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Present Status, Practices, Limitations, and Future Prospects of Organic Fruit Production in Nepal

Sushil Rai[1], Ankita Nepal[1], Sabin Basi[1], Thakur Dhakal[2], Rameshwar Rai[1*]

[1]Organic Agriculture Program, Madan Bhandari University of Science and Technology, Chitlang, Thaha Municipality-9,Nepal
[2]Department of life sciences,Yeungnam University,Gyeongbuk 38541,Repubic of Korea

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ABSTRACT

Organic fruit production in Nepal has significant potential due to the country's varied agro-climatic conditions and reliance on traditional agricultural practices. However, this sector faces considerable challenges, including high certification costs, limited market access, and inadequate infrastructure. Despite the increasing global demand for organic products and a growing interest among local consumers, only 0.3% of Nepal's agricultural land is certified organic. This review analyzes 27 studies that examine the current status, practices, limitations, and prospects of organic fruit cultivation in Nepal. The findings reveal that smallholder farmers comprise most organic fruit growers, primarily using traditional methods such as composting and animal manure, which align well with organic farming principles. However, the lack of certification limits their access to premium markets. To enhance organic fruit production in Nepal, this review emphasizes the need for policy reforms that simplify certification procedures, improve infrastructure, and strengthen market linkages. Increased involvement of cooperatives and non-governmental organizations (NGOs) can provide smallholder farmers with essential training, technical guidance, and resource access. Furthermore, raising community awareness through targeted initiatives will boost local demand, encouraging more farmers to adopt organic practices. Despite the existing challenges, the study highlights Nepal's strong potential to compete in the global organic marketplace. By addressing key barriers and promoting sustainable farming practices, Nepal can enhance environmental sustainability, improve rural livelihoods, and strengthen its organic fruit industry. This review also presents policy recommendations to foster a more robust and inclusive organic farming system in Nepal.

* Corresponding author

E-mail: rameshwar.rai@mbust.edu.np (Rameshwar Rai)

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1 Introduction

Over the past 50 to 60 years, agrochemicals' widespread use in fruit production has led to significant environmental and health hazards and socio-economic challenges (Pathak and Ram 2004). In response, organic farming practices have gained global interest as a viable agricultural method that minimizes environmental harm and offers substantial health benefits to consumers. By 2020, the global area dedicated to organic fruit production reached 1.1 million hectares, driven by increasing consumer demand and supportive policies for sustainable agriculture (Willer et al. 2022). Apples, kiwis, and citrus fruits are prominent in this sector, with FAOSTAT noting organic farming's integration into global agricultural systems. These trends highlight organic agriculture's growing importance in addressing environmental and market needs (FAO 2023).

In Nepal, organic fruit production is still in its early stages but is gradually gaining traction due to rising interest from farmers, consumers, and policymakers (Atreya et al. 2020). There is an urgent need for cost-effective input generation, optimization of agrochemical combinations, ongoing soil health improvements, enhanced produce quality, and eco-friendly technologies (Ram and Kumar 2019).

Globally, organic farming has experienced significant growth, fueled by robust consumer demand for sustainable agricultural practices (Granatstein et al. 2013). The organic food market has expanded rapidly, with fruits being one of the most popular organic products. Countries like the United States, European nations, and Australia have emerged as leaders in organic production, offering models that Nepal and other nations could emulate. However, Nepal's challenges, especially regarding infrastructure and market access, differ markedly from those experienced in more developed countries (Granatstein and Kirby 2016). Currently, there are no structured markets for selling organic produce. Global organic cultivation generally relies on demand and is often conducted on a contractual basis (Mondal 2012). Worldwide, fruit and vegetable biodiversity is declining, necessitating urgent conservation efforts. Genetic resources are under-conserved, which calls for national strategies, global partnerships, sustainable practices, and awareness campaigns for effective germplasm conservation (van Zonneveld et al. 2023).

For instance, organic production in Turkey started in the mid-1980s and has seen a significant increase in demand over the past decade, with the leading organic fruits being raisins, figs, and apricots. Turkey's diverse conditions offer great potential for organic agriculture, but challenges include loss of diversity, low soil fertility, and high certification costs (Gubbuk et al. 2004). The production of organic fruits worldwide is thriving due to increasing consumer demand, favorable policies, and robust infrastructure. Nepal's organic fruit sector faces high certification costs, limited market access, and a lack of farmer awareness. Insufficient infrastructure, fragmented supply chains, and inadequate government policies hinder growth. Addressing these issues is critical for Nepal to align with global trends and leverage its agro-climatic potential.

Despite technological advances since the early 1990s in conventional and Integrated Fruit Production (IFP), fruit growers remain hesitant to transition to the newer, less specialized organic fruit market, primarily due to increased risks of lower yields (Weibel 2002). Organic production of oilseeds, largely soybeans, saw a 28% increase, while vegetables, particularly those from Mexico, experienced an 88% increase. However, the production of vegetable oils, tropical fruits, and feedstuffs faced a 15% decline, including olive oil from Tunisia and palm oil from Latin America (Willer et al. 2024). Nevertheless, organic fruit production can be successful and rewarding if pest, disease, and weed control are effectively managed, soil fertility is maintained, and various management practices are implemented (Neeson 2008).

Organic farming suggests that organically grown foods may be nutritionally superior, containing higher levels of vitamins, minerals, and amino acids (Shaltout 2024). A review of 343 studies indicates that food produced under organic standards may have beneficial antioxidants and reduce exposure to harmful heavy metals (Baranski et al. 2014). This review examines the current status, traditional practices, and limitations of organic fruit production in Nepal while exploring its growth prospects. The analysis is based on 27 research articles, providing a comprehensive overview of the country's prevailing conditions, challenges, and opportunities for organic fruit producers.

2 Methodology for Systematic Review Using PRISMA Model

A systematic review followed PRISMA guidelines to evaluate the current status, practices, limitations, and future prospects of organic fruit production in Nepal. Researchers utilized Google Scholar and PubMed to search for relevant articles using key terms such as "organic fruit farming in Nepal" and "sustainable fruit production in Nepal." The review focused on peer-reviewed, English-language studies related explicitly to organic fruit production in Nepal while excluding non-relevant and non-open-access papers. The initial search resulted in 216 articles undergoing a multi-stage screening process. Firstly, 35 duplicates were removed, and 11 irrelevant materials were excluded. Title analysis led to the filtering out of 104 articles. Following this, an abstract screening eliminated 20 more articles. During the full-text screening, an additional 19 articles were excluded. Ultimately, 27 articles that met all inclusion criteria were selected for the final review, providing valuable insights into the landscape of organic fruit production in Nepal (Figure 1).

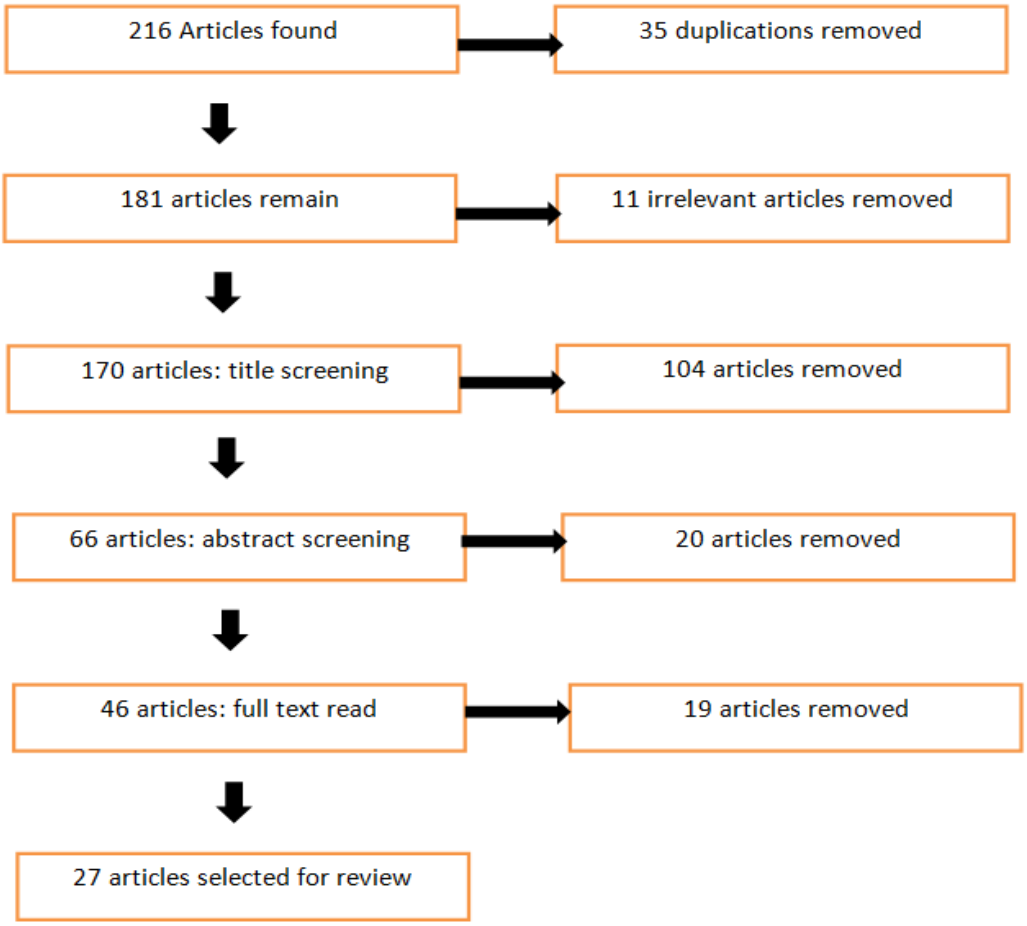

Figure 1 Flowchart of the methodology

3 Present Status of Organic Fruit Production in Nepal

3.1 Organic Farming in Nepal: An Overview

Nepal's diverse topography, varying altitudes, and climates create favorable conditions for cultivating various fruits, from temperate varieties like apples and pears to tropical fruits like citrus (Tamang et al. 2011). Despite this potential, organic farming in the country remains relatively underdeveloped. Only 0.30% of Nepal's agricultural land is certified for organic agriculture (Atreya et al. 2020). This low adoption rate can be attributed to several factors, including a lack of awareness, high certification costs, and limited market access (Chand et al. 2022). Organic fruit production in Nepal is primarily driven by smallholder farmers in remote hill and mountain regions, where traditional farming practices align closely with organic principles (Rokaya and Pandey 2023). In these areas, farmers rely on age-old techniques such as composting and using animal manure, making the transition to organic farming more feasible (Figure 2). However, the lack of formal certification prevents these farmers from accessing premium domestic and international organic markets (Sharma 2014).

3.2 Organic Fruit Varieties in Nepal

The geography of Nepal supports cultivating a diverse range of fruits under organic conditions. In temperate regions such as Mustang and Jumla, fruits like apples and pears are grown organically. Meanwhile, in lower-altitude areas, various tropical fruits, including specific citrus varieties, are cultivated organically (Hijazi 2021). One of Nepal's most popular organic fruits is citrus, particularly mandarins, which farmers practice sustainable agriculture in regions like Salyan (Dahal et al. 2023).

Organic apple production is particularly prominent in high-altitude areas, with Jumla benefiting from a cool climate ideal for growing these apples. However, two significant challenges to enhancing organic apple production are pest management and water scarcity (Neilsen et al. 2009). Additionally, inadequate storage facilities lead to substantial post-harvest losses, preventing farmers from realizing their expected economic benefits (Peck et al. 2009). Beyond apples and citrus, Nepal also produces organic pears, plums, and other stone fruits (Acharya and Atreya 2012). However, the production of these fruits is often limited; most are

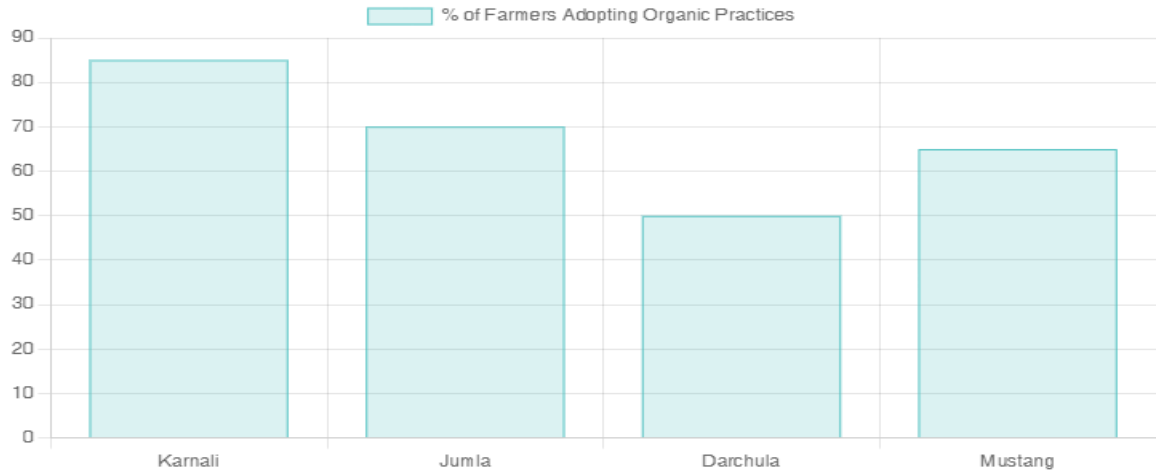

Figure 2 displays the percentage of farmers adopting organic farming in Karnali, Jumla, Dachula, and Mustang, showing Karnali with the highest adoption and Dachula with the lowest. Factors like policy support, awareness, and agricultural conditions influence these variations.

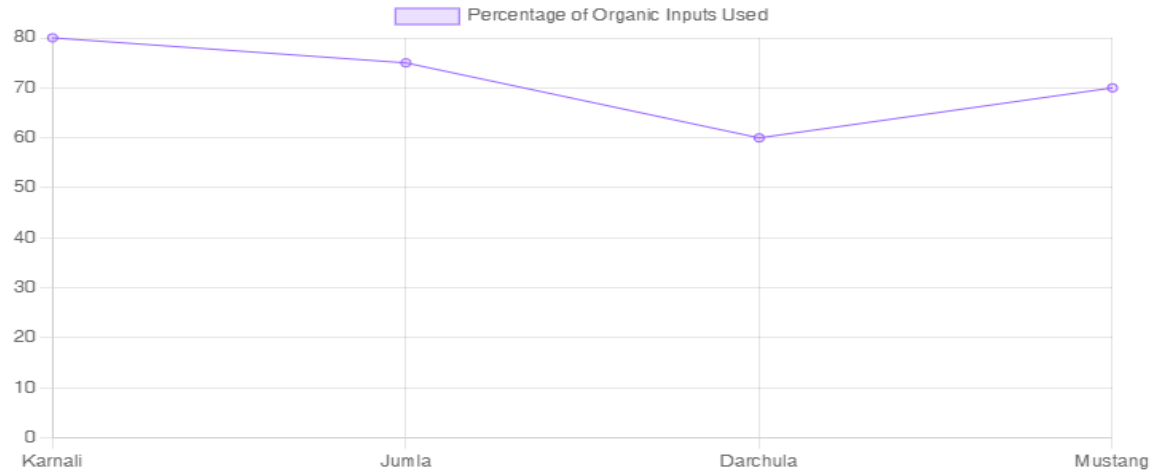

Figure 3 illustrates the percentage of organic inputs used by farmers in Karnali, Jumla, Dachula, and Mustang, showing a decline from Karnali to Dachula, with a slight increase in Mustang. This variation may reflect differences in resource access, farming practices, or regional policies supporting organic agriculture.

grown in small quantities, primarily for local consumption. The absence of proper certification further limits efforts to access wider markets (Shrestha 2021).

3.3 Certification and Market Access

Certification poses one of the biggest challenges for organic farmers in Nepal. While urban areas like Kathmandu are experiencing increased consumer demand for organic products, many rural farmers either lack awareness of the certification process or find it prohibitively expensive (Tamang et al. 2011). The high costs and complex bureaucratic steps in obtaining organic certification from agencies like Organic Certification Nepal (OCN) create significant obstacles for smallholder farmers (Chand et al. 2022). For many of these farmers, the benefits of certification seem distant. With limited market access and inadequate infrastructure, especially in remote areas, the steep certification costs often outweigh the potential for higher prices associated with certified organic products. Consequently, many farmers resort to selling through local informal networks, where there is usually no clear distinction between organic and conventional produce (Banjara 2016).

4 Practices of Organic Fruit Production in Nepal

4.1 Use of Organic Inputs

One of the fundamental principles of organic farming is the use of natural inputs. In Nepal, this often involves compost and livestock manure. Organic fruit production in the country heavily depends on local inputs, particularly for maintaining soil fertility (Figure 3). For example, Burmese grapes (*Baccaurea ramiflora*) have been

shown to benefit from organic fertilizers like Kazi and Payel, which help plants absorb nutrients, grow, and increase yields (Munna et al. 2021). Incorporating compost enhances tree growth, flowering, and yield over time, making compost-filled spaces more productive than untreated areas (Schupp and Mora 2004). Organic matter improves the soil's ability to retain water and nutrients, while lime helps maintain soil calcium levels. This highlights Nepal's widespread use of animal manure and compost to support soil health (Shrestha 2021). The organic approach to fruit production emphasizes natural reproduction methods, allows for artificial insemination, prohibits synthetic drugs, promotes nutrient conservation, and encourages the cultivation of diverse crops to improve soil quality (Chandran et al. 2019). Despite frequent organic inputs, access to these materials can be limited in remote areas (Granatstein and Kirby 2016). Transportation challenges in these regions hinder farmers' ability to obtain organic fertilizers, which affects their capacity to increase production. Effective organic nutrient management requires a long-term perspective, soil testing, compost incorporation, a holistic approach to agricultural ecosystem management, addressing calcium deficiency, and compliance with organic standards set by the Organic Materials Review Institute (OMRI) (Schupp and Mora 2004).

4.2 Pest and Disease Management

Managing pests and diseases is one of the most significant challenges faced by organic fruit producers in Nepal. Due to the limited availability of biopesticides and natural pest control methods, farmers often rely on traditional pest management practices (Weibel et al. 2002). For example, neem extracts and biopesticides such as *Bacillus thuringiensis* (Bt) and *Beauveria bassiana* (a fungal pathogen) are commonly used to control pests in fruit orchards (Hijazi 2021). However, the effectiveness of these methods can be inconsistent, highlighting the urgent need for more research into sustainable pest management techniques, especially for high-value fruits like apples and pears (Rozpara and Głowacka 2012).

Preventive methods are crucial for successfully growing organic fruit, but various regulations, registration issues, and complex production requirements hinder the effectiveness of alternative pesticides (Tamm et al. 2002). Many organic fruit farms face pest management challenges due to their geographical isolation, which limits access to modern pest control technologies. This isolation also restricts the exchange of knowledge regarding organic pest management practices, making it difficult for farmers to adopt new methods that could enhance yields. Diseases and pests, such as scab, sooty blotch, and fire blight, complicate organic fruit cultivation. To address these issues, effective control methods, resistant varieties, and natural predators are necessary (Tamm et al. 2002).

Some organic compounds that effectively manage pests include volatile organic compounds (VOCs) and natural plant products, which aid in integrated pest management (IPM). Certain VOCs, such as eucalyptol and methyl salicylate, deter pests like *Aphis punicae* and *Delia radicum* by attracting natural enemies, which can enhance biological control (Lamy et al. 2017; M'sakni et al. 2024). Plant oils, including pine and castor oil, demonstrate strong insecticidal effects, achieving up to 80% mortality in pests such as whiteflies (Böhme and Dimitrov-Skatov 2018). Additionally, plant-based compounds and semiochemicals like pheromones play a crucial role in altering pest behavior through strategies like "push-pull" and "lure and infect," which make pest control more effective (Alves and Ascari 2019; Shashank et al. 2024). These organic solutions contribute to sustainable agricultural practices. However, regulatory barriers limit access to innovative pest control methods (De Wilde et al. 2024; Muhammad and Umma 2024).

4.3 Water and Soil Management

Water and soil management are crucial for the success of organic fruit farming, particularly in water-scarce regions of Nepal. Farmers in these areas have adopted innovative techniques such as rainwater harvesting and using organic mulches to conserve soil moisture (Singh et al. 2018). These practices have proven effective in conserving water, improving soil health, and increasing the productivity of fruit crops (Granatstein and Kirby 2016). Improper cropping practices can harm water quality, while nutrient conservation helps protect water bodies. Integrated farming systems enhance sustainability, and organic farming improves animal health and product quality (Chandran et al. 2019). Organic mulches have been incredibly beneficial in regions like Karnali, where water resources are limited. These mulches help retain soil moisture, reduce soil erosion, and enhance soil structure, making them a key component of sustainable organic farming practices in Nepal (Shrestha 2021). Using organic mulches in water-limited environments improves soil moisture retention and crop yields. For dryland and semi-arid farming, mulches such as straw, spent mushroom compost, and grapevine pruning debris help prevent soil evaporation, make nutrients more accessible, and improve soil structure (Demo and Bogale 2024; Mairata et al. 2024). These mulches also support plant health and growth, increasing yields and enhancing physiological responses, particularly in grapevines (Mairata et al. 2024). Biodegradable mulching technologies are gaining popularity as long-term alternatives to plastic mulches. They provide similar benefits while being more environmentally friendly (Shcherbatyuk et al. 2024). Overall, organic mulches contribute to sustainable agriculture by conserving resources and enhancing crop productivity in water-scarce regions (Renzi et al. 2024; Shcherbatyuk et al. 2024).

5 Limitations of Organic Fruit Production in Nepal

5.1 Lack of Infrastructure and Market Access

One of the most frequently cited challenges in the literature is the lack of infrastructure and market access for organic fruit producers in Nepal (Tamang et al. 2011). Farmers in remote areas often encounter significant difficulties in transporting their produce to markets, and the absence of cold storage facilities further aggravates post-harvest losses (Peck et al. 2009). These infrastructure gaps hinder organic fruit farmers from scaling up their operations or accessing higher-value markets. In contrast, Turkey's export markets dominate while domestic demand grows. The country's diverse climate supports a wide range of organic crops, and its regulatory frameworks align with EU standards (Gubbuk et al. 2004); Nepal has possessed similar potential.

Another major limitation is the absence of organized supply chains for organic products. Farmers struggle to connect with consumers willing to pay a premium for organic fruits without effective distribution networks. This lack of market access not only limits the profitability of organic farming but also discourages farmers from transitioning to organic practices in the first place (Shrestha 2021).

5.2 Inadequate Government Support

Although the Nepalese government has acknowledged the potential of organic farming, current policies and support systems are still inadequate (Banjara 2016). Farmers often lack access to essential resources such as subsidies, training programs, and technical assistance to transition to organic farming successfully (Chand et al. 2022). Additionally, many short-term government initiatives focus on immediate gains rather than long-term sustainability. Like Pakistan, Nepal has significant potential for organic fruit production; however, limited awareness and other challenges must be addressed to establish a national organic certification organization and implement legislation that promotes growth (Baig and Raza 2022).

Organic farming in Nepal is gaining momentum due to its sustainability and health benefits. However, a small certified land area and inadequate policies hinder its development. Firm government decisions, stakeholder coordination, consumer awareness, and legal frameworks are necessary for its promotion (Banjara and Poudel 2016; Baral et al. 2020). The lack of coordination among various government bodies further complicates the situation. Farmers often navigate a maze of bureaucratic procedures without clear information about available resources or support programs (Banjara 2016). This lack of government engagement has left many organic farmers feeling isolated, with little incentive to invest in organic certification or expand their operations (Chand et al. 2022).

5.3 Low Consumer Awareness

Despite the increasing global demand for organic products, consumer awareness in Nepal remains low (Figure 4). A study conducted in the Lalitpur District revealed that only 40% of

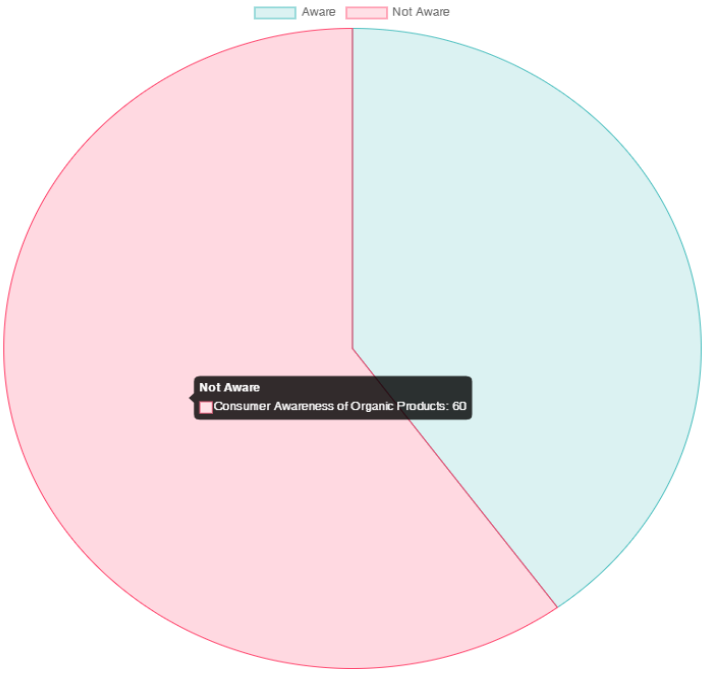

Figure 4 Consumer Awareness of Organic Products: The pie chart shows that 60% of consumers are unaware of organic products, highlighting the need for better education and marketing to promote them.

consumers are aware of organic produce, with many citing high prices as the primary reason for not purchasing organic fruits (Shrestha 2021). This lack of awareness limits domestic demand for organic products, discouraging farmers from investing in organic certification and production processes (Banjara 2016). Factors such as limited consumer awareness, small landholdings, the absence of a national policy, and the lack of organic certification hinder growth in the sector (Uma and Kumar 2025). Additionally, the global biodiversity of fruits and vegetables is declining due to insufficient conservation efforts, decreased pollinators, and an urgent need to preserve wild fruit species. School feeding programs and global partnerships are crucial in addressing this challenge (van Zonneveld et al. 2023).

6 Future Prospects for Organic Fruit Production

6.1 Growing Global and Local Demand

The global organic product market is rapidly expanding, creating significant opportunities for Nepalese farmers to access international markets (Granatstein et al. 2013). Fruits such as apples and citrus, which are already grown organically in regions like Mustang and Jumla, could be marketed as premium products if the challenges of certification and market access are addressed (Neilsen et al. 2009). Additionally, as urban consumers in Nepal become more health-conscious, the demand for organic fruits gradually increases, leading to a more substantial local market for organic produce (Shrestha 2021). Key factors influencing purchasing intentions include health awareness, knowledge of organic products, and availability (Upadhyay and Niraula 2023). In areas like Birendranagar, consumer trust in organic labeling and understanding of health benefits significantly shape preferences (Rokaya and Pandey 2023). Many consumers are willing to pay a premium for pesticide-free and organic fruits due to their perceived nutritional and environmental benefits (Ghimire and Khadka 2023; Regmi et al. 2023). This trend highlights the need for improved access and marketing strategies to support organic market expansion in urban areas (Paudel et al. 2023).

6.2 Role of Cooperatives and NGOs

Cooperatives and non-governmental organizations (NGOs) have been instrumental in promoting organic farming in Nepal by providing training, technical support, and market access to smallholder farmers (Sharma 2014). These organizations have enabled farmers in remote areas to adopt organic practices by supplying necessary resources and knowledge. Expanding these initiatives could help overcome barriers to organic fruit production, especially in underserved regions (Chandran et al. 2019).

Additionally, cooperatives can play a crucial role in organizing farmers into larger production units, which enables them to achieve economies of scale and enhance their bargaining power in the market (Sharma 2014). Organic agriculture in Nepal contributes to health and environmental sustainability, with many farmers expressing satisfaction with their income. Family farming is vital for food security, and farmers' cooperatives can address the challenges faced in this sector; therefore, the government needs to promote organic agriculture (Banjara and Poudel 2016). By pooling resources and coordinating production, cooperatives can help farmers access larger markets and negotiate better prices for organic products.

6.3 Policy Recommendations

The government must implement comprehensive policies supporting organic farmers to realize Nepal's full potential in organic fruit production. This includes simplifying the certification process, providing financial incentives, and investing in infrastructure such as cold storage and transportation (Hijazi 2021). Additionally, the government should focus on long-term strategies that promote sustainable farming practices rather than short-term projects that offer limited benefits. While consumer awareness is growing, current government policies hinder progress. Karnali Province strives to achieve full organic status due to constitutional support for organic initiatives and promoting climate adaptation through subsidies (Baral et al. 2020). Increasing consumer awareness through public campaigns, school programs, and media outreach could shift demand toward organic products (Hijazi 2021; Chand et al. 2022). By fostering a more informed consumer base, the government can help create a more substantial domestic market for organic fruits, encouraging more farmers to adopt organic practices.

Conclusion

Organic fruit production in Nepal has significant potential due to the country's diverse agro-climatic conditions and traditional farming practices. However, various challenges hinder the growth of this sector, including inadequate infrastructure, limited market access, high certification costs, and insufficient government support. To overcome these barriers, comprehensive policies are necessary, alongside increased support for smallholder farmers and improved consumer awareness. Strengthening cooperatives, streamlining certification processes, and enhancing market access are essential steps for Nepal to establish itself as a significant player in the global organic market. With the right strategies and support, Nepal can transform its organic fruit production sector, benefiting local farmers and consumers while contributing to environmental sustainability.

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Conflict of Interests

There is no conflict of interest among the authors about the contents of this manuscript.

Ethical Clearance

Not applicable.

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