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Review paper

Review on Dairy Cattle Productive Performance under Different Production Systems in Ethiopia: Current Scenario and Future Perspective

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ABSTRACT

In the present scenario and future outlook, the efficient output of dairy cattle in various production systems in Ethiopia was reviewed. Product output parameters for dairy cattle such as daily milk yield, lactation period and average milk yield in various production systems such as pastoral and agro-pastoral (1.7±0.1liters,240±4 days and 2630±454 liters), urban and pre-urban production system (1.52±0.8 liters,610.59±0.86 days and 482.904 liters),small holder dairy production (3.9±1.6 liters , 258.81±68 days and 970.4±402 liters and intensive dairy production system (11.48 liters, 9.8 months and 3375.12 liters from Boran, Bark x jersey, horrors and cross bred cows, respectively. By using crossbred dairy cows, buying and retaining feed, rising profits, creating jobs, recycling organic waste, market-oriented systems emerge as an essential part of milk production systems in urban and pre-urban production system of Ethiopia. Commercial milk production system is more specialized; the state sector and a few private commercial farms practice market-oriented milk operations. The primary milk production in the lowland regions of Ethiopia, where livelihoods are heavily dependent on livestock, is the pastoral and agro-pastoral production system. In general, the performance of dairy cattle production in terms of daily milk yield, lactation duration, parity and average milk yield under different production systems has been poor in current scenarios. This showed that the intensification of dairy cattle production in Ethiopia should be promoted to meet growing demand for dairy products and to reduce imports of dairy commodities in order to improve milk production output in different production systems. As a result, population growth, the increase in urbanization, the increase in demand for dairy products and income would promote the growth of the output of dairy production in the future. Thus, in order to raise efficiency and productivity and thus improve the welfare of dairy cattle farmers, all the organized work of all the bodies concerned should be in progress.

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1. Introduction

Ethiopia is one of Sub-Saharan Africa's largest producers of cattle. The nation is the first among African nations and the ninth in the world to have a population of cattle. The country's total cattle population is estimated to be around 60.39 million. Of this total cattle population, about 54.68 percent are female cattle (CSA, 2018).

The development of cattle plays a multi-purpose role in providing milk, meat, fertilizer, fuel, drainage power to cattle and also as a means of economic uplift from the selling of milk and milk products. The sector accounts for 15 to 17% of gross domestic product (GDP) and 35 to 49% of agricultural GDP, as well as 37 to 87% of household income (Behnke and Metaferia, 2011).

Lower milk production efficiency is due to decreased lactation length, prolonged calving interval and late age at first calving, poor genetics and lack of quality and quantity of dairy feed, especially during the dry season (Ahmed et al., 2010). Poor nutritional status, poor breeding management, lack of own bull and artificial insemination service, longer days open, diseases and poor management practices can mean a long calving interval (Belay et al., 2012)

Due to their high nutritional value, milk and milk products play an important role in feeding Ethiopia's rural and urban populations. It is produced on a daily basis, sold for money or readily processed. It is a cash crop in the milk shed areas that helps families to buy other food items and makes a major contribution to the food security of the household (Abebe et al., 2012).

Despite having the largest cattle population in favorable climate, and potentially large market, the contribution of cattle to income and nutrition has remained very limited in Ethiopia (FAO, 2007), due to a number of reasons such as the low genetic capacity of the indigenous cattle, the poor genetic potential for productive traits, substandard feeding, poor health care and management practices (Belay et al., 2012; Ulfina et al., 2013). This resulted in very low per capita milk consumption in Ethiopia (19 liter/year) as compared to the global average of 100 litters even far below the average for sub-Saharan Africa 40 kg/year (CSA, 2013).

Formal dairy development efforts in Ethiopia began in the late 1940s (Zegaye, 2003) and have continued to date. So far, so many efforts have been made to develop milk and various research projects have been undertaken in some parts of the country, and the results and impact have not been satisfactory. Indigenous cow breeds are usually known to be small producers of milk.

They are, however, the main source of milk in Ethiopia, accounting for 98.24 percent, while 1.54 percent and 0.22 percent, respectively, were represented by hybrids and pure exotic breeds. Out of 12.39 million milking cows in the country, total milk production is currently only estimated at about 3.1 billion liters, which translates into 1.37 liters of milk per cow per day (CSA, 2018).

In fact, the production of dairy cattle in Ethiopia is generally low and, compared to its potential, its direct contribution to the national economy is small (Sintayehu et al., 2008). To this effect, different knowledge on the efficient output of dairy cattle under different production systems was evaluated on the basis of the current scenario and future perspective. Knowing the state of the present situation and future outlook is a key to this essence.

2. Objective

To review dairy cattle productive performance under different production systems in the current scenario and future perspective in Ethiopia.

3. Ethiopia's Separate Milk Production Method

Four major livestock production systems are included in the current dairy cattle production systems in Ethiopia: advanced commercial dairy production systems, pastoral and agro-pastoral production, rural production of smallholders (mixed crops and livestock) and urban and peri-urban production of smallholders. Milk, with little to no land resources, only utilizes the human and capital resources primarily made available under stall feeding conditions for advanced dairy production (Azage et al., 2013).

The Ethiopian milk production system is primarily focused on indigenous zebu cattle, which are well adapted and distributed to the country's various ecological conditions and management

systems. Although there has been no comprehensive identification and characterization work, it is suggested that there are over 25 types/breeds of indigenous cattle, including Boran, Horro, Fogera, Arsi, Karayu and Nuer, the most common ones (IBC, 2004).

4. Agro-pastoral and Pastoral

For an estimated 10 percent of the country's human population living in lowland areas, pastoralists collect about 30 percent of the indigenous livestock population that serves as the main milk production mechanism. In the pastoral and agro-pastoral systems, milk production is characterized by low yield and seasonal availability (Zegeye, 2003).

The primary milk production in the lowland regions of Ethiopia, where livelihoods are heavily dependent on livestock, is the pastoral and agro-pastoral production system. The livestock population is dominated by cattle, supplemented by camels, goats, and sheep. Major pastoral areas spread to the southern and south-western lowlands from the north-eastern and eastern lowlands (Afar and Somali) (FAO, 2017). The main milk production method is pastoral/agro-pastoral production. Cows represent about 40 percent of the herd. Major pastoral areas range from the lowlands of the north-east and east (Afar and Somali) to the lowlands of the south and south-west (Borana and South Omo) (FAO, 2019).

5. Program in Peri-urban and Urban Development

Peri-urban livestock keeping suits various livelihood strategies and contributes to food security, generation of income and jobs, saving and insurance (Azage et al., 2006). Peri-urban milk systems are primarily located in rural areas or on the outskirts of urban areas, with comparatively better access to urban centers where milk products are highly required. Market-oriented urban and peri-urban systems are emerging as a major component of milk production systems in Ethiopia. The most significant benefits are considered to be food and nutrition, increased wages, work creation, recycling of organic waste and uplifting social status. Market-oriented urban and peri-urban systems are emerging as a major component of milk production systems in Ethiopia. The most significant advantages are food and nutrition, increased wages, work creation, organic waste recycling and uplifting social status (Gillah et al., 2012). The use of crossbred dairy cows, purchased and conserved feed and stall-feeding intensifies urban and peri-urban systems (Azage et al., 2010).

The key feed tools are by goods and purchased roughages, agro-industrial. Small to medium sized dairy farms owning crossbred dairy cows are part of the scheme. Farmers use all or part of their land to grow forage (Azage et al., 2000). Agro-industrial by-products, purchased roughage, crop residue and pasture land are the main feeding services. The main aim of milk production is to produce additional cash income (Aneteneh et al., 2010).

The urban and peri-urban milk production system is an expanding system of production, mainly located in the highlands and concentrated in the milk shed area of Addis Ababa as well as in the regional capital cities, where an adequate fresh milk market is readily available. It is practiced by many poor urban and suburban landless households. Some businessmen and retired civil servants, however, still hold some dairy animals depending on hired labor, fully or partially. Market-oriented producers respond to enhanced technological, input supply and marketing services (Bogale et al., 2000; 2014).

6. Development of Mixed Crops-livestock Dairy

In the mid- and high-altitude agro-ecological zones where cereals and cash crops are dominant farm activities, mixed crop-livestock dairy production is a subsistence-oriented farming system based. Most of the total nationally produced milk and about three quarters of the commercially processed liquid milk (FAO, 2019).

The main feed types are natural grass, crop residues, and weeds and crop thinning. Most of the management style is a typical extensive method of low-input, low-output. Approximately 65% of the total milking cows are found in this system and produce around 72% of the national annual milk production (FAO and NZAGRC, 2017).

Water comes from rivers and from rainwater. The type of housing can be open kraal, partition

within the family house or sharing with humans the same space. On average, the milk yield per cow is 1.9 liters per day (Felleke et al., 2010). In this production method, milk production is largely based on indigenous breeds and on limited quantities of cross-breed cattle. Most milking cows are indigenous animals with poor production efficiency with an average first calving age of 53 months and 25 months with an average calving interval of 25 months. Feed requirements are obtained from native pasture with crop residue supplement and stub grazing from the farming system (Afras, 2018).

In the mixed crop-livestock system, milk production is critical for the supply of the bulk of milk and milk products to the Ethiopian population, even if it is not essentially market-oriented. Smallholder farmers either informally sell surplus milk to individual consumers and collectors of milk or refine it for sale into butter and cottage cheese. Productivity is extremely low per unit of land and per animal head. At the same time, poor facilities, particularly veterinary services, make it susceptible to disease outbreaks and losses due to mortality and morbidity (FAO, 2019).

7. Intensive System for Dairy Production

Intensive systems of dairy production are located in and around Addis Ababa and essentially maintain high-grade or purebred dairy stocks (Azage et al., 2000). Small to large-scale dairy farms are commercial farms, with large-scale farms clustered in and around Addis Ababa. The herd is dominated by enhanced dairy cattle and the production system is market-oriented and milk production (surplus production) is for sale (Ahmed et al., 2003). Geographically, near major cities and towns, they are concentrated mostly in the central highlands. More than 100 milking cows for large-scale farms can be typical herd sizes; 30-100 for medium-scale and <30 for small-scale farms (FAO, 2019)

Commercial milk is an increasing sub-system in Ethiopia, driven by the unprecedented increase in demand for milk and other dairy products. However, the scarcity of inputs, in particular feed, genotypes, and veterinary services, is limited. Most commercial farmers are expected to turn their milk into different dairy products, but not all have the financial and infrastructural capacity to fulfill these obligations (Shapiro et al., 2015; FAO, 2017).

Table 1. Dairy cattle production performance under different production system

Production system	Breed	DMY	LL	AMY	Reference
Pastoral and agro-pastoral	Borana	1.7±0.1	240±4	2630±454	Haile et al. (2010)
Small holder dairy production	Barka x Jersey	3.9±1.6	258.81±68	970.4±402	Tesfaye Kumsa (2018)
Urban and pre-urban	Horro breed	1.52±0.8	610.59±0.86	482.904	Demissu (2014)
Intensive dairy production	Cross breed	11.48	9.8	3375.12	Zenebe et al. (2016)

DMY= Daily milk yield, LL= Duration of lactation, AMY= Median milk yield Ethiopia's Dairy Production Success

8. Regular Yield of Milk

The average daily milk yields are 1.37 and 6.5 liters, respectively, for indigenous and crossbred dairy cows (CSA, 2018). Farmers had more cattle in western Oromia in highland and midland agro-ecological areas than other livestock species (Mekonen et al., 2012). The majority, however, are indigenous and only a few cross-bred cows with milk production of 2.2 and 6.5 liters per day were raised (Ulfina et al., 2013).

Damissu et al. (2014) recorded very low daily milk production (1.5±0.03) for Horro cows, which is the western dominant breed of cattle. Wassie et al. (2014) also recorded low daily milk yields for Friesian x Arsi and Friesian x Boran, respectively, of 6.38± 0.09 and 7.02± 0.11liter per day. Zelalem (2011) recorded that, on average, indigenous cattle breeds do not yield more than 1.25 kg of milk per cow per day in high and mid-altitude areas. The North Showa zone study shows that 50 percent of cross breeds (1511.5 liters) yield more milk than local breeds (457.89 liters) per lactation (Mulugeta and Belayneh, 2013). The difference in milk yield was due to differences in management conditions and exotic gene inheritance levels in crossbred animals (Zewdie, 2010).

Table 2. Average milk yield performance of Zebu breeds and crossbred cattle (location: Ethiopia)

Breed	Daily milk yield in liters	Reference
Native	1.37	CSA (2018)
Horro	1.5±0.03	Damissu et al. (2014)
Friesian x Arsi	6.38± 0.09	Wassie et al. (2014)
Friesian x Borana	7.02± 0.11	Wassie et al. (2014)

9. Lactation Cycle Period

The length of lactation is defined as the time between two consecutive calves during which cows can produce milk or lactation (Amasaib et al., 2008). As it affects the total milk yield, lactation length is an important manufacturing characteristic. A lactation period of 305 days is widely recognized as a standard for most modern dairy farms. This norm allows for calving every 12 months with a 60-day dry period. The 12-month interval has deemed "Ideal" for several years. If a cow is milked for more than 305 days, her yield is taken as the lactation yield for the first 305 days. Some cows do not milk for a full 305 days because, for any of many reasons, they go dry or the lactation stops (Zewdu et al., 2013).

Lemma et al. (2005) reported that local cows in the East Showa region of Oromia had a longer lactation length of 9.5 months. Study conducted in the North Showa zone found that local breeds had a shorter lactation period (273.9 days) than cross breeds 333.9 days (Mulugeta and Belayneh, 2013). Zewdie (2010) recorded that in Debre-Birhan, Jima and Sebeta, the average lactation period of crossbred dairy cows was 291,288 and 300 days, respectively. The genetic community and parity have an important influence on the duration of lactation (Kumar et al., 2014).

Table 3. Average Lactation length in days (location: Ethiopia)

Breed	Lactation length in days	Reference
Arsi	272	Gabriel et al. (1983)
Boron	211	Gebregziabher et al. (2013)
Horro	234	Gebregziabher et al. (2013)
Begait	184	Rege et al. (2006)

10. Normal Milk Lactation Yield

The lactation output of dairy cattle is typically determined by determining total milk yield, average daily milk yield, and lactation period, per lactation or per year (Zewdu et al., 2013). Management, diet, turn of lactation or the age, year and season in which lactation began are the key environmental factors influencing the success of lactation in cattle (M'hamdi et al., 2012). The difference in milk yield from lactation is primarily caused by genetic and various non-genetic factors. Genetic community, herd size, calving season, and parity have a major impact on the yield of lactation milk (Kumar et al., 2014).

Table 4. Average lactation milk yield in liters (location: Ethiopia)

Breed	lactation milk yield in liters	Reference
Fogera	270	Rege *et al.* (2006)
Arsi	809	Gabriel *et al.* (1983)
Boron	947	Gebregziabher *et al.* (2013)
Horro	1201	Gebregziabher *et al.* (2013)
Begait	645	Rege et al. (2006)

11. Conclusion

The efficiency of dairy cattle production under different production systems has been checked. The level of input and intensity of production, agro-ecology and consumer orientation were very different on the basis of the integration of the dairy cattle production system with crop production. Under different production systems, dairy cattle production output such as daily milk yield, lactation period, average milk yield and parity were distinct. Pastoral, agro-pastoral, mixed crop dairy cattle production, urban and peri-urban dairy farming and intensive dairy production systems have been established in different production systems. The main milk production method practiced in the lowland regions of Ethiopia, where livelihoods are heavily dependent on dairy cows, is pastoral/agro-pastoral production. Major pastoral areas stretch to the southern and south-western lowlands of Borana and South Omo from the north-eastern and eastern lowlands of Afar and Somali. In the mixed crop-livestock system, milk production is critical for the

supply of the bulk of milk and milk products to the Ethiopian population, even if it is not essentially market-oriented. Productivity is extremely low per unit of land and per animal head. At the same time, poor facilities, particularly veterinary services, make it susceptible to disease outbreaks and losses due to mortality and morbidity. Through the use of cross-bred dairy cows, purchased and preserved feed, increased income, jobs generation, organic waste recycling, market-oriented systems, intensive, urban and peri-urban milk production is intensified as an essential part of milk production systems in Ethiopia. In general, the performance of dairy cattle production in terms of daily milk yield, lactation period and average milk yield under different production systems has been poor in current scenarios. This showed that the intensification of dairy cattle production in Ethiopia should be promoted to meet growing demand for dairy products (population growth, changes in dietary preferences/wealth and urbanization) and to minimize imports of dairy commodities in order to increase milk production output in different production systems. Thus, in order to raise production and productivity and thus improve the welfare of dairy farmers, all the organized work of all the bodies concerned should be in progress.

12. Future Perspective

There is a need to improve a variety of factors that could affect the development and potential consumption of dairy products, competition for land and water, climate change, the role of socio-cultural drivers and ethical issues. The vital shortages of feed, animal health, water supply availability, the effect of climate change on milk production, and pastoral and agro-pastoral animal welfare should be improved. The numerous dairy production systems, such as pastoral and agro-pastoral, urban and pr-urban, mixed dairy production systems and extreme dairy production systems, should be researched in depth. The proposed livestock master plan initiatives in our country would increase commercial-scale specialized dairy units and, if properly implemented, boost milk production from indigenous dairy cattle breeds through artificial insemination and synchronization in the milk shad region. Smallholder interest in the fluid milk markets of the Ethiopian highlands will be supported by dairy cooperatives and milk associations. Increasing milk production has become a major policy choice, both to meet the rising demand for livestock products and to contribute to improving household incomes at the same time. Specialized milk production systems are being enhanced through improved genetics, feed and health facilities, and quantity units are being increased to increase the number of milk cows and the contribution of specialized milk producers to national milk production. The milk cow extension system, which could enhance the provision of veterinary services and effective technology to increase the availability and quality of feed for dairy farmers, has to be improved. Coordinated work should therefore be conducted by all the bodies concerned to increase production and productivity and thereby improve the livelihoods of dairy farmers.

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