Austin Journal of Veterinary Science and Animal Husbandry

Open Access

Austin Publishing Group

Review Article

Advancing Sustainable Dairy Cattle Production: Future Prospects in Ethiopia: A Review

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Received: October 08, 2025
Accepted: November 11, 2025
Published: November 14, 2025

Abstract

This review was conducted with the objective of assessing the dairy cattle production and its future sustainability in Ethiopia. Dairy cattle production system refers to the methods and practices involved in the production of live animals, milk and dairy products. Their production system is classified into pastoralism, highland smallholder, urban and peri-urban, and intensive dairy farming. The majority of milk production in the country primarily comes from dairy cattle. Ethiopian dairy industry plays a crucial role in the country's economy and food security. It has a significant potential for dairy production due to its large livestock population, favorable climate and availability of natural resources. The future of sustainable dairy production looks promising, with increasing efforts towards modernization and improved practices. This includes promoting dairy cooperatives, providing training and technical assistance to farmers, and facilitating access to financing and markets. However, the dairy sector was faced various challenges, including low productivity, limited access to improved breeds and technologies, inadequate feed and veterinary services, and inadequate market linkages. To ensure a sustainable future dairy industry and to advance the country's dairy production, use of superior breeds of dairy cattle, teach farmers on healthy diet and feeding practices, expand the availability of veterinary care, provide workshops and training courses; promote the establishment of groups and cooperatives among dairy farmers. Further research and extension services are needed to encourage the development of policies and procedures that support farmers effectively to ensure a sustainable future for Ethiopia's dairy cattle industry.

Keywords: Dairy; Future; Ethiopia; Sustainable

Introduction

The dairy industry contributes significantly to the global food chain by generating jobs in rural areas and supplying vital nutrients for human consumption (Shamsuddoha *et al*., 2023). When human inedible feedstuffs are converted into milk and related dairy products, dairy cattle greatly benefit the world. However, as advantageous as this process has become, there are also potential limitations (Peterson and Mitloehner, 2021). Ethiopia has a lot of potential for the development of dairy products because of its large population of livestock, ideal climate for breeding better, higher-yielding breeds of animals, developing market, better policy environment for private sector involvement, and generally disease-free environment for livestock (Gebreyohanes *et al*., 2021). Dairy production, especially in Ethiopia, makes a substantial contribution to improving smallholders' access to food (Derbe *et al*., 2023). Their production in Ethiopia is classified into four major systems: pastoralism, highland smallholder, urban and peri-urban, and intensive dairy farming (FAO, 2018; Fekata, 2022). Dairy sector face several challenges including, lack of access to credit, environmental problems, reproductive difficulties, a lack of trained labor, a lack of concentrate feed and water, a lack of sustainable breeding and milk marketing, the health and manure disposal of dairy stock, a lack of infrastructure, and reproductive difficulties are some of the main causes of the poor performance of dairy cattle production, which results in a significant loss of production and productivity of dairy cattle in the whole country (Guadu and Mengistie, 2016;Didanna *et al*., 2019). Additionally, in most of Ethiopia, a number of factors limit the amount of milk that dairy cattle can produce including a lack of suitable grazing land, disease and parasites, a lack of space for the production of better fodder, poor veterinary care, and low milk production potential in the area's zebu cattle, a lack of artificial insemination services, and a labor shortage waste management and housing challenges that constraint the development of the dairy sector in Ethiopia (Getabalew *et al*., 2019; Nyokabi *et al*., 2023). Due to enteric and waste fermentation, as well as nitrogen emissions from their urine and feces, dairy cows are a source of greenhouse gasses (Peterson and Mitloehner, 2021). Since dairy cows consumed the majority of the farm feed supply, they were responsible for 80% of all emissions. Because manure was applied frequently throughout the year, manure emissions (15%) were low (Wiesner *et al*., 2020). These challenges have resulted in low productivity and profitability of the dairy sector, which has led to a decline in the livelihoods of smallholder farmers who depend on it (Gebreyohanes *et al*., 2021). In order to concurrently address food security and climate change mitigation, developing countries must overcome numerous obstacles in order to grow and develop their dairy industry sustainably (Tricarico *et al*., 2020). The best feeding and nutritional management techniques to reduce the amount of methane produced during rumination include

Citation: Abera Geleta Sime and Bekana Selgan Duguma. Advancing Sustainable Dairy Cattle Production: Future Prospects in Ethiopia: A Review. Austin J Vet Sci & Anim Husb. 2025; 12(4): 1178.

dietary manipulation, by increasing the amount of concentrate and improved forage crops, as well as chemically treating crop residue and pasture hay, fat supplementation, and the addition of feed additives like saponins, tannins, and essential oil (Feyissa *et al*., 2022; Mijena and Getiso, 2022). The demand for the consumption of milk, the creation of favorable policies, the improvement of the quantity, quality, and distribution of dairy products in Ethiopia, as well as local knowledge, access to services and land inputs, are all made possible by dairy farming (Guadu and Mengistie, 2016). The most important dairy opportunities in the country are the availability of official milk selling channels and agro-industrial by-products (Didanna *et al*., 2019). To increase the sustainability of the dairy business, the Ethiopian government is implementing a number of programs. The National Dairy Development Strategy, for instance, was created by the government with the intention of raising milk output, enhancing the quality of dairy products, and improving the standard of living for smallholder farmers (Gebreyohanes *et al*., 2021). The adoption of modern agricultural technologies in Ethiopia's dairy production system, either in isolation or in combination, has been shown to enhance farmers' livelihoods, production, and the welfare of farmed animals which stimulate rural development, and the fight against poverty and maintaining environmental sustainability (Zegeye *et al*., 2022 ; Korir *et al*., 2023). Therefore, understanding Ethiopia's dairy production and future sustainability is incredible.

Dairy Production Systems

Dairy production in Ethiopia is subsistence smallholder-based and characterized by low production and productivity (Gebreyohanes *et al*., 2021). Even though dairying has not been properly utilized and promoted in Ethiopia, it is one of the subsectors of livestock production that supports the owners' way of life by providing significant sources of food and revenue (Beyene *et al*., 2015). Dairy production in Ethiopia is classified into four major systems: pastoralism, highland smallholder, urban and pre-urban, and intensive dairy farming (FAO, 2018; Fekata, 2022). The majority of milk production in Ethiopia comes from cows, but small quantities of milk are also obtained from goats and camels in some regions, particularly in pastoralist areas.

Pastoralism

One of the livestock production techniques used in practically every country in the world, including Ethiopia, is dairying, which involves a huge number of small, medium, and large farms that are either market-oriented or subsistence-oriented. Pastoral groups understand well the importance of milk to their diets. The best milk for children's overall health, strength, and growth in pastoral areas comes from camel and goat milk (Getabalew and Alemneh, 2019). Pastoral/agro-pastoral production is the primary form of milk production used in Ethiopia's lowland areas, where dairy cows constitute a major source of income. Large pastoral grounds connect the northeastern and eastern lowlands of Afar and Somalia to the south and southwest lowlands of Borana and South Omo (FAO, 2019; Fekata, 2022). In the lowlands, this system of dairy farming system is the main source of milk production and about 40 percent of the herd consists of cows. However, milk production is limited and heavily dependent on the pattern of rainfall and related factors (FAO, 2019).

Highland Smallholder

The majority of milk production method is a mixed subsistence smallholder farming system, where crop and livestock husbandry are usually done under one management unit. Almost three quarters of the liquid milk that is properly processed and the majority of milk produced nationally (FAO, 2019). Natural grass, crop wastes, weeds, and crop thinning are the primary feed sources. Around 65% of the total milking cows are located in this system, which yields around 72% of the country's yearly milk production and the majority of the management style is a typical extensive way of low-input, low-output (FAO, 2017). With this production method, minimal amounts of crossbred cattle and native breeds account for the majority of milk output and the majority of milking cows are local animals with low productivity levels. Even though milk production in the mixed crop-livestock system is not primarily market-oriented, it is vital for providing the majority of milk and milk products to the Ethiopian population. In addition to productivity being incredibly low per animal head and per unit of land, inadequate facilities, especially in the veterinary field, render the area vulnerable to disease outbreaks and losses to mortality and morbidity (Fekata, 2022; FAO, 2019).

Urban and Peri-Urban

Urban and peri-urban milk production system developed in and around major cities and towns which have a high demand for milk (Gebreselassie, 2019). For low-income households in Ethiopia, urban and peri-urban small-scale dairy farming is essential for enhancing household income, nutrition, food security, and employment (Duguma, 2022). In most Ethiopian towns, the peri-urban and urban dairy cattle production methods are used with little to no land resources for milk production and sale (Dekebo and Kebede, 2023). Utilizing an expand management system Compared to other dairy cattle production systems, urban systems have better access to services and inputs to the public and private sectors (Gebreselassie, 2019). The main obstacles to urban and peri-urban dairy production systems were high feed costs, land scarcity, space limits, and feed quality availability (Alemu, 2019; Duguma, 2022). In spite of this, it offers chances to generate cash for the family and serves as a reserve bank where goods or animals could be sold to pay for living expenditures, educational costs, and medical expenses (Lombebo and Wosoro, 2019).

Intensive

In Ethiopia, intensive dairy farming is becoming increasingly popular (Tschopp *et al*., 2021). High input and output levels per animal as well as per unit area define this milk production method. The Ethiopian highlands in the center, where there is great potential for dairy expansion, are the primary locations for the production of milk. A highly specialized agricultural method used by the state sector and a small number of private farmers is commercial dairy production (Moti *et al*., 2020). Geographically, they are largely situated in the central highlands, close to big cities and towns (FAO, 2019). A key element of Ethiopia's milk production systems is the use of cross-bred dairy cows, purchased and saved feed, enhanced income, the creation of jobs, the recycling of organic waste, and market-oriented

systems (Fekata, 2022). Commercial milk is an increasing sub-system in Ethiopia, driven by the unprecedented increase in demand for milk and other dairy products. The majority of commercial farmers are expected to process their milk into various dairy products, but not all are able to do so due to lack of infrastructure and financing (Shapiro *et al*., 2015; FAO, 2017).

Challenge and Consequence of Dairy Production Systems

The issues facing associated with the dairy industry differ vary between areas and within production systems (Getaachew *et al*., 2022). Ethiopian dairy farmers deal with a wide range of concurrent issues, such as animal health, nutrition, hygiene, waste management, and housing, poor genetic resources, insufficient training services, and inadequate access to credit which hinder the growth of the country's dairy industry (Gebreyohanes *et al*., 2021; Nyokabi *et al*., 2023). These challenges have reduced the dairy industry's productivity and profitability, which has lowered the livelihoods of the smallholder farmers who depend on it (Gebreyohanes *et al*., 2021).

Limited to Access Improved Breeds

Due to their low genetic potential, dairy cooperatives had very little potential for productivity (Misganaw *et al*., 2017). Because of their genetic tendency to produce very little milk, local breed of cows predominate in the environment. As the primary bottlenecks in the sector, achieving greater productivity and milk production are the focus on it (Sander *et al*., 2021). Limited market accessibility, lower milk yield due to inferior breeding services, and seasonal price fluctuations greatly hinder dairy production (Moges *et al*., 2019).Poor genetic resources have resulted in low milk yields and poor animal health, which has led to a decline in the quality of dairy products (Gebreyohanes *et al*., 2021). Lack of superior dairy cattle breeds was hindering dairy development in the country (Tsegaye *et al*., 2022).

Feed Limitation

The primary challenge, regardless of the dairy production technique and agro-ecology, is the scarcity of feed, both in terms of quality and quantity (Gobena, 2016 ; Belay, 2020). The main supplementary feeds for dairy cattle in Ethiopia are crop residues, natural pasture, various agro-industrial byproducts, and locally accessible by-products. However, these feeds frequently don't contain enough macro and micro mineral concentrations (Bekele *et al*., 2019). The problem of low feed supply was made worse by tiny land holdings, particularly in urban and peri urban settings where farmers had small plots of land and no space left over to produce fodder. Farmers and purchasers competed for grass in urban areas because it was needed for coffee ceremonies, which were held in restaurants and cafes, as well as for decoration for religious and national festivals (Nyokabi *et al*., 2023). There are other consequences from these challenges, and the lack of feed has decreased milk production, which has decreased farmers' income (Gebreyohanes *et al*., 2021).

Lack of Veterinary Service and Market Linkages

In intensive zero-grazing systems, where dairy animals were confined to a single area with poor foot hygiene (wet foot and no bedding), cattle arthritis and body sores were widespread (Nyokabi *et al*., 2023). Inadequate veterinary services have led to an increase in the prevalence of diseases, which has further reduced milk production and quality (Gebreyohanes *et al*., 2021). The price that milk shops offer and the method of payment are the crucial elements that influence consumers' decision about market outlets (Mengistu and Meressa, 2023). Limited market accessibility, diseases, inadequate veterinary care and seasonal price fluctuations greatly hinder dairy production (Moges *et al*., 2019; Belay, 2020). Disease and a distance from marketing locations were an obstacles of dairy development in the country (Tsegaye *et al*., 2022). The expansion of dairy farming generally and farmers' choices for high-paying marketing channels like cooperatives and milk processing plant outlets are hindered by their lack of access to institutional financial sources for lending services (Mengistu and Meressa, 2023).

Knowledge Gap and Training

Affordability, restricted access to knowledge and training, which is a significant barrier to quality, and increased milk production are some of the obstacles that prevent the adoption of innovative methods and technology (Akzar *et al*., 2019; Janssen and Swinnen, 2019). Insufficient training services have led to a lack of knowledge and skills among farmers, which has further reduced productivity and profitability (Gebreyohanes *et al*., 2021). The majority of dairy owners have lesser educational backgrounds, which could have a big impact on their ability to manage and their willingness to accept new technologies (Bekele *et al*., 2019). Inadequate access to credit has limited the ability of farmers to invest in their businesses, which has further reduced their income and livelihoods (Gebreyohanes *et al*., 2021). Lack of knowledge about better production and marketing techniques was hindering dairy development (Tsegaye *et al*., 2022).

Opportunity and Future Sustainability

There are numerous prospects for the development of the dairy industry because of the country's diverse flora and agro ecological types, which have given native knowledge of how to preserve milk and its products in the dairy farming system by using a variety of herb sources (Gebreselassie, 2019). The Ethiopian government has implemented several initiatives to improve the dairy industry's sustainability. For instance, the government has established a National Dairy Development Strategy that aims to increase milk production, improve the quality of dairy products, and enhance the livelihoods of smallholder farmers (Gebreyohanes *et al*., 2021). The strategy focuses on improving the dairy value chain by addressing the challenges faced by smallholder farmers, such as access to finance, improved animal health, and better market linkages (Gebreyohanes *et al*., 2021). The demand for milk is anticipated to rise further in the upcoming years as a result of population growth and rising per capita consumption (Getaachew *et al*., 2022). The government has also established milk collection centers to improve the efficiency of milk collection and reduce post-harvest losses (Gebreyohanes *et al*., 2021).

Breed Improvement Programs

To increase productivity and milk output, high-yielding dairy breeds are being introduced and promoted. Crossbreeding was the primary method used to improve genetics, and the milk yield of the crossbred cows is three to five times higher than that of the traditional production system (Hunde, 2018). Golden prospects in

dairy production were identified as the strong demand for milk and milk products, the suitable agro-ecology for animals, and the high milk yield from cross-breed dairy cows (Getachew and Tadele, 2015).

Technology Adoption

Adoption of modern dairy technology, such as improved breeds, enhanced fodder, and animal health and hygiene promotion, is promise as a driver of rural development and poverty reduction and is crucial to boost production, farmer profits, and the welfare of poor farmers (Janssen and Swinnen, 2019). Using more dairy technologies may be preferable in terms of productivity increases than adopting fewer technologies, and the deployment of one technology may not be independent of the implementation of another because many of them may be complementary (Akzar *et al*., 2019). Adoption of contemporary technologies, either in isolation or in combination, has been shown to enhance farmers' livelihoods, production, and the welfare of farmed animals which stimulate rural development, and the fight against poverty and maintaining environmental sustainability (Zegeye *et al*., 2022 ; Korir *et al*., 2023). Therefore the adoption of modern technologies such as improved feeding practices, better animal health management, and efficient milk processing techniques can contribute to increased productivity and quality for sustainability.

Capacity Building and Market Development

Smallholder farmers are adopting hygienic milking, milk handling and storage practices, biosecurity, and animal health technologies to ensure improved milk quality as a result of growing consumer awareness of food safety risks, food safety legislation, and rising standards of milk quality demanded by dairy processors (Burkitbayeva *et al*., 2019). Training programs and knowledge transfer initiatives are being conducted to enhance the skills and knowledge of dairy farmers, extension workers, and other stakeholders in the sector. Increasing farmer access to extension services and having development specialists and agricultural professionals provide technical oversight are essential to improving farmers' usage of marketing channels. This suggests that extension services could aid in enhancing farmers' perceptions of the advantages of milk marketing and their knowledge of the selection process for the best milk market outlets (Mengistu and Meressa, 2023). Establishing dairy centers and milk collection facilities, transporting produce to processors, and providing related equipment and supplies are all prospects. These dairy centers are necessary to ensure proper storage and cooling conditions, boost collection volumes, ensure milk quality, and make consistent and predictable purchases from farmers (Sander *et al*., 2021).

Conclusion and Recommendation

The dairy industry contributes significantly to the global food chain by generating jobs in rural areas and supplying vital nutrients for human consumption. Ethiopia has a lot of potential for the development of dairy products because of its large population of livestock, ideal climate for breeding better, higher-yielding breeds of animals, developing market, better policy environment for private sector involvement, and generally disease-free environment for livestock. Their production in Ethiopia is classified into four major systems: pastoralism, highland smallholder, urban and peri-urban, and intensive dairy farming. There are numerous prospects for the development of the dairy industry because of the country's diverse flora and agro ecological types, which have given native knowledge of how to preserve milk and its products in the dairy farming system by using a variety of herb sources. The sector had faced several challenges including, lack of access to credit, a lack of trained labor, a lack of concentrate feed and water, a lack of sustainable breeding and milk marketing, the health and manure disposal of dairy stock, are some of the main causes of the poor performance of dairy cattle production, which results in a significant loss of production and productivity of dairy cattle in the whole country. In order to ensure a sustainable future for Ethiopia's dairy industry and to advance the country's dairy production, promote the use of superior breeds of dairy cattle, teach farmers on healthy diet and feeding practices, expand the availability of veterinary care, provide workshops and training courses; promote the formation and establishment of groups and cooperatives among dairy farmers. Further research and extension services are needed to encourage the development of policies and procedures that support farmers in effectively to ensure a sustainable future for Ethiopia's dairy industry.

Data Availability

The data used to support the findings of this review are available from the corresponding author upon request.

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