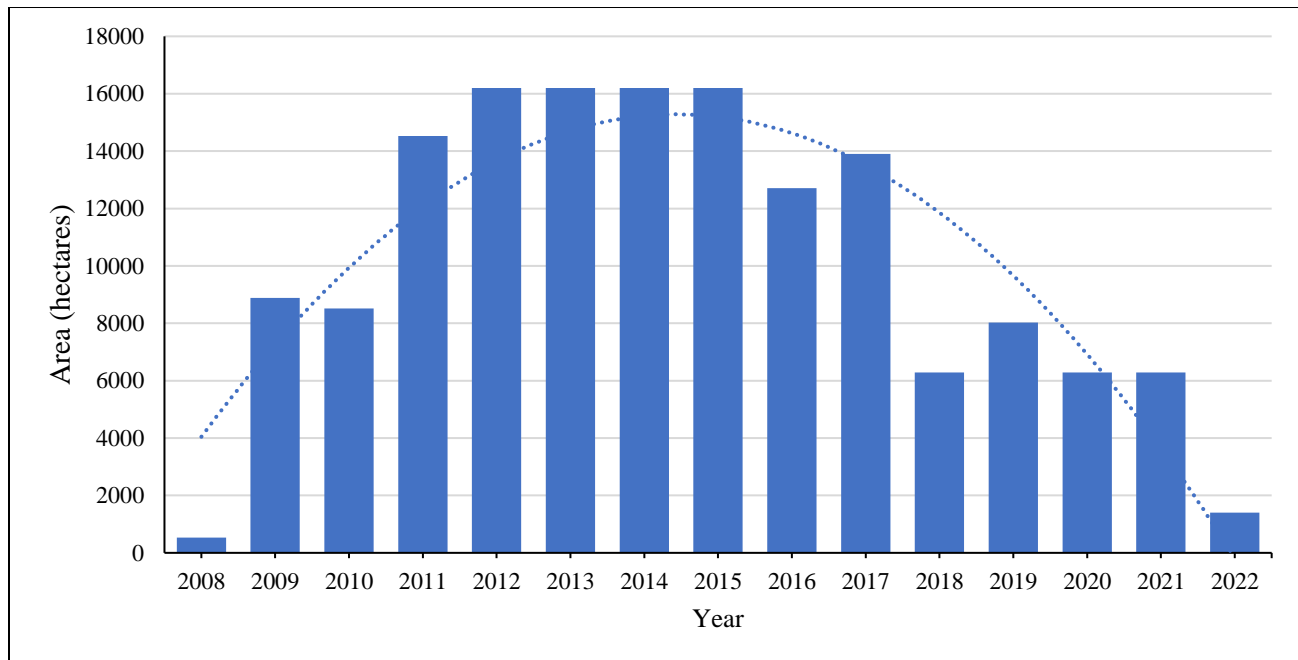
Sources: ^aBSS, 2022; ^bDhaka Tribune, 2024; ^cDhaka Tribune, 2024; ^dByron, 2023)

Lack of awareness and fragmentation of land

The preference for synthetic fertilizers in Bangladesh stems from both a lack of awareness about organic farming and the issue of fragmented land, which hinders the use of alternative practices. Many farmers lack knowledge about the profound effects of organic farming on our environment and ecosystem. Furthermore, land fragmentation, with most farmers operating on small. Scattered plots make it more difficult to execute labour-intensive methods like organic methods like composting. This small-scale farmer finds chemical fertilizers more practical and manageable, requiring less time and effort, making them a preferred choice for boosting productivity.

Present status of organic farming in Bangladesh

The Bangladeshi organic agriculture movement is being introduced and expanded across the nation by the commercial sector, which has emerged as a pioneer in this area. By raising consciousness, educating the public, and assisting the marketplace for organic products, NGOs and other private entities have stood in the forefront. In order to guarantee that the manufacturer receives a fair price, they have established a value chain for organic goods. Additionally, they provided materials for organic farming along with innovative strategies for cultivating climate resilience. Currently, the government is also participating in such attempts by putting legislation into action, offering subsidiaries, and creating a certification program to encourage organic farming across the nation. Together with other non-governmental organizations, Bangladesh managed 177,700 hectares, or 2% of its total area, under organic farming in 2006, making it the second-largest country in Asia (IFOAM, 2006). A few traditional growers who are not affiliated with non-governmental organizations have begun to grow organic crops after witnessing the advantages of doing so from NGO members. After analysing the data from 2008 to 22, it was found that the land used for organic farming showed increasing tendencies up until the years 2012 to 2015. Following that, the area showed dropping patterns until the present (Figure 2). Nevertheless, just 526, 16198, 8030, 6285, and 1400 hectares of land had been transformed as of 2008, 2015, 2019, 2021, and 2022, respectively (Willer et al., 2024). Organic farming is used in Bangladesh for growing fruits, vegetables, shrimp, and tea (*Camellia sinensis* L.).



Source: (Willer et al., 2011, 2015, 2019 & 2024)

Figure 2: Average organic farming area (ha) in Bangladesh across different years

Organic market in Bangladesh

Although Bangladesh's organic food business remains in its beginning stages, it is expanding quickly. Bangladeshi's limited financial resources prevent them from affording organic food. Bangladesh's organic food market is primarily composed of middle-class to upper-class, educated, health-conscious people who value the hygiene and nutritional advantages of organic products. A lot of organizations specifically focused on organic farming have been started as a result of the market demand and high cost of organic products. Supermarkets, specialty shops, internet retailers, and other retail establishments are among the places where organic items can be found. Probertana, PROSHIKA, and Meena Bazar are among the popular organic stores in Bangladesh. In rural regions, the scenario is the reverse. Producers typically grow organic food for domestic consumption, ensuring it is devoid of any artificial pesticides or fertilizers. These food items are rarely sold. Bangladesh has a lot of prospects for exporting its organic vegetable crops. Even though Bangladesh's vegetable exports account for a very small portion of the world's vegetable international trade, they are expanding quickly. Export revenues from this industry climbed from US\$ 14.5 million to US\$ 49.26 million over fifteen years from 1995-1996 to 2009-2010, representing an ordinary yearly rise of 16% (Bhuyan and Uddin, 2010). Nonetheless, the marketplace for organic goods is projected to have reached value at \$10 million or more by 2023 and is predicted to grow to \$50 million by 2025 (Rahman, 2023).

Limitations of organic farming in Bangladesh

Organic farming in Bangladesh holds immense prospects for promoting sustainability of the environment and ecosystem; however, it faces several drawbacks that hamper its widespread adaptation. Transitioning from traditional crop production practices to eco-friendly practices often involves high initial costs, which many small-scale farmers find unaffordable. By reducing chemical fertilizer demand, it helps to increase the sustainability of natural resources like water, soil, and microorganisms. This approach not only produces healthier produce for consumers but also ensures the long-term sustainability of agriculture. Realizing the full potential of organic farming in Bangladesh, successful adaptation requires addressing several challenges to transition farmers from inorganic practices to sustainable crop production. However, key limitations are summarized below:

Government and farmer perception

Policymakers think that hunger and extreme poverty would have been more severe than they are now if cereal production hadn't increased so dramatically. Organic farming is said to produce lower yields, and there isn't enough organic fertilizer to significantly increase yields. In Bangladesh, the government defines nutritional safety as having a sufficient supply of rice. Additionally, having the necessary amount of rice in his home gives a Bangladeshi farmer a sense of security regarding food (UBINIG, 2011). It has been reported that food security problems may arise as a result of the yield difference between traditional and organic agriculture (De Ponti et al., 2012; Kniss et al., 2016).

High production costs

Organic farming in Bangladesh faces a lot of challenges, making its adaptation and sustainability difficult for farmers. The high cost of organic inputs like biofertilizers, composts, and vermicompost's, along with their limited availability, significantly increases the production cost. Also, this farming method is labour-intensive, requiring more manpower for activities like weeding, pest control, and compost preparation, which has limited the farmer's perception of towards organic farming. Moreover, transitioning to organic farming involves a period of reduced yields as the soil restores its natural fertility and productivity, which raises the costs per unit of production. Organic farming also faces difficulties coping with the high price of biopesticides, which ultimately exacerbates the issues.

Low yield and productivity

In the initial stages, organic farming results in lower yields compared to chemical-based crop production. This happens due to the long period of time it requires for the soil to adjust to using organic pesticides as opposed to synthetic pesticides. Additionally, a considerable amount of time is spent encouraging the development of beneficial creatures for the farm's pollination. At the same time, the farmer loses a significant amount of yield, making organic cultivation considerably less appealing to the typical Bangladeshi producer. As a result, this has become a significant deterrent for the farmers to meet household needs or market demand, who are relying on high-yielding crop cultivation with inorganic fertilizers. The research by Uddin et al. (2016) revealed that the tomato yield was initially low at 55.45 t ha⁻¹ during the 2008-09 farming year. However, by the 2014-15 period, after continued organic farming practices, the yield increased to 65.91 t ha⁻¹.

Lack of organic inputs

Organic farming heavily depends on inputs like compost, green manure, vermicompost, farmyard manure, green manure and biofertilizers. Unfortunately, in Bangladesh, these inputs are not widely produced or distributed properly. Most farmers find it difficult to source organic alternatives, forcing them to continuously use synthetic fertilizers. Moreover, organic fertilizer production requires additional labour and resources, which may not be feasible for resource-poor farmers.

Lack of awareness and training

The lack of awareness and training facilities considerably hinders the growth of organic farming in Bangladesh. Many farmers are unfamiliar with the principles and long-term benefits of this practice, leading them to rely on conventional chemically intensive methods that provide faster results. Without adequate knowledge, they may struggle to adopt organic techniques like composting, crop rotation and biological pest control. Similarly, access to training programs and expert guidance is limited, particularly in rural areas. Farmers frequently lack the skills to manage soil fertility, productivity, pests and disease organically. The absence of proper government or institutional initiatives to educate farmers further ignites the problem. Without proper guidance, farmers are reluctant to swift away from the chemical-demand methods they are accustomed to, fearing potential crop failures or reduced incomes.

Limited market access and infrastructure

There are few facilities for preservation, packaging, and transportation in the weakened market structures for organic products. Farmers' capacity to effectively meet customer demand for fresh products is impacted by this. Furthermore, the transportation and cold storage of biological goods from rural to city centres are hampered by a lack of reliable facilities.

Market demand

Organic items are costlier in Bangladesh than inorganic ones. Consumers in the country are often cost-sensitive and organic items are typically more expensive than conventional products due to higher input and maintenance costs and limited economies of scale. This lack of affordability makes it more difficult for farmers to sell their products at a profitable price. The domestic market for organic products is not well structured. Moreover, the export market for these products remains untapped due to challenges meeting international certification standards, which require substantial time as well as monetary demand and expertise. Without strong consumer demand, organic farmers face difficulties recovering their high production costs.

Soil fertility management

It is more difficult for farmers to regulate soil fertility in an organic farming system because of the tougher guidelines regarding the use of synthetic fertilizers. In order to efficient replenish of soil nutrients, a lot of farmers struggle to locate sufficient supplies of organic matter, vermicompost, compost, green manure, or other organic fertilizers in a timely manner.

Pest and disease control

Managing pests and diseases in organic farming is quite challenging in Bangladesh due to a combination of environmental, technological, and knowledge-based factors. The country’s warm and humid environmental conditions foster rapid pests and disease proliferations, especially in highly valuable crops like rice, wheat, and maize. Unlike traditional farming, organic farming adheres closely to natural pest control techniques; yet, employing natural predators to eradicate insects may prove to be less efficient and require more time than utilizing chemicals. The main challenge facing farmers is the infestation of pests and diseases, which can lead to crop loss. As a result, illnesses, pest infestations, and pests become some of the barriers to large-scale dissemination of organic farming practices. Furthermore, pests may develop resistance to commonly used organic remedies, making management more difficult, which makes pests and disease control a persistent obstacle for organic farming in Bangladesh.

Policy and support issues

Policy and support issues significantly influence the adaptation of organic farming in Bangladesh, often acting as barriers due to misaligned government priorities. The emphasis on chemical fertilizer, along with a large number of subsidiaries, discourages farmers from transitioning to organic farming in Bangladesh. Such policies make conventional farming more attractive to farmers due to its economic viability in the short term.

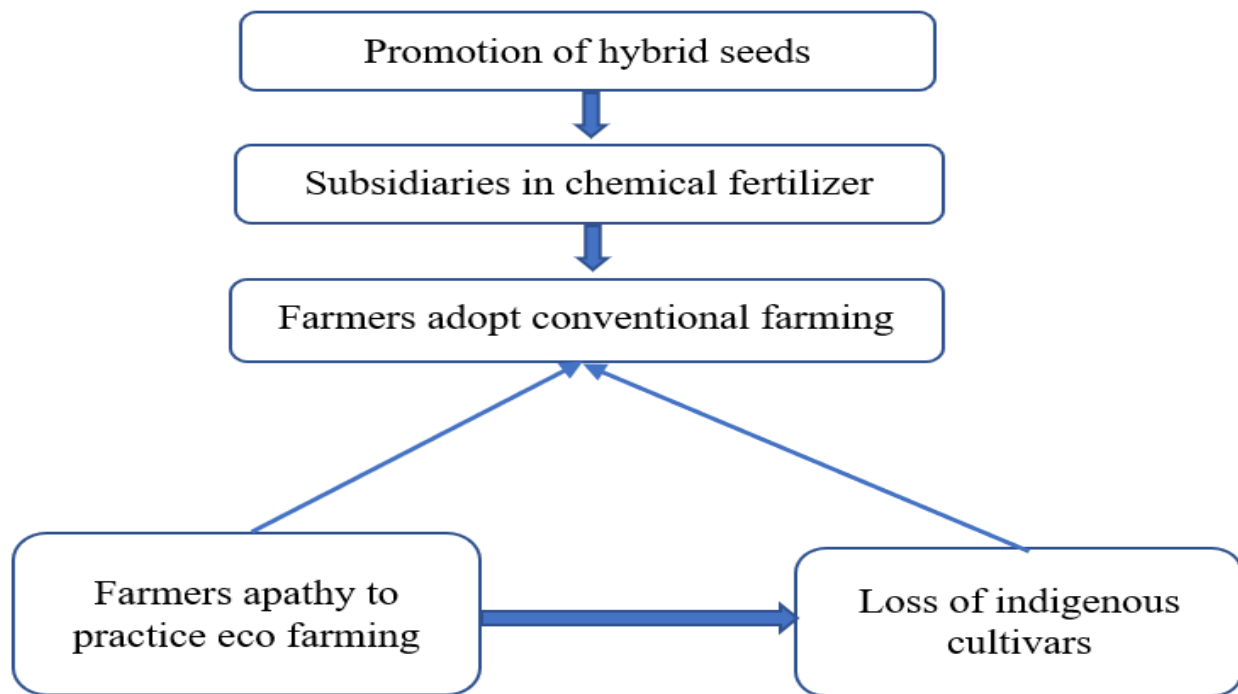


Figure 3. Influence of government policies on organic farming

Land fragmentation

Land fragmentation creates consistent challenges to organic farming in Bangladesh, stemming from a number of structural and economic determinants. The country's farming landscape is determined by small and scattered plots, a result of population pressure, stick regulations, and rapid urbanization. These fragmented lands limit the implementation of organic farming practices such as crop rotation, intercropping, and conservational crop production techniques. Additionally, farmers face further difficulties in monitoring and controlling pests and diseases, as fragmented plots create barriers to employing integrated diseases and pest management strategies. Moreover, land fragmentation reduces economies of scale, making it harder for farmers to collectively market their organic produce or share their essential infrastructure, such as compost pits and irrigation systems. The lack of cooperative farming models and government support compound these issues, discouraging farmers from transitioning to organic farming. Furthermore, land fragmentation often suffers from uneven soil fertility, which is one of the most limiting factors for organic crop production. These factors highlight the structural limitations, necessitating policy interventions to encourage land consideration and cooperative farming to support sustainable farm practices.

Prospect of organic farming in Bangladesh

Organic farming in Bangladesh holds substantial promise offering solutions to environmental, economic, and health challenges. Below is a detailed exploration of key prospects for organic farming in Bangladesh:

Diverse agro-ecological zones

Bangladesh is blessed with a diverse climate that allows the cultivation of various crops throughout the year. Thus, it is ideal for organic farming, where crop rotation and diversification are key practices. Organic farming can enhance soil health in the long term through diversified crop planting. Furthermore, the alluvial soils in Bangladesh's delta are highly fertile, providing a good foundation for organic farming.

Traditional knowledge of farmers

Many farmers in Bangladesh have a long history of traditional farming practices like floating agriculture, sorjan methods and ring methods, which align with organic principles. These existing knowledge bases can be built upon to introduce more sustainable methods, ensuring a smoother transition for farmers moving towards organic farming.

Environment sustainability

Organic farming can mitigate the adverse effects of conventional farming in several ways:

Improving soil health:

From 1980-81 to 2022-23, the use of major chemical fertilizers like urea, TSP, and MoP in Bangladesh has significantly increased (Abusiddique, 2022). This surge in fertilizer use has led to a decline in soil fertility and beneficial microorganisms, resulting in plants not receiving sufficient nutrients despite increased fertilizer application. Most arable land in Bangladesh contains less than 1.5% organic matter, while healthy soil should have at least 2.5% (Cavallito, 2023). Additionally, the nitrogen balance is negative and other essential nutrients like phosphorus and potassium are either deficient or near zero, worsening the overall soil nutrient status. Organic practices emphasize the use of compost, green manure, and crop rotation, all of which help to replenish soil health naturally. Unlike synthetic fertilizer, organic farming helps to increase soil organic matter, which improves soil structure, texture, water retention, and microbial diversity. This leads to a long-term increase in soil fertility.

Reducing pollution

The extensive use of agrochemicals has resulted in water and soil pollution in Bangladesh. Fertilizer runoff can contaminate above-ground and underground water resources, causing issues such as eutrophication, which harms aquatic ecosystems. Excessive nitrate in water used for drinking (more than 50 mg NO₃⁻/L) can cause the water to become eutrophic and cause serious health risks such as cardiac disease, blue baby syndrome, stomach cancer, goiter, and birth defects (Feigin & Halevy, 1989). Organic farming reduces the use of synthetic chemicals, thereby preventing the leaching of harmful substances into water resources and reducing the negative impacts on biodiversity. It has been reported that organic agriculture helps to considerably lower the amount of persistent and water-soluble chemical pesticides that contaminate waterways by avoiding artificial chemicals (Vincent & Fleury, 2015).

Economic opportunities

Globally, there is an increasing demand for organic food due to growing health concerns among consumers. In Bangladesh, this trend is also catching up, particularly among the urban middle-class population who are willing to pay a premium for chemical-free products. With improved consumer awareness and demand for organic products, farmers in Bangladesh can tap into new markets both domestically and internationally, creating new economic opportunities for organic products.

Employment generation

Organic farming tends to be more labour-intensive than traditional farming. Practices such as crop rotation, manual weeding and compost preparation require more human labour, which can create employment opportunities, especially in rural areas. This is crucial in Bangladesh, where agriculture is still the primary source of income for millions of people. By promoting organic farming, Bangladesh can create sustainable job opportunities that will ensure rural development.

Health benefits

Shifting towards organic farming can significantly impact public health, especially in a developing country like Bangladesh, where the population faces health risks due to the consumption of foods containing pesticide residues.

Chemical free produce

One of the most significant health benefits of organic crop production is the production of food that is free from harmful chemicals. Pesticides, herbicides, and any synthetic fertilizers commonly used in traditional farming can leave residues on crops that are detrimental to human health. Chronic exposure to these chemicals has been linked to various health issues, including cancer, neurological disorders, and reproductive problems. For instance, long-term excessive nitrate consumption has been linked to several gastrointestinal disorders, including cancer (Jones et al., 2016). Young children are primarily affected by methemoglobinemia, which is caused by consuming water that contains excessive NO₃⁻ (Johnson, 2019). Evidence suggests that consuming high-level NO₃⁻ containing drinking water increases the incidence of birth abnormalities of the eye, ear, face, neck, and nervous system (Stayner et al., 2022). However, eating organic food may lessen exposure to microorganisms that are resistant to antibiotics. Organic practices can eliminate these risks, providing consumers with safe and healthier food, as organic products have also been demonstrated to have higher levels of antioxidant activity, carotenoids, phenolics, and flavonoids (Rempelos et al., 2021; Crinnion, 2010).

Reduced health care cost

With the reduced use of chemicals in food production, there is a potential decrease in pesticide-related health problems. This reduction in chemical use can lower healthcare costs related to diseases and other health disorders caused by long-term exposure to pesticides.

Policy support and initiatives

While organic farming is still in its initial stage in Bangladesh, there are promising signs of support from the government as well as non-government organizations.

Government efforts

The Bangladesh government has begun to recognize the importance of organic farming for ensuring food security and environmental sustainability. Several pilot’s projects and programs have been launched by the government to encourage farmers to adopt organic farming. The government is also promoting organic farming through the Department of Agricultural Extension (DAE) by providing training and offering support for the transition to organic agriculture. However, more policy invention is needed to scale these efforts.

Table 3. SWOT analysis for organic farming in Bangladesh

Strengths	Weaknesses
<ul style="list-style-type: none"> ➤ Favorable agro-climatic ➤ Growing consumer awareness ➤ Fertile agricultural land ➤ Rich traditional farm practices ➤ Government initiatives ➤ Export opportunities ➤ Diverse climatic conditions 	<ul style="list-style-type: none"> ➤ Small landholdings ➤ Lack of inputs ➤ Limited knowledge of farmers ➤ High input cost and certification barriers ➤ Lower initial yields ➤ Weak marketing channels ➤ Cultural resistance
Opportunities	Threats
<ul style="list-style-type: none"> ➤ Increasing domestic demand ➤ Export potentials ➤ Sustainability goals ➤ Increasing urbanization ➤ Government supporting programs ➤ Digital marketing platforms ➤ Youth and entrepreneurship 	<ul style="list-style-type: none"> ➤ Competition from conventional farming ➤ Vulnerable to climate change ➤ Consumer affordability ➤ Consumer awareness gap ➤ Lack of certification bodies ➤ Pests and diseases infestations ➤ Lack of proper organized market

Non-government organizations

NGOs in Bangladesh have been playing a key role in promoting organic farming, especially in rural areas. These organizations provide farmers with technical support, organic inputs, and training on organic farm practices. It also helps farmers access organic certification, which is essential for marketing. Their efforts contribute to raising awareness about the benefits of organic farming to improve the livelihoods of smallholder farmers.

SWOT analysis for organic farming in Bangladesh

The analysis was conducted based on collected responses from both farmers and consumers, providing a clear understanding of the current landscape and future perspective of organic farming in Bangladesh. Producers highlighted key challenges such as high production costs, limited access to organic inputs, and market

uncertainties. However, many also recognized the growing demand for organic products and the potential for higher profits with proper market access. In contrast, consumers were significantly aware of the benefits of such products, like chemical-free options. However, issues like affordability and availability of organic products in local markets were noted as obstacles. The analysis, based on collected responses, is summarized in table 3.

Conclusion

The agriculture sector of Bangladesh is a critical platform, where ensuring food security for an increased population along with environmental sustainability has become challenging through organic farming. The synthetic fertilizers have become a crucial factor in achieving food security for dense populations with limited arable land. Chemical fertilizer significantly increased the crop yield, resulting in meeting the food demand of a growing population. However, the dependency on chemical fertilization has become a great concern for the country. One of the primary concerns is that excess use of synthetic fertilizer degrades the soil quality through the disruption of microbial activity, reducing the water holding capacity of the soil, depletion of organic matter, increasing the soil acidification, reduction of soil infiltration capacity, increasing heavy metal contamination, and so on. As a result, fertilizer dependency is increasing day by day. On the other hand, organic farming is the platform for overcoming these challenges. Organic farming practices, which involve the use of organic residues from animals and plants, ensure the long-term development of soil, water, and air quality through the reduction of nitrate contamination in water and greenhouse gas emissions in the air. The adaptation of organic farming restores soil fertility through the increment of organic matter in soil and microbial activities and thus promotes pesticide-free food for a healthy population. However, the limited availability of inputs and lower yield have become the most important limiting factors for organic crop production in Bangladesh. Indeed, organic farming can't meet the food demand of Bangladesh, as the demand for rice is high and increasing day by day. Despite these limitations, there is great opportunity for the organic market, as the increasing domestic and global demand for organic foods is creating a lucrative market for organic produce. At present, turning fully to organic farming with limited arable land can condense food insecurity, resulting in the enhancement of the import cost of different goods from other countries. Integration of organic and inorganic farming can be the possible way to ensure food security as well as sustainable uses of natural resources in contemporary terms.

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Authors contribution: Mejbah Uddin contributed to conceptualization, visualization, methodology, reviewing literature, extracting information, synthesizing, and manuscript writing.

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