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Review

Organic dairy farming in Bangladesh: current status, challenges and prospects

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Abstract: Organic dairy farming (ODF) is a method of dairy production that emphasizes the use of natural and sustainable practices, aiming to minimize synthetic inputs, promote animal welfare, and protect the environment. The aim of this review is to elucidate the current status, challenges and prospects of the ODF in Bangladesh. Starting from the current situation, the challenges and future potential of the ODF are presented, as well as strategies to overcome the difficulties are also highlighted. The ODF has the great potential, challenges and opportunities in Bangladesh. This involves the production of milk, meat and dairy products using sustainable and organic practices. Farmers need certification, and challenges include limited awareness, access to organic inputs, and market demand. Government initiatives, training programs, and cooperative models can support the growth of the ODF. Market opportunities and ongoing research are essential considerations. Animals raised in the ODF systems are provided access to pasture or outdoor areas and are fed organic feed, which is free from synthetic additives, antibiotics and hormones. The transition to the ODF is driven by a combination of economic, environmental, and health-related motivations, aiming to produce dairy products in a more sustainable, economically viable and environmentally friendly manner. Organic dairy farmers prioritize the well-being of their animals and advocate for a natural environment, which is integral to animal welfare. The popularity of organic products, including meat, dairy, and value-added items, from these producers continues to rise, driven by the expanding organic market, higher prices for organic milk, and consumer preferences for products from more sustainable production systems. Despite a mammoth of challenges exist in the ODF, farmers need to implement and adhere to strict standards for organic products, animal welfare and the use of organic inputs to gain the full benefits of this sustainable farming system. This review article examines the present status of the ODF industry, emphasizing key considerations, management practices, challenges, and future prospects. It also provides insights into the relevant regulatory authorities, aiming to inform farmers and stakeholders in Bangladesh and beyond about ODF. However, there is a need for future research to concentrate on improving sustainability and efficiency within the ODF sector.

Keywords: sustainable farming; management; animal welfare; organic milk; organic meat

1. Introduction

The interest in organic farming and organic products has been steadily increasing worldwide, including in developing countries like Bangladesh (Schwendel *et al.*, 2015; Manuelian *et al.*, 2020; Ferdous *et al.*, 2021).

This global interest and demand for organic farming practices suggest a shift toward more sustainable, environmentally friendly, and healthier agricultural methods. Developing countries are increasingly recognizing the potential benefits of organic agriculture for improving food security, reducing environmental impacts, and providing healthier food choices for their populations. The reasons for this trend include concerns about chemical residues, the transfer of antibiotic resistance from animals to humans, animal welfare issues associated with conventional farming methods, and the desire for higher-quality food (Manuelian *et al.*, 2020; Dallago *et al.*, 2021; Ferdous *et al.*, 2021).

The traditional and/or conventional dairy farming system poses numerous challenges, including environmental pollution from synthetic pesticides and fertilizers, soil degradation, antibiotic resistance due to overuse in conventional practices, loss of biodiversity, and concerns about animal welfare (Guadu and Abebaw, 2016). Additionally, conventional dairy farming may contribute to resource depletion, climate change impact, and health risks for consumers through the presence of chemical residues in dairy products (Guadu and Abebaw, 2016; Wagner *et al.*, 2021). The traditional dairy farming practices also overlooks the potential benefits of soil carbon sequestration and misses market opportunities driven by increasing consumer demand for sustainable and environmentally friendly dairy products (Escribano, 2016; Yu *et al.*, 2020). To address these challenges dairy producers across the world are searching for alternatives. What would be the key research areas in ODF, and how can studies on organic feed formulations, biodiversity conservation, disease management alternatives, economic and social impacts, soil carbon sequestration, consumer preferences, digital technology integration, climate resilience, and market dynamics contribute to a comprehensive understanding of sustainable dairy production? Establishing ODF systems is crucial to addressing these issues, promoting sustainable agricultural practices, and meeting the growing demand for ethically produced dairy items (Maji *et al.*, 2017; Butler and Stergiadis, 2020; Grodkowski *et al*., 2023).

Organic farming embodies a holistic approach to production management aimed at enhancing health through the promotion of biodiversity, biological cycles, and soil biological activity. It prioritizes management strategies over synthetic inputs, emphasizing the use of natural methods. The overarching objective is to enhance the health and productivity of interconnected ecosystems comprising soil life, plants, animals, and humans (Butler and Stergiadis, 2020; Blair, 2021). By adopting these integrated and sustainable practices of organic farming, agricultural systems can become more resilient to environmental challenges, improve food security, and contribute to a healthier ecosystem for both current and future generations.

Organic farming isn't a recent development in food production. It's already established in 160 countries, covering 37.2 million hectares of agricultural land worldwide. In 2009, global sales of organic food and beverages reached $54.9 billion. The United States saw organic food sales surpass $60 billion in 2022, marking another milestone for this resilient sector. Asia hosts 40% of the world's organic producers, with Africa at 28% and Latin America at 16%. Leading the pack in terms of producer numbers are India, Uganda, and Mexico (Willer *et al.*, 2020).

While animal products represent a smaller portion of the organic market compared to fruits, cereals, and herbs, they are significantly less prevalent in exports from developing nations. Within organic livestock production systems, consumers anticipate that items like organic milk, meat, poultry, eggs, and leather goods originate from farms subjected to thorough inspections ensuring compliance with stringent standards. These standards necessitate the use of organic feed, forbid the use of prophylactic antibiotics, and mandate that animals have access to outdoor environments, fresh air, and sunlight (Manuelian *et al*., 2020). The production methods employed must adhere to all health regulations while operating in synergy with the environment, promoting biological diversity, and nurturing healthy soil and growing conditions. Animals are marketed as being raised without the utilization of persistent toxic pesticides, antibiotics, or parasiticides (Von Borell and Sørensen, 2004).

Since ODF in Bangladesh has the potential for export and meeting the demand for organic products despite challenges, farmers need to implement and adhere to strict standards for animal welfare and the use of organic inputs to gain the full benefits of this sustainable farming method. Bangladesh can create a conducive environment for the establishment and growth of organic dairy farming, ensuring sustainability, economic viability, and positive contributions to the local agricultural sector. Initiatives should focus on raising awareness and providing education to farmers about the benefits of organic practices. Implementing training programs to equip farmers with the necessary skills and knowledge, streamlining certification processes, and advocating for government support are essential steps. Additionally, investing in research and development, promoting cooperative farming models, and developing the market for organic dairy products are critical components. Ensuring financial support, improving infrastructure, and monitoring progress through evaluation mechanisms contribute to the success of organic dairy farming initiatives. Public-private partnerships play a key role in

creating a supportive ecosystem. By addressing these aspects comprehensively, Bangladesh can foster sustainable and environmentally friendly dairy production while meeting market demands and improving farmer livelihoods. This review paper therefore discussed the current state of organic dairy farming in Bangladesh, highlighting the considerations and management practices, challenges, and prospects within the industry. This comprehensive information on organic dairy farming may contribute valuable insights for policymakers, researchers, and practitioners involved in the organic dairy sector in Bangladesh, fostering a more informed and sustainable approach to its future development.

2. Standards and regulation of organic dairy farming

Organic dairy farming is regulated by specific standards and guidelines established by various certifying bodies and government agencies to ensure that dairy products labeled as "organic" meet defined criteria (Schwendel *et al.*, 2015; Murshed and Riaz Uddin, 2020; Grodkowski *et al.*, 2023). In contrast to conventional production methods, organic production systems operate under a set of stringent standards that producers must adhere to. These standards are enforced by certification agencies authorized by relevant governments. A farm can attain organic classification if it satisfies the criteria outlined in a set of guidelines referred to as organic standards. The assurance of production quality under organic management is maintained through certification procedures utilizing internationally recognized standards. Organic certification not only assures the quality of the end product but also validates the integrity of the production process. Organic agriculture is primarily consumer- or market-driven, as these products are distinguished through certification and labeling (Willer *et al*., 2020).

Organic dairy farming standards outline the practices and requirements that farmers must adhere to in order to obtain organic certification. These standards typically cover aspects such as feed, animal health, housing, pasture access, and the use of antibiotics and hormones (Ertl *et al*., 2014; Manuelian *et al*., 2020). In organic dairy farming, cows must primarily be fed organic feed, which is cultivated without the use of synthetic fertilizers, pesticides, or genetically modified organisms (GMOs). Additionally, access to pasture or outdoor areas for grazing is a fundamental requirement (Orjales *et al*., 2019). Prohibitions exist on the use of synthetic chemicals, antibiotics, growth hormones, and other artificial substances in organic dairy production. Only approved natural treatments are allowed for animal health (Rosati and Aumaitre, 2004). Standards for organic dairy farming emphasize animal welfare regulations, minimize environmental stewardship, proper certification and inspection of products by authorized bodies, and maintain accurate labeling and traceability of the products (Stiglbauer *et al*., 2013).

Any farmer willing to adhere to the principles and guidelines of organic farming can practice it. However, for the food to be marketed or traded as organic, it must be certified by an accredited agency. The certification process involves several steps, including the registration of producers and processing industries, providing basic information on feeds and farms, field and processing unit inspections for verification, and inspection of production methods and practices by an appointed inspector from the certifying agency. A transition period of one to three years is necessary during which no inorganic fertilizers, agrochemicals, antibiotics, or synthetic hormones can be used on the farm before the produce can be marketed as organic. Since production during this transition period is typically low, farmers intending to switch to organic farming may experience some financial losses unless compensation is provided. Additionally, the cost of organic products is further elevated by the fact that organic production is generally 20% to 38% less efficient than production using conventional agricultural practices, especially in the initial years (Willer *et al.*, 2020).

Moreover, the current standards of organic farming are notably rigorous regarding the use of organic manures, specific requirements for animal feed or fodder, permitted minerals or soil conditioners, the quality of surface irrigation and underground water, as well as the agricultural practices implemented on neighboring farms (Trade and Markets Division, 2002). In addition, various governmental and non-governmental organizations set and enforce standards for ODF. These entities develop and oversee regulations to ensure compliance and maintain the integrity of the organic certification. Adherence to these standards and regulations ensures that organic dairy products meet specific criteria and are produced using sustainable, environmentally friendly, and animal-friendly practices. Consumers can rely on these certifications to make informed choices about the food they purchase. The important differences between organic and conventional dairy farming are described in Table 1.

Table 1. Key differences between organic and conventional dairy farming.

Factor	Organic dairy farming	Conventional dairy farming
Feed	Cows are fed organic feed and pasture, with no synthetic fertilizers or pesticides.	Cows are fed conventional feed, often with antibiotics and growth hormones.
Grazing	Cows are required to have access to pasture for at least 120 days per year (Neuman, 2010; Rinehart and Baier, 2010).	Cows may be confined to feedlots and may not have access to pasture.
Health	Use of antibiotics is prohibited except in cases of illness, and animals are treated holistically to prevent diseases (Manuelian *et al.,* 2020).	Routine use of antibiotics and growth hormones may lead to the development of antibiotic-resistant bacteria and other health problems.
Environment	Organic farming practices prioritize soil health, biodiversity, and reduced greenhouse gas emissions (Squalli and Adamkiewicz, 2018).	Conventional farming practices may contribute to soil degradation, pollution, and increased greenhouse gas emissions.
Market demand	Organic dairy products are in high demand, and may command a higher price (Datta *et al.,* 2019; Ferdous *et al.,* 2021).	Conventional dairy products are widely available, but may not have the same market appeal as organic products.

Within the European Union (EU), organic food production is governed by Regulation (EU) 2018/848, the latest update of EU regulations, which became effective in January 2022 (European Union, 2018). The legislation delineates the fundamental EU standards, farming practices, and inspection protocols for organic producers and processors. Despite the longstanding recognition of organic production, the inclusion of a Livestock Annex in the EU regulations only occurred in August 2000. While each member state of the EU must adhere to the baseline EU regulations, they also have the discretion to augment these regulations, making them more stringent if desired. Additionally, the United States Department of Agriculture (USDA) inaugurated the National Organic Program (NOP) in October 2002 to oversee and harmonize organic production, farming, and marketing within the United States (USDA, 2019). Presently, all products labeled as "Organic" in the United States are required to be produced, handled, and processed in accordance with a unified standard known as the NOP "Final Rule" (CFR: Title 7 - Agriculture, 2022; Oruganti, 2011). In India, the National Program on Organic Production (NPOP) was formally inaugurated in 2000 and officially recognized under the Foreign Trade and Development Regulation (FTDR) Act in 2001. The NPOP received equivalency status from the European Union for its regulations on organic agriculture, aligning with EC Regulation 2092/91 (Gokulakrishnan *et al*., 2023). The Japanese Agricultural Standards (JAS) for organic agriculture are founded on the Codex requirements, as outlined in MAFF (Ministry of Agriculture, Forestry and Fisheries) in 2001. Livestock standards were subsequently incorporated into the JAS in 2006 (MAFF, 2006). The criteria for organic animal products, including acceptable feed categories, were established in the 2006 guidelines. Permitted feeds for organic cattle include organic feeds and feed produced on-site, along with natural compounds or chemicals derived from natural sources. Notably, silkworm pupa powders that are neither irradiated nor produced using recombinant DNA technology are also included in the list of acceptable feeds. In 2008, new labeling standards were introduced (Blair, 2021). NOP standards align with JAS norms, enabling organic products from the United States to be imported into Japan (USDA, 2016). Ireland, the United States, Argentina, Italy, the United Kingdom, Australia, Austria, the Netherlands, Greece, Switzerland, Sweden, Spain, Denmark, Germany, New Zealand, Finland, France, Belgium, Portugal, and Luxembourg have Organic Rules and Standards that are equivalent to the Organic JAS System (Jones, 2002). However, in Bangladesh, there are no government-set standards for such farms.

3. Organic dairy farm management

Organic dairy farm management involves overseeing various aspects of the farm to produce organic milk while maintaining compliance with organic standards and ensuring animal welfare, environmental sustainability, and profitability (Guadu and Abebaw, 2016; Åkerfeldt *et al*., 2021; Grodkowski *et al*., 2023). Organic livestock farming in Bangladesh is an emerging sector that is gaining popularity among farmers and consumers due to its emphasis on natural and sustainable practices (Figure 1).

Figure 1. Map of Bangladesh, the country under review in this study.

Successful organic dairy farm management involves a holistic approach that prioritizes animal well-being, environmental sustainability, compliance with organic standards, and effective business operations (Grodkowski *et al.*, 2023). However, the management practices used in organic livestock farming in Bangladesh may differ from those used in other countries due to the unique cultural, economic, and environmental conditions in the region. The key steps involved in managing an organic dairy farm are illustrated in Figure 2.

Figure 2. Key steps involved in managing an organic dairy farm.

Some important considerations for organic dairy farm management are described below,

3.1. The origin of livestock

It is an important aspect of organic livestock production since it establishes whether the animals were raised per organic standards. Organic certification demands that animals be raised without the use of genetic engineering, ionizing radiation, or sewage sludge and that they be managed in a way that protects natural resources and biodiversity (Coffey and Baier, 2012). Synthetic hormones, antibiotics, and GMOs are also prohibited in animal husbandry. As a result, farmers and producers must guarantee that their animals fit these standards, as well as to maintain a clear and transparent audit trail that documents the origin and history of the animals. Therefore, selecting suitable dairy cow breeds and genetics that thrive in organic systems is essential. Proper breeding programs aimed at producing healthy, high-yielding cows that adapt well to organic farming practices are key.

3.2. Quality of the livestock feed

Providing organic feed, free from synthetic pesticides, GMOs, and chemical fertilizers, is a fundamental aspect (Blair, 2021; Dallago *et al*., 2021). Organic forage, grass, and other natural supplements are utilized to ensure proper nutrition for the animals. Therefore, farmers and producers must ensure that the feed they use meets these standards and that it provides a balanced and nutritious diet for their animals (Organic Materials Review Institute, 2010; Coffey and Baier, 2012). This requires sourcing feed from trusted suppliers who meet organic standards and having a transparent audit trail to ensure traceability.

3.3. Housing

Housing is a critical component of ODF that affects the welfare of the cows, milk production, and environmental sustainability. To meet the standards of organic regulations, housing must provide enough space, feed, water, air, and light for the cows while protecting them from harsh weather and predators. Different housing systems are available for organic dairy farming, including tie-stall barns, cubicle barns, free-walk barns, and bedded-pack barns (Galama *et al*., 2020; Carty, 2021). The design and management of these systems depend on various factors such as the climate, herd size, breed, grazing system, bedding material, and ventilation. One potential housing type is a loose house with a solid floor covered with straw or other litter that can be used for land fertilization (Carty, 2021). Another option is a shelter along one side of an open paddock where cows can access feed, water, and rest under the shade. Regardless of the system used, the housing should meet the minimum internal floor area and stocking density requirements specified by organic regulations. Organic, grass-fed dairy cows require higher pasture and forage intake than conventional cows (Dallago *et al*., 2021). Hence, housing systems should provide enough space, comfort, hygiene, and natural behavior for the cows while also minimizing emissions of ammonia and greenhouse gases.

3.4. Waste management and environmental sustainability

Effective waste management strategies, such as composting manure for use as organic fertilizer, are important. Implementing environmentally sustainable practices to minimize pollution, conserve soil, and protect water quality is integral to organic dairy farming. Waste management for organic dairy farming is a practice that aims to reduce the environmental impact of animal manure and bedding by converting them into valuable soil amendments. This can include composting, vermicomposting, and other natural waste management techniques (Aalok *et al*., 2008). A Carbon: Nitrogen ratio of 30:1 is considered ideal for composting (Yu *et al*., 2020). This helps to reduce the environmental impact of animal waste and maintain soil health.

3.5. Health care and disease management

Organic dairy farming places a strong emphasis on animal health and welfare. Disease management in organic dairy farming is a challenging task that requires a holistic approach based on preventive measures, alternative treatments, and careful monitoring of animal health and welfare. Some of the common diseases affecting organic dairy cows are mastitis, lameness, parasitic infections, and metabolic disorders (Marley *et al*., 2010). To prevent these diseases, organic dairy farmers use various strategies such as choosing suitable breeds, providing optimal feed and housing conditions, applying pre- and probiotics, rotating pastures, vaccinating animals, fly control, garlic for parasite control, and using homeopathy or phytotherapy (Jones *et al*., 2016). However, the effectiveness of some of these methods is not well established by scientific evidence and more research is needed to evaluate their impact on animal health and productivity. In case of a disease outbreak, organic dairy farmers may use conventional drugs as a last resort, but they have to respect the withdrawal periods and record the treatments (Oruganti, 2011; Brock *et al*., 2021). However, other experts believe that using conventional

drugs, in any case, contradicts the organic criterion. Organic dairy farmers also need to monitor the health status of their animals regularly and report any disease incidence to the authorities (Bloksma *et al*., 2012; Brock *et al*., 2021).

3.6. Audit trail

Organic certification requires farmers and producers to have a clear and transparent record of all inputs, including feed, housing, and health care, used in the production process. This allows for traceability and ensures that organic standards are being met. This can be done through the use of records, inspections, and certifications (Gokulakrishnan *et al*., 2023). Organic dairy farming in Bangladesh has unique characteristics, such as traditional breeding practices, natural feed and forage, waste management, animal health care, and a robust audit trail system to ensure compliance with organic standards. These practices are adapted to the cultural, economic, and environmental conditions in the region, and help to promote natural and sustainable farming methods (Hoque, 2013; Datta *et al*., 2019; Murshed and Riaz Uddin, 2020).

4. Organic farming and udder health

Organic farming practices often emphasize natural and holistic approaches to ensure animal health, including udder health in dairy cows. ODF is governed by strict standards set by the National Organic Program of the USDA (Fetter and Caswell, 2002; Klonsky and Greene, 2005) standards aim to limit the use of synthetic drugs and prevent diseases in livestock. While antibiotics are generally prohibited in organic farming, exceptions may be made if the animal is removed from organic production immediately after treatment. Nonetheless, diseases like mastitis, which is inflammation of the udder, remain a major issue for organic dairy farmers (Hardie *et al.*, 2022). Mastitis not only affects animal welfare but also decreases milk quality and productivity. Conventional dairy farmers typically use intramammary antibiotics to treat mastitis, but this is not allowed in organic farming, highlighting the need for effective alternative treatment options (Pol and Ruegg, 2007).

Maintaining udder health is vital for dairy farming sustainability (Sundberg *et al*., 2009). Cows with low somatic cell counts produce milk with a longer shelf life, fetching higher prices in international markets. Unfortunately, many organic farms struggle with high somatic cell counts, which can result from mastitis (Bouchard *et al*., 2015; Hoque *et al*., 2022). Mastitis, an inflammation of the udder caused by bacterial infection, is a significant concern in dairy farming. Proper udder health management is crucial for preventing and controlling mastitis (Hoque *et al*., 2016, 2022). Frequently observe cows for indications of mastitis, including swelling, warmth, discomfort, and irregular milk appearance such as clots, flakes, or discoloration. Employ regular milk tests such as the California Mastitis Test (CMT) or somatic cell count (SCC) to promptly identify subclinical mastitis (Hoque *et al*., 2015). Mastitis is also a leading cause of culling cows (Ahlman *et al*., 2011). The disease impairs animal welfare, increases labor and veterinary costs, and reduces milk production and quality. Considering the limited availability of effective alternatives to antibiotics (Gruet *et al*., 2001), organic dairy producers must employ effective strategies to prevent mastitis and mitigate associated losses.

Organic dairy farmers have tried alternative products to treat mastitis, with varying degrees of success (Åkerfeldt *et al*., 2021). However, some farmers choose to dry off the affected quarter or cull the animal instead of using antimicrobial alternatives (Brock *et al*., 2021). Studies have suggested that garlic, thymol, and carvacrol could assist in controlling *S. uberis*-induced mastitis. However, bacterial cures were not consistently achieved, and it was recommended that organic herds using these products observe a withholding time of at least 24 hours (Mullen *et al*., 2018). Herbal products such as Phyto-Mast and Cinnatube have been shown to be comparably effective to conventional therapies, without causing adverse effects on cows (Mullen *et al*., 2014). A common practice on organic farms is frequent stripping or using a topical udder rub (Sorge *et al*., 2016) to eliminate bacteria and toxins from the udder and enhance healing. Additionally, topical udder creams containing ingredients like peppermint or similar components may aid in reducing swelling, enhancing blood flow, and clearing infections from the udder. There is limited data to support the effectiveness of these therapies in treating clinical mastitis. Probiotic bacteria produce antimicrobial compounds which may exhibit either bactericidal or bacteriostatic properties (Kamal *et al*., 2021). Lactic acid bacteria (LAB) have been extensively studied as probiotics in recent decades and are considered promising due to their Generally Recognized as Safe (GRAS) status and their well-established technological and inhibitory properties (Bouchard *et al*., 2015). Several studies have indicated that LAB strains may impact susceptibility to MG infection through various mechanisms, including microbe-microbe interactions and modulation of immune responses (Kober *et al*., 2022).

During the dry period, cows may be susceptible to intramammary infections that can cause clinical mastitis at the start of lactation. While conventional and intensive dairy systems use antibiotics during this period, the USDA National Organic Standards do not permit their use (Electronic Code of Federal Regulations, 2023).

Organic dairies may use non-antimicrobial products, but their clinical efficacy is uncertain (Ruegg, 2009). The dry period is crucial for udder regeneration, and it is suggested to lower milk yield at dry-off to prevent infections during the early dry period (Rajala-Schultz *et al*., 2005). However, reducing feed can increase stress and metabolic disease incidence in cows (Tucker *et al*., 2009). While organic farming practices aim to promote overall cow health, including udder health, it's important to note that each farm may have unique approaches and practices within organic standards. Regular monitoring, veterinary care, and adherence to best practices for udder health management are essential for the well-being of dairy cows in organic farming systems in Bangladesh and beyond.

5. Organic farming and animal welfare

Organic farming practices often emphasize animal welfare as a crucial aspect of their philosophy. The principles of organic farming advocate for ethical and humane treatment of animals, focusing on their health, natural behaviors, and overall well-being (Krohn *et al*., 2001; Grodkowski *et al*., 2023). ODF is a system of production that aims to respect and promote the natural environment, animal health and welfare, and product quality. Organic dairy cows are typically managed with preventive measures, such as pasture access, outdoor exercise, and natural remedies, to reduce the risk of diseases and injuries. However, organic dairy farming also faces some challenges and limitations, such as pain mitigation for disbudding calves, adverse behaviors of first-lactation cows during milking, and compliance with the EU regulations on animal welfare. Organic dairy farming doesn't automatically ensure good animal welfare but presents an opportunity for improvement that demands continuous monitoring and evaluation. Despite this, organic farms still have room for enhancement, particularly in terms of animal health (Wagner *et al*., 2021). Ineffective practices pose a significant challenge for organic dairy animal welfare. The human-animal relationship can also be strained during milking, as first-lactation cows may exhibit adverse behaviors like kicking and stomping (Phillips and Heins, 2021). EU regulations pertaining to organic dairy cattle and their impact on animal welfare argue that identifying welfare deficits in organic livestock production is the initial step toward enhancing welfare. Currently, EU regulations primarily focus on action-based requirements and should be supplemented by outcome-based assessments to address and safeguard health-related aspects of animal welfare (von Keyserlingk *et al*., 2009). The association between organic livestock production and animal welfare suggests that an increased emphasis on animal welfare could positively influence the demand for organic animal production in the future (Bowles *et al*., 2005).

6. Challenges of organic dairy farming

Organic dairy farming, while offering numerous benefits, also faces several challenges. Some serious problems are still restricting growth in organic farming. Here are a few of the challenges outlined.

6.1. Lack of certification

At present, small-scale farmers lack accessible and affordable certification programs, posing a challenge, especially in tropical nations. They may face difficulty in covering the costs of mandatory inspections carried out by foreign certification agencies operating through their subsidiaries in producing countries (Chander *et al*., 2011). To fully realize the potential benefits of organic farming, it is crucial to provide certification for organic production techniques for both organic trainers and advisers, as well as the farmers themselves (Escribano, 2016; Ferdous *et al*., 2021). Without certification, consumers may doubt the credibility of the labeling of the word organic in products. Such barriers could dissuade numerous farmers from transitioning to organic production, particularly if the domestic market is underdeveloped and export opportunities for livestock products are limited (Von Borell and Sørensen, 2004; Ferdous *et al*., 2021).

6.2. Lack of knowledge and training

The absence of knowledge and training in organic dairy farming can indeed present a significant challenge. Overall, there is insufficient awareness about organic production practices, animal welfare concerns, and the import requirements of other countries, particularly among individual organic trainers, advisers, and farmers (Åkerfeldt *et al*., 2021; Ferdous *et al*., 2021; Wagner *et al*., 2021). Organic production necessitates a thorough comprehension of the principles, standards, production practices, and requirements set by organic certification agencies. However, a majority of the literature on organic farming is primarily available in English, through print media and the internet. This poses a significant challenge for small-scale farmers, particularly in regions where illiteracy rates are high and English is not commonly spoken or understood (Ferdous *et al*., 2021).

6.3. Sourcing organic inputs

Achieving success in organic dairy farming demands excellent stockmanship and a suitable geographical environment for the farm. The primary focus is on optimizing the efficient utilization of high-quality forage, whether it's grazed or conserved (Orjales *et al*., 2019; Blair, 2021). Organic concentrates can be costly to produce or purchase, making it economically and environmentally advantageous to prioritize efficient forage utilization. Despite the expenses linked to feeding concentrates or grain feeds, the overall returns, including enhanced milk production potential from cows and improved herd health, often justify the moderate expense of concentrate feeding (Cukur, 2015; Blair, 2021). In herds where poor quality forages are fed, the primary effects often include a decrease in overall milk yield or a reduction in milk protein percentage. Additionally, poor body condition scores in cows may indicate insufficient energy supply. Regular body condition scoring at crucial points in the dairy cow's cycle is recommended to establish a comprehensive herd-level understanding of energy balance (Blair, 2021; Rodriguez *et al*., 2021). These factors limit the adaptability of organic livestock farms and their access to high-quality feed additives and materials. Consequently, the organic livestock sector encounters a significant challenge, leading to a situation where organic livestock farms may struggle to produce organic products. This diminishes their profitability and undermines their prospects for future success (Flaten *et al*., 2006; Escribano, 2016).

6.4. Stock replacement

Stock replacement, or the process of replacing animals in a herd, is a common issue faced by organic dairy farmers. This typically involves using natural breeding methods, such as artificial insemination with semen from organic bulls, rather than genetically modified or cloned animals (CFR: Title 7 - Agriculture, 2022). This can make it more difficult to find replacement animals that meet the necessary organic standards. In addition to the challenge of finding suitable replacement animals, organic dairy farmers also face the issue of cost. Organic animals are often more expensive to purchase than conventionally raised animals, due to the additional time and resources required to produce them using organic methods (Butler and Stergiadis, 2020). This can make it financially challenging for farmers to replace animals as needed. Finally, organic dairy farmers may also face challenges related to the age and productivity of their animals. As with any farming operation, the animals in an organic dairy herd will eventually reach the end of their productive life and need to be replaced. However, due to the longer production cycle of organic animals, it can take longer for them to reach this point compared to conventionally raised animals (Butler and Stergiadis, 2020). This can make it difficult for farmers to plan for and budget for stock replacement.

6.5. Small farm size

Small-scale farmers heavily depend on livestock production for their livelihoods. However, the landless animal husbandry system, which is incompatible with organic livestock production practices, presents a challenge for small farms. These farms tend to have limited land and processing infrastructure, leading to poor product quality. Additionally, milk production is typically carried out by small producers, resulting in low volumes and issues such as dilution, contamination, and traceability (Datta *et al*., 2029; Dallago *et al*., 2021). To address these challenges, both technical and policy interventions are necessary. Government support for added-value initiatives and product marketing has the potential to enhance the sustainability of small-scale livestock production (Datta *et al*., 2019; Ferdous *et al*., 2021).

6.6. Problems in livestock feeding

Organic farming, being a sustainable and environmentally-friendly approach, prohibits the utilization of synthetic feed supplements, pesticides, or GMOs in the diet of animals (Murshed and Riaz Uddin, 2020; Blair, 2021). However, in Bangladesh, grazing and foraging are prevalent and dependent on natural resources such as water and vegetation. Furthermore, the lack of technical knowledge and information among farmers regarding organic feed production, coupled with the high costs of organic feed, can create difficulties for farmers in providing a nutritious and balanced diet to the animals, leading to negative effects on the health and productivity of the animals, and subsequently compromising the organic authenticity of the products (Datta *et al*., 2019; Murshed and Riaz Uddin, 2020; Ferdous *et al*., 2021).

6.7. Sanitary regulations

Due to stringent sanitary criteria set by importing countries, only a limited number of lower-income countries can export standard animal products. These disease control regulations are even more stringent for organic cattle products. Governments are taking proactive measures, emphasizing adherence to clean milk production

guidelines, good manufacturing practices (GMP), hazard analysis and critical control points (HACCP), International Organization for Standardization (ISO) certification, and best practices recommended by GLOBALGAP. These initiatives must persist to enhance access to foreign markets for organic livestock products (Waller *et al*., 2020).

6.8. Existence of diseases

The prevalence of infectious and zoonotic diseases adversely affects the trade of livestock products (Åkerfeldt *et al*., 2021; Brock *et al*., 2021). Enhancing the overall health status of animals, especially in organic livestock production, requires effective control and prevention measures against diseases such as Foot and Mouth Disease (FMD), swine fever, and Rift Valley fever (Chander *et al*., 2011; Brock *et al*., 2021). These diseases have a significant impact on exports from many developing countries, making it essential for authorities to prioritize their control. Currently, significant efforts are directed towards managing Foot and Mouth Disease (FMD), recognized as an economically impactful disease by the World Organization for Animal Health, with far-reaching consequences for production and trade. In the realm of organic livestock production, the focus lies on preventing health issues and diseases through the adoption of improved management practices. However, it's worth noting that these fundamental standards may not yet suffice to ensure a higher level of animal health or product quality compared to conventional production methods. Comparative studies examining the health of organic and conventional dairy farms have indicated no significant difference in the animal health status of dairy cows between the two systems (Manuelian *et al*., 2020; Brock *et al*., 2021). Addressing these challenges necessitates support from policymakers, investment in research and development of organic farming methods, enhancement of infrastructure, facilitation of market access, and the promotion of consumer awareness and demand for organic dairy products (Brock *et al*., 2021; Dallago *et al*., 2021).

7. Prospects of organic dairy farming in Bangladesh

Despite these challenges, with proper planning, education, infrastructure development, and policy support, ODF has the potential to flourish in Bangladesh, offering economic, environmental, and health benefits to both farmers and consumers. There is a growing awareness and demand for organic products worldwide, including dairy products. This trend is also noticeable in Bangladesh as people become more health-conscious and environmentally aware (Datta *et al*., 2019; Murshed and Riaz Uddin, 2020; Ferdous *et al*., 2021). According to a study by Datta *et al.* (2019), dairy farming is a profitable enterprise in Bangladesh, with an average net return of US$ 58 per cow per month. However, the study also found that the milk quality and productivity were low due to various factors such as adulteration, contamination, feed scarcity, and poor management. The study suggested that improving the breed, feed, and health of the cows could increase the milk yield and quality significantly. One of the pioneers of ODF in Bangladesh is Oggro Dairy Ltd. Oggro Dairy Ltd. started with just three cows in 2014 and now has 90 cows that produce around 600 liters of milk per day. They claimed to be the first dairy farm in Bangladesh that brings pasteurization and farm processing together, delivering fresh processed milk within 12 hours to the consumers. They also claimed that they follow strict quality control measures and have brought in experts from the Netherlands and the United States to train their staff. Oggro Dairy Ltd, now securing more foreign investment, aims to be the best organic milk brand in Bangladesh and plans to introduce several diversified products in the future (Murshed and Riaz Uddin, 2020).

The underdevelopment of marketing channels and industry, limited consumer awareness of organic products, and reluctance among consumers to pay premium prices all hinder the demand for organic animal products. Consequently, many farmers struggle to sell their products to the organic market at prices that cover their production costs. In cases where producers do offer organic products, the absence of well-established channels maintains a significant price gap between organic and conventional products, perpetuating a cycle characterized by low per capita consumption and limited availability of organic products in supermarkets. Expanding the distribution of these products is crucial for reducing the observed price disparity and boosting consumption (Nunes *et al*., 2014). Some of the initiatives that can promote organic dairy farming in Bangladesh are: a. Developing a national policy and regulatory framework for organic agriculture and dairy farming, b. Establishing a credible certification and labeling system for organic dairy products, c. Providing incentives and subsidies for organic dairy farmers to cover the costs of transition and certification, d. Creating awareness and demand for organic dairy products among consumers through media campaigns and education programs, e. Supporting research and innovation on ODF practices and technologies, f. Strengthening the capacity and network of organic dairy farmers' associations and cooperatives, g. Enhancing public-private partnership (Hoque, 2013; Murshed and Riaz Uddin, 2020; Ferdous *et al*., 2021).

Importantly, the increasing consumer demand for healthier, environmentally sustainable, and ethically produced food products has contributed to the rising popularity of organic dairy items. This shift in consumer preferences is encouraging more farmers and producers to adopt organic practices to meet this growing demand. If marketed effectively, organic dairy products can gain popularity among health-conscious consumers. Moreover, government's support through policies, subsidies, and initiatives promoting organic farming could encourage more farmers to transition to organic practices.

8. Conclusions

In summary, ODF in Bangladesh emphasizes holistic practices, including environmental friendliness, biodiversity conservation, soil health improvement, and animal welfare. Transitioning to organic farming faces challenges such as knowledge dissemination, initial investment costs, and certification requirements. Addressing these challenges requires training programs, subsidies, and extension services to support farmers. ODF holds potential for rural development and increased farm profitability. Embracing organic principles aligns with global sustainability goals, meets consumer demands, and promotes environmentally friendly practices. However, achieving organic standards while ensuring sustainability poses a significant challenge, requiring collaboration and supportive policies. To maximize success in Bangladesh, key issues must be addressed. These include the need for farmer education on sustainability, feeding solutions for environmental constraints, standardization of feed additives, expanded veterinary understanding, and enhancements to Common Agricultural Policy schemes. These strategies aim to conserve ecology, culture, and tradition, revitalizing rural areas from economic, social, and environmental perspectives. Critical attention should be given to organic product marketing, focusing on strategies such as organic plus products and effective marketing channels. Overcoming marketing challenges presents significant opportunities for improving farm profitability and overall food system sustainability in the ODF sector.

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Data availability

All required data utilized in this study will be provided by the corresponding author upon valid request.

Conflict of interest

None to declare.

Authors' contribution

Anas Bin Harun: Preparation of Original Draft Manuscript; Abdullah Al Bayazid: Preparation of Original Draft Manuscript; M. Nazmul Hoque: Writing Final Manuscript and Editing; Ziban Chandra Das: Supervision, Writing Final Manuscript and Editing. All authors have read and approved the manuscript.

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